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Digital Therapies in Psychosocial Rehabilitation and Mental Health

Antonio Jose Pereira da Silva Marques and Ricardo Queirós

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Digital Therapies in Psychosocial Rehabilitation and Mental Health

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Detailed Table of Contents

Several people with mental health problems do not receive suitable treatment and often avoid or delay seeking help due to concerns about being treated differently and other practical barriers (for example, services costs and unavailability). The mobile health concept has gained more enthusiasts worldwide exactly because it helps mitigate some of these issues. However, despite the emerging scientific evidence in the last decade that proves the efficacy and safety of these interventions, professionals have shown some doubts and worries about their implementation, especially in the mental health field. Thereby, this chapter provides a review on the subject, presenting several mobile applications for mental health problems and also the expectations and needs of health professionals and users for development and implementation of a mobile application.

Depression is a prevalent and severe medical illness that negatively affects how people feel, think, and act, with estimates pointing towards more than 300 million suffering from depression worldwide. Although effective treatments exist, about 80% of people in low and middle-income countries do not receive therapy. Therefore, technology has become a promising tool to assist in reducing disparities.

This study aims to identify and map the available evidence on mobile health applied to depression and clarify key concepts. The authors analyzed clinical trials developed over the last five years. EBSCO and PubMed were searched, and a total of 14 conducted RCTs were selected and reviewed. Despite some limitations regarding dropout rates and several ethical and safety concerns, the mobile mental health future seems promising.

Intervention in mental health urges new solutions that merge solid theoretical foundations and new possibilities provided by technological development. This chapter is structured around results from a data mining technique using VOSViewer, which organized the field into five clusters of published literature: (1) most affected populations, (2) mental illness/disorders and their impact, (3) the expansion of remote interventions, (4) ICT potential to overcome limitations and (5) a positive approach to ICTs in mental health care. Solutions and recommendations are presented to overcome the issues identified, including how future interventions should consider old and new issues as the ones raised by the COVID-19 pandemic. Computer-based or web-based interventions are hereby presented as part of the revolution towards digital mental health or e-mental health. This approach has the potential to deconfine interventions, releasing them from the traditional settings and reaching new populations. It also reinforces the path already started, from the secondary to the primary and primordial prevention, towards the modification of the psychopathological trajectories.

The literature has recognized peer support as a fundamental part of the recovery process for people with severe mental illness (SMI). These populations frequently experience barriers related to (self) stigmatization, social relationship, poor friendship quality, ostracism, isolation, and fear of being rejected or embarrassed. Scientific research suggests those individuals are more willing to share personal and sensitive details through digital technologies, building friendships and using the internet to access health information rather than their peers who do not experience SMI. The purpose of this chapter is to explore

Section 5
Virtual Reality in Psychosocial Interventions

Preface

INTRODUCTION

Digital health is the convergence of digital technologies with health, to enhance the efficiency of healthcare delivery and make healthcare more personalized and precise. The discipline involves the use of information and communication technologies to help address the health problems and challenges faced by people under treatment. These technologies include both hardware and software solutions and services, including telehealth, wearable devices, augmented reality, virtual reality, mobile apps, among others. Generally, digital health is concerned about the development of interconnected health systems to improve the use of computational technologies, smart devices, computational analysis techniques, and communication media to aid healthcare professionals and their patients manage illnesses and health risks, as well as promote health and wellbeing. Digital tools will play a central role in the most promising areas of healthcare innovation. In future, healthcare can be more integrated, value-based and with a stronger focus on patient outcomes.

Digital therapeutics treatments are usually defined as "evidence-based therapeutic interventions that are driven by software programs to prevent, manage, or treat a broad spectrum of physical, mental, and behavioral conditions. Digital therapeutics have the potential to address unmet patient needs that traditional treatments and therapies have been unable to provide.

This book is a reference guide for mental health professionals and technology providers involved in the ongoing digital transformation of the healthcare sector. The book presents a comprehensive state-of-the-art approach to digital mental health technologies and practices within the broad confines of psychosocial and mental health practices. It provides a canvas to discuss emerging digital mental health solutions, propelled by the ubiquitous availability of personalized devices and affordable, easy to use wearable sensors, and innovative technologies like virtual and augmented reality, mobile apps, intelligent platforms, among others.

GOALS

Digital technologies are currently dramatically changing healthcare. This book introduces the reader to the latest digital innovations in the mental health field, points out new ways in patient care and describes the limits of its application.

The main goals of this book are:

- To provide an understanding of the current state of digital mental health interventions and the factors influencing the ongoing transformation of the mental health sector.
- To describe the important role of emerging technologies in the prevention, diagnosis and treatment of different neuropsychiatric disorders.
- To present case studies from innovative digital mental health interventions
- To provide a set of templates and frameworks for developing and implementing a digital mental health sector roadmap.

This book will be submitted to be indexed in Scopus, which will increase their visibility and interest to the community.

The target audience comprises professionals and researchers working in the field of Digital Health Technologies in healthcare, more precisely, in Digital Therapies in Psychosocial Rehabilitation and Mental Health. The following group of people should be highlighted:

- Health sciences professors and students;
- Researchers;
- Practitioners of healthcare companies;
- Managers and other professionals where Digital Health Technologies can be useful.

DESCRIPTION AND ORGANIZATION OF THE BOOK

All fifteen chapters help to understand the present and shape the future of Digital Health Technologies. For accomplishing it, the book is divided into six sections:

1. Mobile Mental Health
2. Computer-based or Web-based of Psychosocial Interventions
3. Gamification and Serious Games in Mental Healthcare
4. Artificial Intelligence in Mental Health
5. Virtual Reality in Psychosocial Interventions
6. Biosensors

The first section of this book, entitled “Mobile Mental Health” has two chapters. This first chapter, entitled “Mobile Mental Health: Opportunities and Challenges” (1), presents the state of art of mobile mental health. The authors will review mobile applications used in the context of mental health and psychosocial rehabilitation, identifying frameworks and guidelines on how they should be developed in a multidisciplinary perspective, in a process not only centered, but participated by the end user. The second chapter, entitled “Mobile Mental Health for Depression Assistance: Research Directions, Obstacles, Advantages, and Disadvantages on Implementing mHealth” (2), is focused on contributing to the increase of the use of technologies in mobile mental health for depression assistance, closing the gap between theory and field application of principles, towards a more inclusive world and promoting health and well-being for all.

The second section of this book, entitled “Computer-Based or Web-Based of Psychosocial Interventions” has four chapters. This first chapter, entitled “The Road to Digitally-Driven Mental Health

Services: Remote Psychological Interventions" (3), emphasizes the importance of health services for digitally-driven mental health towards the improvement of the knowledge about an area that has peaked in the past year due to the COVID-19 pandemic. The second chapter, entitled "Digital Peer Support for People With Severe Mental Illness: Key Concepts and Findings Overview" (4), aims to explore the new paradigm of digital peer support as an emergent approach in psychiatric interventions due to its potential of accessibility and ubiquity. As an alternative psychiatric intervention, peer-to-peer support is presented as a mutual aid provided by people who share similar experiences concerning mental health challenges. This service aims to promote hope through a path of understanding and connection, decreasing social isolation. The third chapter, entitled "Web-Based Psychotherapy and Exercise Interventions for Depressive and Anxiety Disorders" (5), researches on the effectiveness of web-based exercise and psychotherapy interventions more precisely concerning the interventions related to web exercise as monotherapy or the combination of web exercise plus web psychotherapy. The study presented concludes that it is important to have a multidisciplinary approach to mental health issues, which is even more important regarding web-based interventions with different subject approaches such as psychological and exercise approaches. The fourth chapter, entitled "Digital Technologies in Dementia Care" (6), addresses how digital technologies can be useful in people with dementia (PwD). The goal of the chapter is to provide a brief overview of the main topics in this field and list some examples of useful digital tools. grouped considering two major functions: (1) to promote independence and safe participation of PwD in all areas of occupation, which include digital solutions for monitoring, assistance in daily activities, and facilitation of leisure and social participation; and (2) to provide therapeutic experiences that seek to delay cognitive decline and diminish BPSD, encompassing diverse non-pharmacological interventions.

The third section of this book, entitled "Gamification and Serious Games in Mental Healthcare" has three chapters. This first chapter, entitled "Digital Games and Mental Health: A Scoping Review on Gaming Disorder in the Last Decade" (7), summarizes a scoping review that clustered twenty-one open access articles available on an online database platform. It focuses primarily on the relationship between digital games and mental health in the last decade. Note that the choice of open access articles relates to the open science principles advocated by the authors. The second chapter, entitled "Gamification Applied to Autism Spectrum Disorder" (8), surveys in the area of gamification and serious games applied to Autism Spectrum Disorders symptoms and associated comorbidities. The third chapter, entitled "Gamification in Stroke Rehabilitation" (9), explores the effects, advantages, and disadvantages of the use of serious games in post-stroke upper limb rehabilitation. Authors also aim with this work to compare the obtained results between the use of conventional therapy and gamification.

The fourth section of this book, entitled "Artificial Intelligence in Mental Health" has two chapters. This first chapter, entitled "Artificial Intelligence in Digital Mental Health" (10), surveys on the use of Artificial Intelligence (AI) for the diagnosis and understanding of mental disorders. AI techniques can offer the ability to develop better prevention tools and formulate models to determine a predisposition or risk of developing mental illness. The second chapter, entitled "AI Chatbots in Mental Health: Are We There Yet?" (11), presents a comprehensive and comparative presentation of the state of art of AI chatbots relevant for mental health, including a critical analysis of weak and strong points of each application. Authors also provide an analysis of how these applications and tools can profit from the inclusion of key stakeholders and potential users right from the design phase and overcome some of the most common obstacles and flaws faced by the most used chatbots. Finally, the authors explore the technical boundaries and the current technical limitations of AI and chatbots, how those limitations are an obstacle to better applications and what the immediate landscape in terms of new developments in conversational AI looks like.

The fifth section of this book, entitled "Virtual Reality in Psychosocial Interventions" has three chapters. This first chapter, entitled "Virtual Reality and Forensic Mental Health" (12), assembles a brief context of Virtual Reality technology and Forensic Mental Health and provides an overview of the studies already made in this area. Furthermore, with the purpose of reinforcing the utility of VR in forensic psychiatry, the authors present the advantages and the barriers of this application, in addition to future recommendations to overcome them. The second chapter, entitled "Usability and Applications of Virtual and Augmented Reality in Older Adults" (13), maps and presents, in a descriptive way, the available evidence about the usability and applicability of VR and AR technologies in interventions aimed at mental health and psychosocial rehabilitation of the elderly population. The third chapter, entitled "Virtual Reality Environments in Pain Management" (14) researches the area of pain therapies, more precisely, it explores the use of Virtual Reality to improve the quality of life of people who experience any pain. Using these technologies does not annul the analgesic treatment but serves as an adjunct to the existing therapies. However, VR is beneficial when associated with traditional therapies, as it allows for significant reductions in pain perception, cognitive pain (time spent thinking about pain), affective pain (emotional discomfort), and sensory pain.

The last section of this book, entitled "Biosensors" has only one chapter, entitled "Biosensors, Biofeedback, and Neurofeedback" (15), which focus on the processes of biofeedback, giving an insight about the sensors that might be used, the overall concept of biofeedback, as well as the evidence regarding the effectiveness of neurofeedback for the treatment of some mental disorders. The main goal is to provide an introduction to the biofeedback as a self-regulation technique, used now for more than fifty years, with concise information about the sensors that might be used to detect the most common measured responses, the main types of physiological biofeedback, and the state-of-the-art evidence about neurofeedback as a form of brain training for individuals with the most prevalent mental disorders.

CONCLUSION

This book, aligned with the goals and vision of the World Health Organisation Global Strategy on Digital Health 2020-2025, intends to improve mental health and psychosocial rehabilitation for everyone, everywhere by systematizing and making accessible different person-centric digital solutions. It also wants to enhance and foster research and development, innovation, and collaboration across sectors to facilitate the introduction of appropriate and efficient digital psychosocial interventions that benefit people living with mental illness in an ethical, safe, secure, reliable, equitable, and sustainable way.

Acknowledgment

First of all, we thank all the authors, reviewers and the editorial board who contribute to this book's success. Then, a particular thanks to IGI and their editorial team for the help provided during the editing process.

Section 1

Mobile Mental Health

Chapter 1
Mobile Mental Health:
Opportunities and Challenges

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ABSTRACT

Several people with mental health problems do not receive suitable treatment and often avoid or delay seeking help due to concerns about being treated differently and other practical barriers (for example, services costs and unavailability). The mobile health concept has gained more enthusiasts worldwide exactly because it helps mitigate some of these issues. However, despite the emerging scientific evidence in the last decade that proves the efficacy and safety of these interventions, professionals have shown some doubts and worries about their implementation, especially in the mental health field. Thereby, this chapter provides a review on the subject, presenting several mobile applications for mental health problems and also the expectations and needs of health professionals and users for development and implementation of a mobile application.

INTRODUCTION

Mental health problems are a global challenge that affect a large number of people of all ages and from all social status. According to the World Health Organization (WHO), 4.4% of the world population, about 322 million people, suffer from depression and 3.6%, about 264 million people, from anxiety (WHO, 2017).

Due to the costs associated with treatment, many individuals who experience mental health problems do not receive timely professional care. But cost is not the only contributing factor; other reasons include a shortage of specialized professionals, difficult access to services, and the stigma yet associated with mental illness.

At the same time, the use of digital therapies is increasingly spreading and the enthusiasm for combining mobile technologies in support of healthcare has led to the appearance of a new interdisciplinary field called mobile health (mHealth). According to data from the report "The New Decade of Health and Science" (IQVIA Institute, 2021), Covid-19 has been a catalyst for change, promoting remote and

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virtual models of healthcare. Nowadays, more than 10.000 mental health applications are available for download (Carlo et al., 2019). Although applications focused on well-being in general still represent the majority of software of this kind, the number of those focused on managing mental health conditions is increasing.

In this context, smartphones have come to stand out as attractive platforms for mental illness self-management and psychosocial rehabilitation because they are easily accessible, can be carried anywhere by the user and, obviously, have the ability to connect to the Internet. Mobile Health presents several purposes, from prevention to intervention: allows its users to better manage their condition by giving them reminders to take their medication, tracking mood patterns, providing coping and problem-solving strategies, delivering cognitive-behavioral interventions, collecting vital signs by sensors, and so on.

mHealth interventions have several benefits: (1) allows the users to use them 24/7 in a portable and flexible way; (2) might reach people who would otherwise not seek treatment; (3) it is easy and intuitive since most people already use their mobile phones and other applications on a daily basis, and the youngest are already considered digital natives; (4) could be used to deliver large-scale interventions in emerging and low-income economies where resources for mental health are scarce; and (5) individuals can be supported in applying treatment-related skills in real life situations, in which behavior change is at its most vulnerable, and clinicians often struggle to support individuals appropriately (Weisel et al., 2019).

Throughout the technological evolution, different functionalities of mobile phones have been used: calls, text messages, emails and more recently mobile applications. Regarding this last item, recent research on the creation of chatbots or virtual assistants has proliferated. Maybe some users find it easier to share potentially embarrassing information with a "virtual therapist"; when patients talk to a psychotherapy bot, they report not feeling judged. In addition, these systems are always available and can offer a much higher frequency of therapeutic interactions compared to a human therapist.

Despite this great interest in the use of mobile applications in the area of mental health, the level of scientific evidence in most of these mobile applications, is relatively low or non-existent. Some trials showed the potential of apps targeting mental health symptoms, but using smartphone apps as stand-alone psychological interventions cannot be recommended based on the current level of lack of evidence (Weisel et al., 2019). What many authors have suggested, is the complementarity with the preferred therapy, whenever possible. These mental health mobile applications seem to contribute to helping its users to engage in health-promoting behaviors outside the clinical context or in other activities such as therapeutic homework and facilitating the generalization and transfer of skills. Obviously, we should pay attention to the applicability to different populations – for instance, young people and older adults will have different needs which could lead to different apps or different features of the same app.

Given the need for instruments to assess the quality and effectiveness of mobile apps before they become publicly available, the American Psychiatric Association (APA) has developed a 4-step evaluation model for mental health apps whose result can help therapists and users decide whether an app can be used to help with treatment or not (2018). Legal regulations and guidelines on these digital therapies are also beginning to emerge in Europe and in the United States of America, which the authors will present in detail in this chapter.

Nevertheless, the user retention rate for smartphone apps in the general population is low, and reports for mental health apps show limited downloads and poor retention, especially outside of clinical trials and research settings (Bauer et. al, 2020). Continuous interaction leads to higher engagement rates which in turn leads to higher retention, and retention is one of the most important statistics to ensure your app's success in the long run. Personalized feedback and motivational support are two important structures to improve use adherence.

Considering Alqahtani & Orji (2020) study, users placed more emphasis on the user interface and the user-friendliness of the app. They valued apps that present them with a variety of options, functionalities, and content that they can choose. Users need a way to have tailored recommendations for their mental health and wellbeing needs because they are busy and often struggle to pay or find a real therapist. Another interesting issue, is that users make a choice for a mental health and wellbeing app based not only on ratings, qualifications and reviews, but also on friends, family or professionals.

Among the most common potential challenges are technical problems and factors related to telecommunication, such as system failures, reliability and sustainability of connections, security and data privacy, in addition to the identification of timely crisis management and risk of damage, elements that must be carefully considered when try to integrate smartphone technology with behavioral health care. Other pitfalls include lack of customer service and trust.

To sum up, the use of mHealth services should consider aspects such as the clinical evidence, the improvement of the quality of mental healthcare, the empowerment of the user, the training and education of professionals and users about mobile applications functioning, the sharing of information between systems, the concerns about security and ethics.

Throughout this chapter, the authors intend to address all these themes with depth and reflection, presenting the state of art of mobile mental health. The authors will review mobile applications used in the context of mental health and psychosocial rehabilitation, identifying frameworks and guidelines on how they should be developed in a multidisciplinary perspective, in a process not only centered, but participated by the end user.

TELEHEALTH ON PSYCHOSOCIAL REHABILITATION

Psychosocial rehabilitation, by definition, encompasses different therapeutic approaches that intend to help people with mental health problems, focusing on developing skills and coordinating resources. Psychosocial rehabilitation is revealed by robust and cohesive principles, which are presented below (Marques & Queirós, 2012; Nemec & Chan, 2017):

- Person-centered practice;
- Evidence of adaptations and modifications, both environmental (social and physical) as well as personal, considering those that best suit the person;
- Focus on the person's strengths and capabilities;
- Demonstration of the existence of a feeling of hope for the person;
- Optimization of the person's vocational capacities, in order to promote autonomy and independence, achievement of personal goals, to have a role in society;
- Eradicate the existing stigma in society with regard to mental illness;
- Person involvement in the treatment/ intervention process, always considering their values, experiences, feelings, ideas and goals;
- Existence of a continuous process over time.

Psychosocial rehabilitation facilitates the recovery of people with mental health problems, maintaining and improving their skills and adaptive supports. However, when face-to-face rehabilitation is not feasible, it is necessary to provide remote psychosocial rehabilitation. This approach consists of using synchronous and other asynchronous digital services. It should be noted that telephone calls are viable, however they are not sufficient to be considered a remote psychosocial rehabilitation (Rudnick, 2020).

The global pandemic of Covid-19 emphasized the role of telehealth and digital tools to provide follow-up in times of need. Even before the Covid-19 pandemic, the recognition of the potential of using technology, especially mobile technology, to support mental health was quickly increasing (Ben-Zeev et al. 2020; Buck et al. 2020; Lecomte et al. 2020). Currently, many health professionals and patients are processing the full potential of these digital tools, since face-to-face monitoring has become more difficult or even impossible (Torous, Myrick, Rauseo-Ricupero, & Firth, 2020; Rudnick, 2020).

Digital interventions have the potential to reduce the prevalence of mental illness disorders and improve mental health in populations by integrating preventive interventions to reduce incidence with clinical interventions to reduce existing cases (Taylor et al., 2020). Telehealth has been described as "the next great frontier in the efficient and effective provision of health care" (Varker et al., 2019, p. 621). This intervention is defined as the provision of psychological and mental health services through technologies and telecommunications. These modalities include telephone therapy, videoconferencing, mobile mental health applications and programs provided over the Internet. In addition, digital interventions can be described as synchronous or asynchronous. Synchronous therapeutic monitoring is interactive communication that takes place in real time, both over the phone and by videoconference, and is more similar to face-to-face. Asynchronous treatments, on the other hand, consist of emails, texts, mobile applications and online programs. Many professionals already use these asynchronous monitoring methods to check the patient's progress, provide complementary materials, online assessments and recommend mobile mental health applications or online programs. Research on online mental health monitoring provided to children, youth and adults demonstrates that interventions are feasible, acceptable and as effective as face-to-face services. For example, a recent meta-analysis of synchronous telehealth monitoring reported its effectiveness for adults with common mental disorders. Most studies have found that therapy by telephone or video-conferencing was as effective as standardized face-to-face treatment (Reay, Looi, & Keightley, 2020).

In addition, technology-enabled mental health services, such as those made available via web or through mobile applications, can help expand the reach of clinical care and decrease demand in the mental health system. There is growing evidence for the effectiveness of mental health treatment and support through mobile applications. However, digital mental health services are often not integrated into mental health systems where they have the potential to have a substantial impact (Lattie, Nicholas, Knapp, Skerl, Kaiser, & Mohr, 2020).

As telehealth becomes more commonly used in mental health, it will be important to assess its relative results and effectiveness. Mental health professionals have different sets of skills and research on the effectiveness of telehealth also needs to be directed to the different professions. Consequently, it will be necessary to develop specific professional training and skills to provide this kind of care. Telehealth technology also needs continuous research, due to the cybersecurity challenges that have been observed (Reay, Looi, & Keightley, 2020). Some authors claim digital monitoring should be considered a complement to existing care and, therefore, evidence is needed on how it can integrate with face-to-face mental health as well as other digital services in the mental health area. (Reay, Looi, & Keightley, 2020).

ADVANTAGES OF MHEALTH ON MENTAL HEALTHCARE

The definition of mHealth is wireless communication technologies that transform health, healthcare and public health (Steinhubl, Muse, & Topol, 2013). Mobile applications are being used to assess psychopathology, improve the quality of care, provide interventions, provide access and monitor patients as well as reduce the stigma surrounding mental illness. The general reason for many digital mental health interventions is the large gap in mental health treatment, which includes a lack of therapists, long waiting lines and individual barriers to stigmatization. These digital mental health interventions cover a wide range of interventions, including virtual and augmented reality programs, telehealth, conversational agents and chatbots, serious games, feedback and reinforcement interventions, routine and results monitoring. Internet-based treatments can also be applied as an adjunct to standardized face-to-face treatment to improve treatment or as independent alternatives for treating people with promising results (Schuster, Topooco, Keller, Radvogin, & Laireiter, 2020). Some authors argue that digital therapies should be integrated into treatment with professional supervision rather than as a self-treatment tool (Chivilgina, Elger, & Jotterand, 2021).

Many studies have reported the benefits of mobile mental health applications, such as improving symptoms and reducing recurrence or relapse. However, there are still a number of aspects to improve related to quality of service and data privacy, among other issues. In order to overcome these barriers, better cooperation with medical institutions and evidence validated with greater rigor as to its effectiveness in the treatment of significant clinical symptoms is necessary (Li, Lewis, Chi, Singleton, & Williams, 2020; Tan, Teng, Qiu, Tang, Xiang, & Chen, 2020).

There is evidence that attitudes towards online psychotherapy were positive, despite the tense contextual factors of the Covid-19 pandemic. In addition, it was evident that some factors such as the previous online experience of psychotherapy, the preparations of both the psychotherapist and the patient and the experience itself during the session. Since the experience of digital psychotherapy has shown a good acceptance by all involved, it is possible that after the decrease in initial stress and with the increase of experience by therapists, the video-conference sessions become something more comfortable, natural and something to consider for the implementation of the common therapeutic follow-up (Békés & van Doorn, 2020).

The advantages of using digital therapies consist of reducing the distance between the therapist and the user, providing evidence-based intervention, psychoeducation and easy adaptation to users with mild disorders and the stimulation of self-management skills by the users. In addition to this, there are benefits such as reduced waiting time, flexibility of time, assistance from minorities and the disinhibiting effect of the user being in a familiar environment which can help the therapist to improve the treatment. This way, as expected, it is easier to share and transmit any relevant information with the household.

As previously mentioned, several authors consider that the combination of face-to-face and online treatment in mental health care is an intervention that can offer several advantages, being defined as the combined intervention. In addition to the benefits mentioned above, this intervention has the potential to increase patient involvement and a sense of control over their own treatment, reduce barriers to receiving mental health care, provide more consistent and evidence-based treatment, lower costs and can also be customized to fit patients perfectly.

However, there are studies that evidence a wide range of difficulties with implementing results for mental health interventions, including acceptance by therapists and patients, the therapists' lack of knowledge on how to adjust digital mental health in the best possible way of treatment. At the same time, there is a sub-ideal adjustment in relation to existing technologies, such as electronic patient records and practical barriers, as well as continuous maintenance of the technology or good access to the internet (Kip, Sieverink, van Gemert-Pijnen, Bouman, & Kelders, 2020). Other disadvantages of any digital intervention are data security problems, risk of discontinuing therapy, difficulties associated with dealing with the crisis and transferring to daily life as well as the use of a lot of technology. In addition to this, it is more impractical to observe non-verbal signs, and the avoidance of a difficult question on the part of the user becomes more feasible. In technologies such as applications, which are mostly not programmed with mental health professionals, there is a shortage of important aspects of the illness. Due to these inconveniences, they can have an impact on the patient's intervention plan. Associated or not with these factors, may be the patient's desire not to participate in these sessions, which ends up becoming another barrier in the implementation of digital therapies.

The lack of successful implementations of technology-enabled mental health services can, in part, be driven by the development of digital mental health tools occurring independently of mental health care providers and the context of the health system and, therefore, these are not well designed for the target population. Without an understanding of the specific needs of healthcare professionals and organizations, and without extensive knowledge.

mHealth can incorporate characteristics often associated with usual health communication methods, such as personalization, tailoring, interactivity, and message repetition at a low cost. Some key features may include voice and video calling, text and multimedia message services, multimedia, several specific sensitive sensors to touch or motion, and device connectivity. Mental health apps are used for many purposes, including: to communicate with other patients, caregivers, or clinicians; to augment psychotherapy and medical support with journaling, symptom tracking tools, and psychoeducation between clinic appointments; to (smart) monitor, that is, to use tools to predict relapse behavior or worsening affective symptoms, through sensors and data activity; to practice self-assessment and care through reflection about their symptoms; and to organize long-term activities, moods, and therapy homework (Hilty, Chan, Hwang, Wong & Bauer, 2017).

Another innovation in the mobile mental health market are the conversational agents, also known as chatbots, which emulate a conversation, sometimes using a simple text interface, others using avatars. Nowadays, speech recognition and natural language processing technologies can provide the chatbot with the capability to identify and express emotions, mimicking a more or less empathic relationship (Luxton, 2020).

Digital health innovations could be used to augment, scaffold, and enhance mental illness management and recovery (Ben-Zeev, et al. 2019). The following table, adapted from Martinez and Farhan, 2019, shows how each individual discipline of data driven applications for mental health respond to the different stages of healthcare: prevention, diagnosis, treatment and monitoring.

DEHUMANIZATION IN HEALTHCARE SERVICES

One aspect that has to be considered when using more and more technology and automatisms in healthcare services is how "human" these services are for the patients. From a patient perspective it is, most of the time, important to feel humanity and empathy as part of the recovery and healing process. In fact, there are multiple studies that suggest that the way patients are treated influence the outcome of their treatments (Vahdat, Hamzehgardeshi, Hessam, & Hamzehgardeshi, (2014).

Table 1. Applications for different stages of mental health healthcare

	Pre-treatment		Treatment	Monitoring
	Prevention	Diagnosis		
Analysis of large data sets	x			
Neuroimaging		x		
Chatbots			x	x
mHealth			x	x
Telemedicine			x	x
Clinical decision support systems		x	x	x
Natural language processing	x	x	x	x
Speech recognition	x	x	x	x
Bio sensors	x	x	x	x
Genomics	x	x	x	x
Virtual therapists		x	x	x
Virtual and Augmented Reality		x	x	x
Implantation of medical devices			x	x
Robot assisted therapy			x	x

Source: (Martinez & Farhan, 2014)

The choice of words, attention to non-verbal communication, empathy, active listening and also body language are all important aspects of communication in healthcare services and especially in mental healthcare (Mata et al., 2021). For that reason, healthcare schools and universities around the world are including classes of healthcare professional - patient interaction in their programs in order to teach best practices and close that communicational gap.

Although the use of cutting-edge technology in healthcare has many positive aspects, the intensive use of some forms of technology can lead to the dehumanization of these services, especially if the technology is used to replace critical activities that are typically taken care of by humans. If we simply replace humans by emotionless healthcare technicians, people that simply execute their job based on data and technical knowledge, leaving aside all kinds of human emotions and empathy by the ones they are treating, we would have a cold, mechanical, emotionless world where the patients would be treated almost fully based by their physical issues forgetting the importance of their psychological and mental wellbeing. Let us imagine a scenario where a difficult diagnosis must be communicated to the patient, the way the diagnosis is communicated has a tremendous impact on the patient. Now let us remove from this scenario all human interaction and replace the healthcare professional in charge of giving the news by some other form of digital communication like a text message or an app and we may have a cocktail that leads to even more negative impacts for the patient and for her/his recovery.

Owners and developers of apps and digital services designed for mental health care must be aware of the risks of dehumanization. Although there may be positive outcomes of having patients using completely autonomous mental health tools - like the full availability of these services or the non-judgmental aspect of chatbots - there is also a downside of how these unsupervised services may negatively affect their users by bypassing all human interaction and replacing it by a set of algorithms and blind rules that are applied to all users without any kind of attention to details and signs that can only be captured by humans. In the absence of a human supervising these interactions, it is nevertheless possible to implement systems that detect patterns that may be an indicator that urgent human intervention is needed for some given cases transforming unsupervised services into semi-unsupervised services with some form of human control. With that in mind, it is possible a balance between procedures that can be automated and taken care of by digital services and human intervention when needed creating a symbiosis of technology and humanity.

INTEGRATION OF DIGITAL TECHNOLOGIES IN MENTAL HEALTH RECOVERY

The interdisciplinarity of two different fields of study like healthcare and technology opens the road for new roles that often make the liaison between both ends and address new challenges that arise from this synergy. The "mental health technology specialist" is a new role proposed by Carpenter-Song, in 2021, that aims to pick the right tools and technologies to apply to a given case in integration and collaboration with the care team. The mental health technology specialist selects the most suitable tools and technologies for each case based on six major principles: accessibility, integration, focus on recovery, focus on the individual, shared decision-making and creativity. From there the intervention begins and it is composed of four different steps: goal setting, researching and evaluating tools, demonstrating and selecting tools, and ongoing support.

In order to follow best practices and standards, the evaluation of the available tools follow the APA framework and in the end a shortlist of apps and services is presented to both clinician and patient based on the needs and goals of each case. A demonstration of these pre-selected tools is given in order to select the most suitable, in a process that again includes the technology specialist, healthcare team and patient. Once the patient starts the use of the chosen technology monitoring and support is given in order to remove any blocker that may appear. A post-intervention analysis is also made in order to fully assess the impact of the selected technology on patients (Carpenter-Song, 2021).

In addition to mobile applications being developed for people with mental health problems, there are some applications designed to simplify the workload of clinicians. Mental health professionals reported a high level of interest towards a mobile app for detection and treatment of mental disorders in the primary healthcare setting (Pokhrel et al. 2021). There is also motivation for practitioners be connected or linked to patients' accounts to facilitate communication and to follow-up their recovery process (Patoz et al., 2021). There are also more informative applications that allow professionals to quickly access specialized information at any time and place (example, PsycEssentials with relevant information on psychotropic drugs, referral resources, and assessment tools).

The ideal model would be an effective integration of the use of mobile applications into the traditional care process by professionals in a unified manner in the flow itself.

APPS AND SERVICES EVALUATION

Given the rapid growth and dissemination of mental health apps, it is very hard for users and healthcare professionals to be up to date with all the new and enhanced applications and services that pop up almost every day. This brings concerns about usability and safety of these apps both for their users and professionals and creates barriers when it comes to recommending apps as part of a treatment. Furthermore, the general public rely more on app store reviews and rankings than on a professional's opinion when they look for a healthcare app or service. This type of behavior adds risks and raises concerns among the mental health specialists (Lagan et al., 2020).

Although hundreds of applications are available on different marketplaces and app stores aimed for different kinds of conditions, therapies and treatments in the scope of mental health, several reviews demonstrated that the apps with the highest number of downloads focus on the scopes of relaxation, mindfulness and meditation. These are also the apps with the most discordant reviews and feedback from the users (Carlo et al., 2019).

Nevertheless, regulatory efforts have been made. The American Food and Drug Administration (FDA) published in 2015 a series of guidelines and best practices that developers should follow in order to deliver safe to use apps and services. Unfortunately, most of these apps are not categorized as medical devices leaving them outside of FDA's regulatory scope. At the same time there is not a real certification alternative provided by the different app stores and marketplaces. To fill this void, various app rankings have emerged to provide a more informed review and evaluation, however none of the more than forty-five existing evaluation frameworks is suitable to be used in health technology assessment (HTA), meaning that the potential effects of the use of these apps are not well described by all these frameworks. The FDA's Pre-cert initiative - a regulatory model of software development best practices - it is already a topic of debate due to the slowness of the process and the lack of engagement of software developers.

An evaluation framework developed by the American Psychiatric Association (APA) assesses an app based on five major parameters: Access and background; Privacy and safety; App effectiveness and clinical foundation; User engagement and usability; Data integration towards therapeutic alliance and goals. For each evaluation parameter there is a set of questions that should have an objective answer. This method brings clarity and transparency to users and professionals and helps to set expectations about the use of these apps. The framework reflects the best practices designed by different stakeholders including healthcare professionals and developers, however the framework is not specific for mental health applications, but for a broader spectrum of any mobile health app. In the table below (Table 1) there are some examples of evaluations of mobile apps using this framework.

These evaluations are not intended to enable the users or professionals to decide about choosing these specific apps for actual use, but it is strongly encouraged that users, along with their clinicians to conduct their own assessment using this framework as reference.

It is clear that the traditional review platforms do not address the specificity of these types of apps and services and that the reviews of a common user are not a guarantee of anything. An app that may have a direct impact on the health status of a user should not be reviewed in the same way as one is reviewing a game or an inoffensive utility. For that reason, alternative review frameworks have popped up recently with the goal of being a more trustable source of truth regarding the assessment, evaluation and review of mental health mobile apps.

MindApps is one these alternative review platforms that provides a public and transparent approach, promotes the discussion around the available features, quality and usability of these apps providing information for an educated choice both for users and healthcare professionals. More than just a review platform, MindApps (https://mindapps.org/) is an enhancement to the APA framework that translates the different evaluation vectors to a set of objective metrics and stores these metrics into an online database that is publicly accessible, searchable and filterable by hundreds of different parameters. Each mHealth application available in the database is scored objectively either by binary or numeric values in order to describe fundamental features grouped by the following major filters: platform, developer type, cost,

Table 2. Mobile apps evaluation based on APA evaluation model

	Description	Evaluation
MoodPath (MindDoc)	Monitoring and self-management application that provides continuous long-term symptom monitoring for individuals with mental health problems. This enables users to recognize patterns in their symptom trajectories which then can be shared with a mental health care provider or used for self-management. It (1) provides users orientation regarding the need to consult a mental health care provider who can use the monitoring data to prepare an actual diagnosis and support a follow-up therapy; (2) enables users to self-manage symptoms and related problems by providing both transdiagnostic and disorder-specific evidence-based courses and exercises which help them to recognize, understand, and cope with signs and symptoms of mental disorders.	ACCESS & BACKGROUND: the source appears to be reasonably trustworthy; the app works when in airplane mode; Moodpath claims to be “developed and validated in collaboration with scientists.” PRIVACY AND SAFETY: it clearly outlines what information is collected and whether it is classified as health-related, technical, or app usage data; It states that health data is anonymously sent to research universities. Users can choose to participate in Health Data processing by giving consent on the app, which they interpret as choosing to use the app. CLINICAL FOUNDATION: the information appears to be well-written and clinically accurate; the website sites that there are studies being done using the app. USABILITY: The app provides free modules for understanding depression, mindfulness and dealing with coronavirus. It also shows several other modules that are restricted until the user subscribes to their quarterly program. These premium modules include: rumination, self-confidence, emotions, and sleep. THERAPEUTIC GOAL: The app suggests new behaviors and ways of thinking about situations. Its modules appear to help users develop insight into anxiety and depressive symptoms. It suggests mindfulness exercises. This could lead to positive behavior change or to skill acquisition. The app is intended to be for individual use, but if user wishes to use app data to supplement care, there is an option for data export.
Woebot	A simulated supportive conversation that encourages authentic disclosure and makes therapy radically accessible. Woebot uses AI and Natural Language Processing techniques to learn from millions of conversations annually and to provide therapeutic encounters that are psychologically related, responsive to a person’s dynamic state of health, and targeted using tools from cognitive, behavioral, and interpersonal disciplines.	ACCESS & BACKGROUND: the app did not identify funding sources and conflicts of interest. PRIVACY AND SAFETY: The app uses data to refine their algorithm to improve their product and tailor the user experience. Woebot shares data with Facebook for users. A special Woebot program may share data with medical academic partners or other partners. When using the app, chatbot informs the user of this policy. CLINICAL FOUNDATION: Woebot provides a citation in-app to a research study at a university. USABILITY: The app clearly outlines its use cases and target audience (e.g., those seeking an automated chatbot to assist with depression symptoms). THERAPEUTIC GOAL: Unclear or no information apparent during this evaluation.
WRAP	● Based on the Wellness Recovery Action Plan, the WRAP App walks the user through the process of creating his/her personal WRAP, with a friend or supporter, or in a WRAP group. Whatever the goals or challenges, the user can: (1) discover simple, safe, and effective tools to maintain wellness; (2) develop a daily plan to stay on track with your life goals; (3) identify what throws you off track and develop a plan to keep moving forward; (4) and gain support and stay in control even in a crisis.	ACCESS & BACKGROUND: Advocates for Human Potential (AHP) funds the app but the reviewers were unable to find information about conflicts of interest. PRIVACY AND SAFETY: The reviewers were unable to determine a clear answer to this question given information provided by the developer. CLINICAL FOUNDATION: WRAP is an established, evidence-based treatment with positive benefits; unclear if the app supports the same positive benefits through virtual services. USABIITY: The app is easy to use and includes a Wellness Toolbox and daily plans (for example, customizable Crisis and Post-Crisis plans), with respect to the needs and priorities of the user. THERAPEUTIC GOAL: the user can e-mail WRAP App-collected user information to provider for treatment purposes. Traditional WRAP is associated with positive features and outcomes; unclear to reviewers based on evidence provided as to whether the WRAP app replicates this as-is.
Youper	AI chat-bot app designed to help users identify, track, and process their thoughts and feelings. Utilizing cognitive behavioral therapy, acceptance and commitment therapy, and mindfulness, it may help users improve their mood and sleep patterns, and reduce their symptoms of anxiety, stress, and depression. The app includes 4 main features: Youper the AI Chat-Bot, Journal Logs, Mood Logs, and an Emotional Health Assessment.	ACCESS & BACKGROUND: Claims to be an “emotional health assistant.” The team which develops the app counts with psychologists and psychiatrists. PRIVACY AND SAFETY: The website states, “We DON’T collect or store medical information or Protected Health Information...” and data could be deleted. CLINICAL FOUNDATION: Youper is based on evidence-based psychological techniques. However, the developers do not reference the sources due to the conversational nature of app. USABILITY: The app is easy to use and it clearly defines its functional scope as using AI to help to treat stress, anxiety, depression. THERAPEUTIC GOAL: The app can be used in conjunction with a provider and works with HealthKit.

Source: (APA – Sample app evaluations, 2019) accessibility, privacy, clinical foundations, features, supported conditions, engagement strategies, inputs, outputs and use types. MindApps also does not provide a ranking, a top or a list of best apps, instead it provides a searchable database that allows any user to find the app most suitable to their needs, however links to the different marketplaces are available with the feedback and scores of users (Lagan et al., 2020).

MOBILE PHONES USAGE IN PEOPLE WITH MENTAL HEALTH PROBLEMS

Covid-19 has changed the field of psychosocial rehabilitation drastically from in-person to virtual or remote services, and there seems to be no question that patient access to clinicians is better than no access. Findings suggested increased use of digital mental health tools and other technologies over time during the early stages of the Covid-19 pandemic (Sorkin et al., 2021).

There is the (wrong) idea regarding the use of smartphones, computers and social media among people with mental health problems and particularly towards people with serious mental illness such as schizophrenia. Approximately three quarters were willing to use a device to access interventions for stress, health and mental health (Brunette et al., 2019). Despite that, smartphone use by those with serious mental illness is generally lower than for the general population (Abu Rahal et al. 2018; Carpenter-Song et al. 2018) and the need to increase digital skills, and the use of multiple consumer technologies should be encouraged and supported (Bauer et al. 2020). Furthermore, some people with mental health problems need skills training to improve digital health literacy and access to health information (Athanasopoulou et al., 2017; Greer, Robotham, Simblett, Curtis, Griffiths & Wykes, 2019).

Obviously, younger people living with schizophrenia use personal technology more than older people with schizophrenia (Simões de Almeida, Sousa, Marques & Queirós, 2018), but in general, all mobile apps and services should be usable, accessible, feasible, effective and follow well known design patterns that deliver a good and predictable user experience. This is no exception in mHealth apps that rely on the user engagement as part of the treatment effectiveness. Multiple best practices and design standards exist to make the use of an app an enjoyable experience and keep the user engaged and interested. On the top of the use of user interface standards and design patterns that deliver a predictable interaction, strategies like gamification are also something to consider as a driver of user engagement. Gamification is a way of transforming a boring or repetitive task into a challenge where physical or virtual prizes are given to the user when a goal is achieved. Some of the most popular mental health apps use this strategy extensively to keep users interested and highly engaged.

The use of mobile devices allows resources like motion sensors or GPS location to be used as an extended source of information that can be used to create better contexts and enhance the set of data that is generated by the user implicitly and explicitly. The best practices and official regulations like the GRDP and CCPA state clearly that the user is the owner of its own data and that every data point collected should be used for the benefit of the user. The user should be informed of what data is collected and with what goal or purpose. The data handling transparency is crucial, especially when the data includes personally identifiable information and health data with a high potential of misuse if poorly collected and stored. Ideally, data management should be a topic of discussion involving the different stakeholders during the design phase of the app and recurring during the different iterations of the product in order to achieve an optimal data handling process with eye on security and privacy.

MHEALTH FROM DESIGN TO IMPLEMENTATION

The private sector is quicker to develop mobile apps, but that brings more risks - this fact does not mean that apps are bad at first, but sometimes they do not have enough evidence to support them (reviews and download pages are not enough to make a thoughtful and correct choice). The use of eHealth services should consider aspects such as efficiency and improving the quality of healthcare, empowering the user, encouraging the creation of a new therapeutic relationship, educating professionals and users about the functioning of the applications, the sharing of information between health facilities, the expansion of care provision, interventions supported by evidence, ethics and equity, and technologies should be accessible to all users regardless of their skills and socioeconomic status (Beentjes, Gaal, Goossens, & Schoonhoven, 2016). Furthermore, the effective management of psychiatric illness requires collaboration between the patient and the professional, so that problems can be identified, goals set, incorporating the most effective self-management strategies and monitoring the patient's progress (Aschbrenner et al., 2016).

It is important to reflect on how these tools are built. There are numerous theories that address the issue of how to design good tools and one of the most used and most suitable methods for designing health technologies is Human Centered Design (HCD). The main idea of HCD is that the lives of the people for whom the product is being designed is fundamental in the project and this must correspond to their needs and their particular context. The design process should focus on finding a solution to a real-life problem experienced by real people, i.e., considering a holistic approach to health: technology, people and context should be involved from the start. This means that each design process starts with figuring out what problem the person is facing and wants to overcome (making sure there is currently no application that responds to that – it is better rather than spending time and money "reinventing the wheel"). The identification of the problem can be done through information obtained from interested parties (through methods such as interviews, focus groups, surveys), through observation of contexts or through scientific literature. Often the identified problem can be categorized into one or more problems.

Next comes the ideation stage and it is at this stage that ideas are generated that could solve the problem analyzed, creating prototypes to visualize these ideas, and testing them with the people who will be the end users (and also indirect users, such as health professionals, family members/ caregivers, hospital organizations or community services). It is essential to define what requirements can be defined as what the technology should do, what content should present, what kind of data is used and what kind of experience should be provided to the user. Not rarely, the formulation of requirements is often left to engineers and software developers who apply a technology-oriented approach without taking the user's point of view, which is wrong. There are different types of needs that can be formulated before designing an eHealth technology: usability and user experience, functionalities (which modules it should contain and in what way); service needs (at the marketing level, for example), organizational requirements (how technology should be integrated into the organizational structure and service routines).

After that comes the actual design process, which usually starts with low-tech prototypes, which serve to communicate the goal and ideas behind the technology. The most important characteristics of the idea must be present in the prototype so that they can be evaluated by users, specialists or other interested parties. This can be done with a paper and pencil layout or something more complex like creating mockups. It is only at a later stage that digital interfaces are developed and the more concrete possibility of testing the usability of the technological tool emerges.

The last phase is implementation, to find out if the product will actually be used successfully by the people it was designed for. According to the international standard ISO 9241-11 (which covers ergonomics and human-computer interaction), usability is defined as the extent to which a product can be used by specific users to achieve particular goals with effectiveness, efficiency and satisfaction in a context of determined use. Usability is not the same as ease of use, nor is it just about a system that works. It is about whether the target users get and do the things they want to do with the system. In this sense, it is easy to understand the need for these tools to be developed by multidisciplinary teams. Broadly speaking, there are two forms of usability testing: based assessments experts and user-based assessments. The former must have in-depth knowledge of both the technology and the health problem in question, while the latter must belong to the target group for which the tool is intended.

In addition to the tool being person-centered, it should also involve them as a participant in its design. In short, it is important to understand how mHealth interventions should be designed and built. User Centered Design or Human Centered Design, as the name implies, involves considering what the user needs at all stages of the design process, representing a systematic process that is essential to ensure that applications are person-focused (McCurdie et al., 2012). In this process, users must be identified at an early stage and then a thorough investigation of their needs and expectations is conducted in order to understand the intended use of the tool (Schnall et al., 2016). However, the design process of these technologies is currently undergoing a change of perspective, as most researchers discuss the application of a new concept called User Participatory Design (Barcellini, Prost& Cerf, 2015). This concept considers that users can, and should, actively contribute to the design of the system, that is, the tool should not only be designed for the user. Concerns about the risk of loss of privacy and confidentiality should also not be neglected in this conception, being one of the aspects frequently identified by end users. Patients must be meaningfully involved in decisions about how technology can be best used to support decisions about their treatment to finally balance the asymmetries and unequal power relationships between patients and professionals in mental health care.

This reflection is extremely important for designing health technologies, but it is even more important when it comes to people with mental health problems. As an emerging area with a unique set of design constraints and concerns, guidelines are beginning to be established that organize the knowledge gained from existing development projects. Thus, theoretical models provide valuable insights for designing effective and sustainable behavioral health interventions, but applying theory to inform digital technology interventions for people with mental illness has received limited attention (Naslund et al., 2017). The health belief model, the theory of planned behavior, the transtheoretical model, and the social cognitive theory are important and overlapping constructs that can inform digital health interventions for people with mental illness.

It should also be noted that the simplicity of the interface and the ease of navigating a program significantly influence how users perceive the quality of online interventions for mental health. User satisfaction and program credibility directly influence therapeutic engagement and benefit. For an intervention to be effective, a pleasant application must be built, with a good graphic design and an intuitive and satisfactory interface. Simplicity also reduces the likelihood of technical difficulties, which can deter user participation. A simpler interface decreases the capacity needed to engage with the application and increases the likelihood of successful engagement. The language used throughout a mental health intervention, particularly a self-help intervention, can also have a great impact on user engagement, and must be simple, concrete, confident and hopeful, so that users understand what is said and get involved in the interventions. User literacy must be considered and the length of sentences and paragraphs is not only limited by smartphone screen restrictions, but also by users' working memory. Making information meaningful to users can help its consolidation by easing memory demands. Using illustrations, such as faces to represent emotions, can also improve understanding. Decreasing the amount of information is even more important for users who suffer from symptoms of depression or anxiety, because these conditions can restrict the working memory function. Although simpler information is needed at an early stage, exploring deeper information is important to satisfy some users. Building a resource such as a "learn more" or "help" button in a mental health application can allow users to access more information about certain content or resources. In addition, navigating an application can be critical to maintaining a sense of autonomy and competence, as an application that limits a user's freedom of navigation can be frustrating and its use may not be rewarding. Features like a button that takes the user to the home screen can solve this.

The last phase is assessing efficacy of the mobile app. It is important to implement randomized controlled trials with follow up to measure the impact of these technologies, collecting quantitative and qualitative data. Over the last 10-20 years we have accumulated information about mobile applications in the field of mental health and it is now time to mobilize it.

RECOMMENDATIONS AND FUTURE RESEARCH DIRECTIONS

Bakker et al. (2016) formulated 16 recommendations, with different levels of robustness, regarding the development of mobile applications in mental health. Although it is no longer recent, it is still useful for bringing some clues for the development of mobile applications for mental health.

Alqahtani, Al Khalifah, Oyebode, & Orji (2019) also presented some behavior change strategies and recommendations for mental health apps development, such as self-monitoring, personalization and reminder schemes. They stressed as well social facilitation strategies and employing reduction and tunneling to simplify mental health apps and guide users through the step-by-step process required to achieve the desired mental health outcome.

Moreover, researchers, developers and clinicians should consider the needs of the different user profiles accessing mental health services, such as children and young people or older people.

Despite the constant boiling of this topic over the past two decades, the trend to research this topic is here to stay. First of all, there is a need of increased formal training in technology-enhanced care (Schueller et al., 2021). Not only novel professionals should have specific training in the area of digital health in their curriculum, but also professionals who have graduated ages before should update themselves in this field of knowledge.

Regarding the technologies themselves, they need to be constantly improved and evaluated. A recent review of mental health apps users shows that, whilst 64% of apps available in commercial app stores claim to diagnose, manage or help ease the symptoms of mental health problems, only 44% of them use scientific language to assure these claims (Larsen et a., 2019). Nevertheless, keep in mind that proliferation of new mental health apps is often unnecessary, sometimes counterproductive, and often redundant with apps that already exist.

Another important question to be raised is how to increase the (digital) therapeutic alliance? Some authors argued the need to seek clarity on this topic (Henson, Wisniewski, Hollis, Keshavan, & Torous, 2019).

Once again, it is necessary to continue to invest in apps certification methodologies, data security and privacy, personalization and interactivity because these are also major factors that inhibit or lead to a drop out in the use of these technologies.

Table 3. Recommendations for mobile applications development for mental health

Evidence	Recommendation	Details
Effective, but further investigation is needed.	1. Based on Cognitive-Behavioral Therapy	Adopt a conceptual framework to maximize effectiveness
	2. Aims to intervene in anxiety and depressed mood	Increases accessibility and addresses comorbidity between anxiety and depression
Probably effective, but further investigation is needed.	3. Designed for non-clinical populations	Avoiding diagnostic labels reduces stigma, increases accessibility and allows use for prevention
	4. Automatic customization	Personalized interventions are more effective than rigid
	5. Recording thoughts, feelings or behaviors	Self-monitoring and self-reflection to promote psychological growth and allow assessment of progress
	6. Recommendation of activities	Behavioral activation to increase self-efficacy and coping strategies repertoire
	7. Mental health information	Development of mental health literacy
	8. Real-time engagement	Allows users to use the app when they need it most
Supported by theory, but needs further investigation	9. Activities explicitly linked to mood problems	Improves understanding of the cause-effect relationship between actions and emotions
	10. Encourage activities without the use of technologies	Helps you avoid potential problems carefully by limiting time spent on technologies
	11. Gamification and intrinsic motivation to get involved	Encourages the use of the app through rewards, positive reinforcement and behavioral conditioning
	12. Previous app usage record	Encourages the use of the application through personal investment
	13. Reminders for use	Notifications for Involvement
	14. Simple and intuitive interface and interactions	Reduce user confusion and detachment
	15. Links to crisis support services	Help users who are in crisis to seek help
Required for validation of principles	16. Experimental trials to establish efficacy	It is important to establish the effectiveness of the application before recommending it as an effective intervention

Source: (Bakker et al., 2016)

CONCLUSION

Mobile mental health is an exciting and dynamic field that combines skills of two different sciences: healthcare and computer science in order to provide tools that help patients and professionals to manage and to cope with different conditions and that open the way to different approaches and treatments of several conditions. It also means the opportunity to reach more people that in different circumstances had little or no chance to have access to basic mental healthcare due the ubiquity of mobile devices, and the low cost of access to these apps and services.

However, there are also risks to consider. Apps with no technical validation or that run unsupervised can lead to disastrous consequences, especially if the users are not being followed or advised by professionals. There is also the risk of picking the wrong tool or having a tool that is giving the wrong direction and advice to their users. For that reason, there is the need to provide standards and best practices for both design, implementation, use and monitoring of these apps and services, something that has come to happen with the help of international institutions that aim to regulate this new field and market. There is also the need for different frameworks of evaluation and review of these apps, as the traditional marketplaces and play stores do not provide the necessary information for an educated choice nor the transparency for what kind of features each app offers and what kind of treatments and goals are provided, making hard for professionals and users to rely on the mainstream review frameworks to make the right choice for their needs.

Mobile Mental Health, as the union of two very different science fields, opens the space for new roles and professions that make the liaison between the two worlds. Having someone that understands what are the needs of a patient in terms of mental healthcare and the knowledge of what tools exists, especially mobile mental health apps and services, is a crucial resource to help professionals and patients making the right choices in terms of technology and help them to use these tools the right way in order to maximize the potential benefits.

Replacing a human resource by a mobile application has several positive and negative impacts. If on one side some users may feel more comfortable by sharing their thoughts and feelings to a non-judgmental application instead of having a in person conversation with a professional, there is also the risk of dehumanizing the healthcare services by removing almost completely all the human interactions - which goes against other efforts of keep healthcare as human as possible increasing the human interaction between professionals and patients as one important vector of intervention.

However, the field of mobile mental health looks promising, the advantages of the use of technology in the mental healthcare field are clear and enormous. In the long-term, these tools, apps and services will deliver personalized care designed for a specific user and its specific needs. Also, the correct collection, analysis and application of data will for sure open the doors for new knowledge, new treatments and new approaches that ultimately will benefit professionals and users.

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KEY TERMS AND DEFINITIONS

Chatbot: A program designed to simulate conversations with human users.

eHealth: Use of digital technologies to facilitate health improvement and health care services.

mHealth: General term for the use of mobile phones and other wireless devices for healthcare purposes.

Recovery: Process not focused on symptom reduction but on a personal path of rediscovering a new feeling of identity, self-determination, and personal empowerment to live, participate and contribute to the community.

User-Centred Design: Iterative design process in which developers and researchers focus on the users and their needs in each phase of the process.

Chapter 2
Mobile Mental Health for Depression Assistance:
Research Directions, Obstacles, Advantages, and Disadvantages of Implementing mHealth

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ABSTRACT

Depression is a prevalent and severe medical illness that negatively affects how people feel, think, and act, with estimates pointing towards more than 300 million suffering from depression worldwide. Although effective treatments exist, about 80% of people in low and middle-income countries do not receive therapy. Therefore, technology has become a promising tool to assist in reducing disparities. This study aims to identify and map the available evidence on mobile health applied to depression and clarify key concepts. The authors analyzed clinical trials developed over the last five years. EBSCO and PubMed were searched, and a total of 14 conducted RCTs were selected and reviewed. Despite some limitations regarding dropout rates and several ethical and safety concerns, the mobile mental health future seems promising.

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INTRODUCTION

The adaptation of the human being to the frantic pace of society involves an enormous physical, mental, and social struggle. The strategies to overcome these challenges of modern society are usually insufficient. According to the World Health Organization (2008, 2017a), more than 50% of the population of middle and high-income countries will suffer from at least one mental disorder at some point in their lives. Since it does not target only a small group of individuals, but crosses every social boundary and degree, mental illness must be understood as a public health issue with dire consequences for society.

Mainly, depression is one of the most common results of everyday society's stress. It affects people in different ways and can cause a wide variety of symptoms. Generally, it can affect people's thoughts, behavior, motivation, feelings, and sense of well-being.

According to the National Institute of Mental Health (2021), depression is a common but serious mood disorder. The resulting symptoms usually affect one's behavior, mainly meddling with the people's thoughts, feelings, and the ability to handle basic daily activities such as working, eating, and sleeping. Some of these disruptive symptoms usually present themselves as a constant feeling of sadness, a sense of hopelessness, pessimistic thoughts, irritability, and several other feelings that usually translate to an overall loss of interest or pleasure in hobbies, activities, and life in general. It can even lead to suicide in some cases.

Even though effective treatments for depression exist, there is still much to learn concerning effective approaches to prevent or treat depression (Cuijpers et al., 2020). For example, the meta-analysis of Levkovitz et al. (2011) concluded that only 54% of adults show improvements after anti-depressive medication, and the meta-analysis of Cuijpers et al. (2014) demonstrated that only 62% of adults show improvement after psychotherapy.

The World Health Organization (2017a) states that depression is the leading cause of disability worldwide, estimated to affect 300 million people. It saw an increase of 18.4% in incidence between 2005 and 2015 (Vos et al., 2016), also establishing itself as the primary contributor to suicide with an approximate rate of 800 000 deaths per year (World Health Organization, 2017a).

Besides personal impact and disability, depression reflects its burden on society as a whole with tremendous expenses to families and national healthcare providers, as well as the loss of productivity (Gangan & Yang, 2018). This growing threat to economic welfare can disrupt healthcare providers and policymakers, and allied with demographic aging can unbalance many countries' economic well-being.

For all these reasons, it is vital to keep an eye out regarding new forms of treatment and especially to be aware of the frontiers that technology has opened. The sense is that mobile mental health can be simple and reach many people.

As a matter of fact, mobile health (mHealth) is an expanding field in the digital health sector, providing healthcare support, delivery, and intervention via mobile technologies such as smartphones and tablets.

Technology is seen as a potential method for recovering health disparities that are typically driven by limited resources and stigma. Innovative solutions for the self-management of mental health issues are beneficial and can be valuable for people who do not have access to the services they need (Bakker et al., 2016). Even when people are aware of their problems and are open to requesting help, support is not always easily accessible, geographically, financially, or socially.

All the possible applications of this technology indicate an opportunity to expand mental health treatment availability and quality. For that reason, the number of mobile health applications for mental health purposes increased at a quick pace in the last few years.

Believing that smartphones have revolutionized our lives, this chapter aims to understand which applications are most used in depression treatment and their potential effectiveness.

It is also essential to understand whether these apps should be designed to only offer assistance in treatment as a complementary tool designed by specialists or as a treatment itself, as many of those apps tend to claim. Nevertheless, patients embrace these technologies with or without the therapist's recommendation (Schueller et al., 2018). This chapter is also crucial for creating knowledge that will guide mental health professionals about which apps to use and recommend to their patients, allowing a controlled and safe environment surrounding these tools.

BACKGROUND

Telehealth may be defined as "*the delivery of health care services, where distance is a critical factor, by health care professionals using information and communication technologies (ICT) for the exchange of valid information for the diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities*" (World Health Organization, 2010).

However, with the evolution of technology and more access to specific ICTs, *electronic health* (eHealth) emerged. It is the network of technology applications regarding health issues, including, for example, remote monitoring, web-based informational programs, teleconsultation, and mobile technology-supported care (World Health Organization, 2011).

Eventually, with the sudden development of mobile devices, what would be known as mobile health (mHealth) appeared.

According to the World Health Organization (2017b), mHealth includes using the mobile phone's utilities such as voice and short messaging services and other functionalities and applications involving general packet radio service (GPRS), global positioning system (GPS), Bluetooth, and 3G/4G mobile technology systems. It is a medical and public health practice backed by wireless devices, including mobile phones, patient monitoring devices, and personal digital assistants.

Universal health coverage by making services accessible to remote or underserved communities as well as granting mechanisms for data exchange on patients and services are the main contributes that mHealth can help attain (World Health Organization, 2017b).

The usage of mobile phones around the world has been increasing worldwide. As of 2020, Statista's survey pointed to 6.95 billion mobile users around the globe and a forecast of 7.41 billion by 2024 (Statista, 2020). It is important to note that an increase in users of low- and middle-income countries has been observed (World Health Organization, 2017b). Many families' lack of infrastructure and weak financial status in those countries has led them to share one device with the whole family or community (Forenbacher et al., 2019). Nevertheless, availability is rising and, thus, accessibility to mHealth.

mHealth can play an essential part in some of the most challenging areas of healthcare, especially aging and mental health. Specifically related to mental health patients, most possess this technology. Around 75% stated that using a mobile app for improving their mental health would be of interest (Peng et al., 2016). mHealth tools are used for appointment and medication reminders, information, education, and self-monitoring, to support mental health in the general population (Rathbone & Prescott, 2017).

Psychological treatments, such as cognitive-behavioral therapy (CBT), mindfulness, behavioral activation, and interpersonal therapy, are evidence-based treatments that can be effectively delivered in person and on digital formats, with emerging evidence to support their delivery via mHealth tools (Rathbone & Prescott, 2017; Sevilla-Llewellyn-Jones et al., 2018). Psychosocial interventions can reach many patients and people from distant locations since mobile technology is used daily and in natural settings. Today, it is undeniable that mobile health facilitates remote access to health services, connecting patients (Qudah & Luetsch, 2019).

Depression is a clinically significant and growing public health issue. Although it is treatable, less than a quarter of people obtain adequate treatment for this disorder given some obstacles such as difficult access, transportation, time, long waiting lists, and cost. Since there are several apps for depression available for download on mobile devices (Shen et al., 2015) and predisposing that they are effective for appropriate care, mHealth applied to depression can become a vital service link to the unfulfilled mental healthcare needs of individuals (Sood et al., 2016).

RESEARCH DIRECTIONS, OBSTACLES, ADVANTAGES AND DISADVANTAGES

Current Research Methods and Outcomes

In this chapter, the authors sought to focus the research on the analysis of clinical trials. The offered overview aims to enlighten the critical aspects of the most demanding clinical results and findings. In addition, the authors agreed that the most recent research would be imperial. So, only clinical trials developed over the last five years were considered. This was also based on the idea that the number of research on mobile health apps has been increasing exponentially, with exceptional growth in the last 5 years (Peng et al., 2020).

The search was conducted on the EBSCO and PubMed databases. A total of fifty-eight articles were retrieved. Fifty articles remained after duplicate removal. Title and abstract screening allowed for the removal of thirty-six papers, to a total of fourteen. Two articles were removed after full-text screening; however, a bibliography search by hand resulted in two additional retrievals. Fourteen articles were included in the chapter.

Reasons for exclusion were mainly due to wrong publication type (14), wrong outcome (10), wrong study design (9), wrong population (4), and background article (1).

As expected, mobile mental health research on depression assistance has been focusing on smartphone apps. Some of those studies tested more than one app (Arean et al., 2016; Bakker et al., 2018; Pratap et al., 2018; Stiles-Shields et al., 2019). In the studies of Pratap et al. (2018) and Arean et al. (2016), the same three apps were assessed: (1) Project Evolution (EVO) is a video game-inspired cognitive intervention that was designed to modulate cognitive control abilities. The app had previous preliminary evidence of effectiveness, also based on the fact that the decline in cognitive abilities has been associated with depression (Anguera et al., 2017). (2) Internet problem-solving therapy (iPST) is an app developed according to this evidence-based treatment for depression. Moreover, (3) Health Tips (HTips) is an information control app that offers daily health tips to help manage depressed moods (Anguera et al., 2016).

On the other hand, the study of Bakker et al. (2018) employed the use of three other apps: (1) The toolkit app (MoodKit) is a CBT-based app that contains tools such as activities, thought checker, mood tracker, and journal. (2) The mood tracking app (MoodPrism) is a self-monitoring mood-tracking app that prompts the user to report his daily emotional state, displaying levels over time and providing relevant links to mental health resources. Furthermore, (3) the CBT strategy app (MoodMission) recommends CBT strategies in response to user-reported low mood levels.

As for the study of Stiles-Shields et al. (2019), two apps were studied. Namely, the android app ‘Boost Me’ is an app that relies upon activity scheduling as a core strategy of Behavioral Activation, and another android app ‘Thought Challenger’, which is based upon thought restructuring as a strategy of Cognitive Therapy.

‘Pacifica’ (in its Premium version) was another app used as an intervention for depression (Moberg et al., 2019). This app is presented as a guided self-help tool for managing stress, anxiety, and depression. However, it clearly states that it is not meant to treat any specific diagnosis or intends to substitute professional treatment. It functions as a daily mood tracker (requesting users to rate their mood) while suggesting activities and allowing access to several psychoeducational lessons.

‘Be Good to Yourself’ is another self-help app developed for iPhone’s operating system iOS. As per our search, it still does not possess an android version. This app consists of forty self-help strategies and exercises based on CBT and its third wave (Lüdtke et al., 2018). Examples of those are cognitive strategies, mindfulness-based exercises, development of social-competence skills, and activating exercises. It also sends adjustable daily reminders to encourage the user’s participation in his self-care.

To determine the efficiency of passive phone sensors in forecasting daily mood, the study of Pratap et al. (2019) is called ‘BRIGHTEN’. It is a large fully remote randomized clinical trial for depression treatment, and it aimed to gather passive data, such as (1) mobility distance, (2) mobility radius, (3) call duration, (4) SMS count, (5) SMS length, (6) Aggregate communication, (7) interaction diversity, (8) missed interactions, and (9) unreturned calls, in an app called ‘Ginger.io’. This data was to be crossed with the self-reported daily mood to observe if it was enough to predict it, facilitating clinical care and triggering follow-up assessment and treatment modification.

Similarly, NeCamp et al. (2020) followed the idea that the mHealth intervention delivery times can be based on real-time data collection. As such, the study used a ‘Fitbit Charge 2’ to collect passive data, and an app to conduct ecological momentary assessment, aggregate and display data, and deliver push notifications. This intervention was oriented specifically to medical interns. Generally, these authors underlined the importance of push notifications as a trigger, potentially providing motivation and strategies for change and reminders to interact with the app. However, a very important conclusion is that poorly timed push notifications can promote loss of engagement and treatment fatigue (Heckman et al., 2015; NeCamp et al., 2020; Suggs et al., 2013).

Regarding the app ‘Feel Stress Free’, it was tested for effectiveness in university students (McCloud et al., 2020). This web-based app is accessible by iPhone, Android, tablet, and computer. Behavioral relaxation activities, mood tracking, thought challenges, and minigames make the composition of the app. As per our search, the app’s name is ‘Thrive: Mental Well-being’ and is only accessible as part of a suite of services in partnership with charities, companies, and other organizations partnered with Thrive Therapeutics Software Ltd.

All these studies tested these apps in a general or specific community sample targeting depressive symptoms. However, some other studies aimed to assess the app’s effectiveness in specific clinical scenarios.

For example, the study of Hantsoo et al. (2018) intended to monitor and manage depressed mood in a vulnerable pregnant population. A mood tracking and alert (to providers) mobile app was assessed for patient engagement and mental health care delivery. Also with a pregnant sample, the study of Chan et al. (2019) used an app called ‘iParent’ to reduce post-natal depression of first-time mothers. The app offered psychoeducation materials equivalent to those offered in the face-to-face antenatal usual treatment classes. This way, the study focused on the outcomes of alternative information delivery.

In patients with antidepressant-resistant major depression, Mantani et al. (2017) compared a CBT app as an adjunct to pharmacotherapy modification against pharmacotherapy modification alone. The ‘Kokoro-app’ is a smartphone self-help app that offers eight sessions divided into one welcome session, two self-monitoring sessions, two behavioral activation sessions, two cognitive restructuring sessions, and the last session aimed towards relapse prevention. Besides the app itself, the monitoring tool ‘Kokoro-web allowed the participants and their psychiatrists to access progression, and a congratulatory email with individual progress was sent weekly to participants.

As for the study of Kuhn et al. (2017), and pertaining that depression is one of the most common symptoms of post-traumatic stress disorder (PTSD), an app called ‘PTSD Coach’ was used as an intervention. The app is freely available on the Apple App Store and Google Play Store. It integrates psychoeducation, symptom assessment, evidence-informed self-management tools, and access to other supportive and professional resources. It also states that it does not intend to replace the professional care, but improve health literacy and provide strategies to improve coping and the management of acute distress.

Regarding people with serious mental illnesses such as schizophrenia, bipolar disorder, and major depressive disorder, Ben-Zeev, Brian, Jonathan, et al. (2018) conducted a study using mHealth (FOCUS) in comparison to a clinic-based group intervention (WRAP). As for ‘FOCUS’ (Ben-Zeev et al., 2014; Ben-Zeev, Brian, Aschbrenner, et al., 2018; Ben-Zeev et al., 2013), it includes three components: (1) App, (2) clinician dashboard, and (3) mHealth support by a specialist. This multimodal, smartphone-delivered intervention includes preprogrammed daily self-assessment prompts and on-demand capabilities available 24 hours a day. The content is delivered by video or audio clips and sequences of written material accompanied by images.

Across the studied apps, depression assessment was carried out mainly using the Patient Health Questionnaire PHQ-9 (Arean et al., 2016; Bakker et al., 2018; Hantsoo et al., 2018; Lüdtke et al., 2018; Pratap et al., 2018; Stiles-Shields et al., 2019) and PHQ-8 (Kuhn et al., 2017; Moberg et al., 2019). It was also used the Beck Depression Inventory BDI-II (Ben-Zeev, Brian, Jonathan, et al., 2018; Mantani et al., 2017), the Hospital Anxiety and Depression Scale HADS (McCloud et al., 2020), the Edinburgh Postnatal Depression Scale EPDS (Chan et al., 2019), and by Ecological momentary assessment (EMA).

About the outcomes of mHealth interventions applied to depression, some studies demonstrated an improvement in depressive symptoms (Arean et al., 2016; Bakker et al., 2018; Kuhn et al., 2017; McCloud et al., 2020; Moberg et al., 2019; Stiles-Shields et al., 2019). Arean et al. (2016) found that mobile apps for depression appear to have their most significant impact on people with moderate levels of depression. In particular, the app ‘EVO’ was designed to engage cognitive correlations of depression and had the most substantial effect on depressed mood across the apps in the study. In addition, (Kuhn et al., 2017) conducted a study in which results show that at posttreatment, ‘PTSD Coach’ participants had more significant improvements in depression symptoms and psychosocial functioning than did participants on the waiting list.

However, other apps also showed a significant impact on depressive symptoms. For example, the Thought Challenger app (Stiles-Shields et al., 2019) and Pacifica (Moberg et al., 2019). Pacifica is a popular commercially available self-help app, which effectively reduces self-reported symptoms of depression, particularly among individuals who use thought record and are not taking psychiatric medication. Also with significant results, the ‘Feel Stress Free’ app (McCloud et al., 2020) seems to be a promising mobile intervention for the treatment of depressive symptoms in students while overcoming

Table 1. Selected research intervention apps, sample, and outcomes

Study	App	Accessibility	Intervention duration	Sample	Outcomes	Other observations
(Arean et al., 2016)	iPST Project EVO Health Tips	Not accessible	12 weeks	626 adults with mild to moderate depression	Improvement in depressive symptoms EVO had the most substantial effect on depressed mood in people with moderate levels of depression	Needs more adherence
(Bakker et al., 2018)	MoodKit MoodPrism MoodMission	Free (android) Paid (iOS)	30 days	226 adults with depressive symptoms	MoodKit and MoodMission groups showed decreases in depression	Increases in mental well-being
(Ben-Zeev et al., 2018)	FOCUS	Not accessible	3 months + 3 month follow-up	163 adults with serious mental illness	Participants in the FOCUS group and the clinic-based group significantly improved and did not differ in clinical outcomes, including general psychopathology and depression.	Improvements regarding recovery and quality of life were observed at six months for the FOCUS group
(Chan et al., 2019)	iParent	No translation	6 months + 4 months follow-up	660 expectant mothers	Associations were found between participation in the intervention and reduced depression	
(Hantsoo et al., 2018)	Mood tracking and alert app (MTA)	For organizations	Eight weeks	72 pregnant women with depressive symptomatology	MTA users had significantly more contacts regarding mental health. As gestational age increased, they rated the ability to manage their health significantly better than women in the control group.	Women who received a contact from a provider alerted by the MTA app were significantly more likely to receive a mental health specialist referral
(Kuhn et al., 2017)	PTSD Coach	Free	12 weeks	120 adults that were exposed to a traumatic event	PTSD Coach participants had significantly greater improvements in PTSD symptoms (p =.035) and depression symptoms (p =.005)	
(Lüdtke et al., 2018)	Be Good to Yourself	Not accessible	Four weeks	88 adults with depressive symptoms	Trend reduction of depressive symptoms	Improved self-esteem and quality of life
(Mantani et al., 2017)	Kokoro-app	No translation	Nine weeks + 8 weeks follow-up	164 adults with major depression	Decrease in depressive symptoms ($p < 0.001$)	An overall side-effect of medication improvement
(McCloud et al., 2020)	Feel Stress Free	For organizations	Six weeks	168 university students	Reduced depression symptoms (p =.006)	Needs more adherence
(Moberg et al., 2019)	Pacifica	Premium plan	One month	500 adults with mild-to-moderate anxiety or depression	Notable significant decreases in depression.	
(NeCamp et al., 2020)	App + fitbit	Directed at medical interns	6 months	1565 medical interns	Current mood state influences receptivity of mHealth interventions for mental health	Timing interventions is critical for the best results in the efficacy of the intervention.
(Pratab et al., 2018)	iPST Project EVO Health Tips	Not accessible	12 weeks	348 adults with depressive symptoms	Depressive symptoms improved over the treatment course, and the treatment outcomes were similar between the three apps	No significant differences were found in treatment outcomes between those identifying as Hispanic/Latino or not
(Pratab et al., 2019)	App + passive phone sensors	For organizations	One month + 2 months follow up	271 adults with depressive symptoms	Passive data facilitate clinical care	Individually, patterns can be associated with depression severity throughout treatment
(Stiles-Shields et al., 2019)	Boost Me Thought Challenger	Free	Six weeks + 4 weeks follow-up	30 adults with depressive symptoms	Thought Challenger - an improvement in depressive symptoms	

many of the barriers of traditional CBT. Nevertheless, further research is needed to assess its effectiveness at six weeks and beyond.

Of the included studies, some outcomes showed the usefulness of the mHealth technology as treatment support in depression. Mantani et al. (2017) demonstrated the effectiveness of a smartphone CBT app in treating patients with antidepressant-resistant depression. They found that adding smartphone CBT to medication change was more effective than the treatment by medication change individually. The smartphone CBT also decreased the overall side effect strain caused by the pharmacotherapy. Another study conducted with first-time expectant mothers with no more than 24 weeks of gestation demonstrated the effectiveness of the app as a complement to mental health intervention (Chan et al., 2019). The smartphone-based intervention as an adjunct to the standard antenatal services effectively reduced post-natal depression at four weeks postpartum compared with a control condition of standard antenatal services only. This allows a cost-effective alternative to psychoeducation intervention for expectant mothers.

The other study with a pregnant population conducted by Hantsoo et al. (2018) demonstrated that the mobile mood tracking and alert app improved service delivery and patient engagement among patients with perinatal depressive symptoms. The results have shown that mobile mood tracking made users had significantly more contacts addressing mental health. As gestational age increased, these women reported significantly increased ability to manage self-health than women in the control group. The mobile mood tracking app triggers alerts (leading to telephone contact by a provider) resulting in those women being significantly more likely to receive a mental health specialist referral.

In our opinion, the two studies that aimed at collecting passive data had very important results to the topic of this chapter. NeCamp et al. (2020) found that an individual's current mood state influences his receptivity to mHealth interventions for mental health. Pratap et al. (2019) stated that passive data has an important impact in facilitating care.

Although, Lüdtke et al. (2018) assessed the smartphone self-help application 'Be Good to Yourself' and only found a trend level in reducing depressive symptoms. Results were associated with a lack of frequent app usage and, for this reason, the authors point that it is vital to increase patients' motivation to use them. Besides the low frequency of usage, a high rate of dropouts was observed across most studies.

Furthermore, despite no significant differences in depression levels between groups, Ben-Zeev, Brian, Jonathan, et al. (2018) reported that a smartphone-delivered intervention (FOCUS) produced equivalent significant gains as a clinic-based group intervention for people with severe and persistent mental illnesses.

In the study of Pratap et al. (2018), it was demonstrated that depressive symptoms improved over the treatment course, and the treatment outcomes were similar between the three apps EVO, iPST, and Htips.

Safety and Ethical Outlines

There are approximately 20 thousand mHealth apps in the app stores with the potential to enrich overall self-care and, specifically in mental health, to enrich counseling or the possibility for simply recording our emotions (mood track). However, there is no governing body to oversee and regulate app development, and many developers are not affiliated with mental health professionals. The mood track and alert apps alert providers when a patient is experiencing worsening mood symptoms (Hantsoo et al., 2018), but many apps lack emergency information if an emergency occurs while using a mHealth app.

Important and mandatory topics exist to protect and not jeopardize the client's safety. Disclaimers that keep clients informed about the app and instruct them to seek professional assistance in case of emergency are necessary.

The collection and sharing of personal data is also a significant concern, primarily because the apps deal with sensitive information and most apps require a Wi-fi connection. In fact, and as the World Health Organization (2011, 2017b) states, data security and privacy are matters that require legal and policy concerns to safeguard that mHealth users' data are adequately protected.

These privacy violation issues constitute a significant barrier to patients' trust in mHealth (Schueller et al., 2018; Stiles-Shields et al., 2017).

Besides this, the shortage of appropriate specifications and reporting guidelines prevents how we characterize an app for depression. Many apps allegedly have depression treatment capabilities; however, many fail to deliver appropriate evidence-based interventions (Bowie-DaBreo et al., 2020). Despite being estimated to be over a thousand (Firth et al., 2017), this dearth of adequate supervision does not establish a rigorous number of apps for depression currently available on the market.

According to Porras-Segovia et al. (2020), most apps for depression are commercially driven, while research teams and healthcare facilities develop only a tiny amount.

A Review and content analysis of the depression app marketplace (Shen et al., 2015) showed that 29.5% of the apps were developed by commercially oriented corporations, while researchers from the medical or academic settings developed only 5.3%. Another finding by the authors is related to the type of treatment or evidence basis that the app was built upon, which is unclear or even misleading, and might lead users to believe that the interventions are medical and evidence-based (Wisniewski et al., 2019).

Adding another concern to this topic, choosing one application in the middle of many offers presents a challenge to patients (Firth et al., 2017). Without advice and supervision, apps for depression may lose their value and purpose and possibly becoming counterproductive. Without proper guidance, patients may be drawn to use specific mHealth interventions and not search for the professional help they may need. The analysis made previously in this chapter is intended to guide mental health professionals by informing them and thus allowing effective patient guidance related to mHealth apps for depression assistance.

Human Relations in Mental Health and mHealth

A considerable debate is being carried out about this topic, especially implicating the lack of physical presence and interaction with mental health professionals (Marshall et al., 2020; Teles et al., 2019)

One of the most critical aspects of therapy is the therapeutic alliance built during the therapeutic process. It is essential to establish a relationship of complete trust between the therapist and the patient. In this phase, an agreement between the parties concerning the objectives, creating an emotional bond, and a pact regarding the work to be carried out inside and outside the office is decisive. Clients with weaker therapeutic alliances were more likely to drop out of psychotherapy (Sharf et al., 2010).

For a variety of concerns, dropouts are standard when RCTs on Mobile Mental Health are performed. For example, distrust of the credibility of a mHealth intervention, fear of or suspicious thoughts about mobile devices, privacy, confidentiality, and online security, resulting in a drop in motivation levels (Arean et al., 2016; Kannisto et al., 2017; McCloud et al., 2020; Pratap et al., 2018; Stiles-Shields et al., 2017). Despite the advantages seen so far in this chapter, it is a common understanding that it is difficult to keep users engaged in the active components of mHapps without therapists or other in-person support (Pratap et al., 2018).

For that reason, the processes used in the studies of Hantsoo et al. (2018) and Pratap et al. (2019) may be interesting to focus on because they aim to improve mental health care delivery by monitoring, predicting, and alerting providers, improving the therapeutic process, patient-therapist interaction and trust, and the overall therapeutic alliance. This trust is also reflected upon mHealth usage and acceptability.

For this, we are led to consider if mHealth should be employed as the treatment itself or only as a complementary tool for depression assistance.

Treatment or Complement?

Mobile-based self-help applications could represent promising complementary means to tackle depressive symptoms (Lüdtke et al., 2018). Nevertheless, the therapist has an underlying ethical obligation. Ethics is an inherent and inseparable part of clinical medicine as the physician has an ethical obligation to benefit the patient, avoid or minimize harm, and respect the values and preferences of the patient (Varkey, 2021). Therefore, therapists need to have in-depth knowledge about the apps that may be recommended to their clients. Since various tools and models are available, counselors must help clients make informed decisions when choosing a mHealth app. In part, finding the appropriate app may be challenging because app stores have inadequate reporting of organization affiliation and content source (Shen et al., 2015). This causes an increased difficulty when assessing the credibility and reliability of the search results.

This chapter aims to assist mental health professionals in this decision-making; however, other guides assist in this assessment of mobile apps focused on mental health (e.g., Psyberguide, American Psychiatric Association App Evaluation Model, and uMARS) (Palmer & Burrows, 2021).

Since the early research on the topic (Donker et al., 2013; Harrison & Goozee, 2014; Kazdin & Blase, 2011; Price et al., 2014; Proudfoot, 2013), it was considered that apps are an opportunity to increase patient access to science-based mental health treatments. However, it was quickly concluded that many apps fail to integrate rigorous, well-studied interventions (Harrison & Goozee, 2014; Hundert et al., 2014; Sama et al., 2014).

The inconsistency between availability and assessment is a problem because a multitude of these apps continues to be advertised with misleading claims to captivate consumers (Kumar et al., 2013; Steinhubl et al., 2013; Tomasella & Morgan, 2021). Regarding this issue, guidance and app prescription becomes essential. However, sustainable and scalable app prescription may be dependent on the development of a trustworthy electronic app repository (Byambasuren et al., 2020) specifically for mental health professionals.

With all this in consideration, the authors suggest that people should use apps as a complement to treatment and "prescribed" by an informed mental health practitioner. However, it is important to note that some people use apps for self-treatment, mainly because of anonymity. Stigma, discrimination, and animosity regarding mental health is still a profound problem and so, mHealth must also find its place in help battling it by educating users, as some apps already do.

But there are other advantages that we should have in mind. mHealth apps are low-cost, 24-hour service, and have the possibility of the treatment being carried out anywhere. These advantages possess an undeniable sense that mHealth should also be considered for full treatment purposes, particularly for those who might not have access to conventional treatment because of economic or geographic conditions.

Reflecting on all the dimensions of mHealth, we cannot firmly take a stand in whether it should be applied as a complement or as a complete treatment. Either way, the authors feel that when in-person therapy is available, mHealth should be effective as a complementary tool, enhancing the treatment.

A practical and urgent application of this technology, for example, is related to the recent COVID-19 pandemic. The decrease in overall mental health was anticipated by the World Health Organization (2020) as a consequence of the measures employed by governments worldwide to fight the pandemic. According to the United Nations Sustainable Development Group (2020), the COVID-19 crisis laid the seeds of a major mental health crisis. It is already estimated that the prevalence of depression increased from 3.44% in 2017 to 25% due to the impact of COVID-19 (Bueno-Notivol et al., 2021).

Besides, with healthcare workers rapidly developing burnout (Cabarkapa et al., 2020; Duarte et al., 2020; Rajhans & Godavarthy, 2021), it also decreases the populations' access to care. With the combination of the reduced capacity of health services with an increased risk of mental illness amongst the population, a future mental health-related epidemic seems plausible. This is when mHealth may have a preponderant role by addressing the shortage of means and professionals, increasing access, treatment management, and follow-up for patients.

A positive outcome of the pandemic is the increased digital literacy, especially amongst the elderly (Lee & Hsu, 2021; Martínez-Alcalá et al., 2021). This increase in technology acceptance and literacy by those segments of the population, that otherwise were sometimes resistant, is important for the successful application of mHealth and must be used to advantage.

FUTURE RESEARCH DIRECTION AND RECOMMENDATIONS

As observed previously, the high level of dropouts is a frequent limitation of the studies assessing mHealth's effectiveness. For example, Arean et al. (2016) state that half of the enrolled participants never downloaded their respective apps, despite completing eligibility screens, consent forms, and baseline assessments. This dramatic dropout rate usually limits the conclusions in terms of interpretation.

For that reason, some studies engage in strategies to improve adherence. Some of the analyzed studies offer payments or other bonuses to participants that remain in the research (Arean et al., 2016; Ben-Zeev, Brian, Jonathan, et al., 2018; Hantsoo et al., 2018; Kuhn et al., 2017; NeCamp et al., 2020; Pratap et al., 2018; Stiles-Shields et al., 2019). Participant retention seems to improve with such incentives; however, it is not enough to keep engagement from declining (Anguera et al., 2016).

As Lüdtke et al. (2018) state, future research should determine the reasons for the high dropout rates. Are these technologies less binding than face-to-face therapy? "Do these apps overburden users?" NeCamp et al. (2020) state that when the app notification delivery is unnecessary, it may negatively affect the patients' mood and behavior. Concomitantly, McCloud et al. (2020) reported some mild to moderate adverse events associated with the intervention.

Either way, dropout and low motivation to use these technologies seem to be the biggest problem, especially in the general population and when the interventions are fully remote. However, higher engagement tends to be noticed when the intervention focuses on particular situations and scenarios.

This way, it is clear that future research should focus on finding strategies to encourage adherence to the intervention and maintain motivation. For that, it seems that is also important to identify the preferences of different groups of users as it increases engagement (Fleming et al., 2019) and decreases resistance behavior and technostress (Cao et al., 2020). From there, it seems beneficial that the development of apps is conducted in co-design, where the end-users are involved in the process. However, even though this design is proposed to increase engagement (Hagen et al., 2012), the benefits of this type of participatory research should be studied further as they are still unclear (Orlowski et al., 2015). Meanwhile, co-design should be focused on the involvement of carers and clinicians to improve implementation in practice (Craven et al., 2014). Besides, cognitive impairment, apathy, and low motivation are characteristics of people suffering from depression. For that matter, it makes sense that carers and clinicians take part in the designing process and contribute to strategies to surpass those barriers.

On the other hand, regarding accessibility, it seems to be one of the vital positive points that mHealth can offer.

This accessibility can overcome economic barriers because of its low cost, social barriers such as stigma because of anonymity, and geographic barriers due to remote capabilities. But, despite good overall results for depression assistance, the lack of human interaction seems to be something that prevents this technology from becoming ultimately employed and may never substitute the mental health professional's role.

In other words, our findings allow us to suggest that the most critical role of this technology is the complementarity that mHealth can achieve regarding mental health services. As an example, the study of Hantsoo et al. (2018) represents how mHealth can monitor the depressed mood of pregnant women, notifying the respective care provider and so, improving mental service delivery and patient engagement.

Another study supporting our suggestion is the one of Mantani et al. (2017) in patients with major depression who had not responded to antidepressive medication. Adding the CBT app 'Kokoro-app' to medication change had better results than medication change alone.

Furthermore, the study of Chan et al. (2019) confirmed that the standard antenatal services plus the 'iParent' app are more effective in reducing post-natal depression than the standard services alone.

However, another scenario where mHealth seems to fit perfectly is pointed out by McCloud et al. (2020) when stating that their app ('Feel Stress Free') can be offered, especially when the demand for therapy is higher than the offer, or in a blended-therapy type manner. It seems very useful to have these interventions available to those actively seeking help and that may even be on the waiting list for traditional therapy. For that matter, it is essential to integrate mHealth in the public health systems in synchronism with traditional therapy.

This positive role of complementarity may seem appealing to mental health clinics and hospitals, but, on the other hand, accessibility is sometimes an illusion.

Our search identified that only a few of these apps are accessible to the general population for free on iOS and Android: Boost Me and Thought Challenger (Stiles-Shields et al., 2019) and PTSD Coach (Kuhn et al., 2017). Others are paid apps on iOS but free on Android: MoodKit and MoodMission (Bakker et al., 2018). Pacifica (found as 'Sanvello') is free on both operating systems. However, the study of Moberg et al. (2019) employed the premium plan of the app. Meanwhile, other apps are only accessible by organizations (Hantsoo et al., 2018; McCloud et al., 2020; Pratap et al., 2019) or oriented to specific populations (NeCamp et al., 2020). Some were not found or accessible (Arean et al., 2016; Ben-Zeev, Brian, Jonathan, et al., 2018; Lüdtke et al., 2018; Pratap et al., 2018). Moreover, Kokoro-app and iParent are not translated to English at the time of our search.

Concerning what was discussed in this topic, future mHealth research and development should aim to address these issues. It is of our opinion that one of the most critical positive characteristics is accessibility. Without genuine free accessible apps, all the barriers by which mHealth would stand out fall short.

It is the opinion of the World Health Organization (2017b) that the progress in implementing mHealth involves sharing global information communication technologies norms and frameworks. This cooperation would help bring down most of the obstacles that currently prevent this technology from asserting itself as an essential and valuable tool for improving mental health treatment.

Finally, the authors believe that training mental health professionals and other health professionals in the use of mHealth is critical to assure safety and effective handling by patients.

CONCLUSION

It seems inevitable that mental health apps will have an ever-greater preponderance shortly, especially with the advances related to 5G technology. However, we cannot fail to mention that many aspects will have to be improved. It is essential to have governmental supervision and interconnection between programmers and mental health institutions, as well as formal training available to mental health professionals. It is also decisive to differentiate the applications that seek to complement treatment from those that are treatment themselves. Improving evidence by reducing dropout rates is crucial for future research, without ever forgetting the ethical and safety concerns regarding mental health apps. Regardless of all those issues, the authors are optimistic about the potential of this technology. The accessibility grants mental health care to those who do not have access to it, acceptability and complementarity to conventional treatment is significant, overall cost-effectiveness is evident, and the way these apps might increase the interest and consciousness about mental health is fundamental.

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KEY TERMS AND DEFINITIONS

mHealth: mHealth (or mobile health) is the access to mobile technology such as smartphones and tablets to provide health solutions typically via applications (apps).

mHealth Passive Data: Data that is usually gathered by an app using the phone's core functions or an external device such as a fitness band or smartwatch to manage or improve health.

Mood Track: An app category that aims to gather data from the user about his mood. The app may prompt the user via a notification or not.

Mood Track and Alert (MTA): An extension of the capabilities of the mood track apps which gather data from the user about his mood and alerts the user or mental health provider about specific cases.

Passive Phone Sensors (PPS): Sensors embedded in the mobile device generate data gathered without user involvement.

Self-Help App: A broad category of apps that aim to improve the users' ability to self-care.

Smartphone: A mobile device with traditional cellphone communicating capabilities such as voice call and short message service (SMS), internet access via wi-fi or mobile data, global positioning system (GPS), and app management accessibility.

Tablet: Usually a larger mobile device with access to the internet via wi-fi, with global positioning system (GPS) and app management accessibility. Some models have access to the mobile network, which grants the device voice call capabilities, short message service (SMS), and internet access via mobile data.

Toolkit App: An app category of mobile applications that usually present several digital tools.

Section 2

Computer-Based or Web-Based Psychosocial Interventions

Chapter 3
The Road to Digitally-Driven Mental Health Services:
Remote Psychological Interventions

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ABSTRACT

Intervention in mental health urges new solutions that merge solid theoretical foundations and new possibilities provided by technological development. This chapter is structured around results from a data mining technique using VOSViewer, which organized the field into five clusters of published literature: (1) most affected populations, (2) mental illness/disorders and their impact, (3) the expansion of remote interventions, (4) ICT potential to overcome limitations and (5) a positive approach to ICTs in mental health care. Solutions and recommendations are presented to overcome the issues identified, including how future interventions should consider old and new issues as the ones raised by the COVID-19 pandemic. Computer-based or web-based interventions are hereby presented as part of the revolution towards digital mental health or e-mental health. This approach has the potential to deconfine interventions, releasing them from the traditional settings and reaching new populations. It also reinforces the path already started, from the secondary to the primary and primordial prevention, towards the modification of the psychopathological trajectories.

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INTRODUCTION

Living with a mental illness continues to pose countless personal, family, and societal challenges. Although most mental illnesses have recognized effective interventions, these treatments are not yet available to all. In recent years, this reality has also been negatively impacted by new phenomena, such as mass displacement of populations, psychosocial risks associated with work, with particular emphasis on emerging risks, and the COVID-19 pandemic that at the end of 2019 ravaged the world, affecting the way of living.

After the appearance of the first case of COVID-19 at the end of 2019, and the declaration of a global pandemic by the WHO on March of 2020 (WHO, 2021a), healthcare systems all over the world had to rapidly adapt to the new contingencies (Bilder et al., 2020). At the time of the writing of this chapter, 177,106,695 cases of the disease were confirmed all over the world, with 3,840,223 deaths being the direct result of it (WHO, 2021). Considering COVID-19's rapid spread, restraining measures hae been constantly applied all over the world until the current time. For example, in Portugal, similar to other countries, measures like national lockdowns (in 2020 and 2021), restriction of movements, physical distancing, prophylactic isolation, and quarantines were applied not only to mitigate the spread of the virus but also, and importantly, to reduce the pressure imposed to the national health system due to COVID-19 (Direção Geral de Saúde (DGS), 2021).

Reports from the Eurofound (2020, 2021) shed light on the fact that over one fifth of European citizens that answered the survey have missed at least one health-related examination or appointment during COVID-19. The reasons pointed by the participants of the survey were, among others, the lack of availability of health services due to the pandemic, long waiting lists, fear of contracting the virus, and lack of money to attend the appointments or to do the examinations. In the European Union, Hungary, Portugal, and Latvia were the countries where the reported values of unmet need for healthcare were higher (Eurofound, 2020, 2021). Similarly, a study about the impact of the COVID-19 pandemic on healthcare services in Portugal (Ordem dos Médicos et al., 2021) found that 57% of the Portuguese people considered that COVID-19 made the access to healthcare services more difficult; the most affected segments of the population seem to have been the elderly (69%) and people with chronic diseases (70%). The same study also found that three in every ten people that felt sick during the pandemic did not use healthcare services and that the main reason for not seeking or not attending healthcare services during the pandemic was the fear of being infected with SARS-CoV-2. These results are in line with a study from Nielsen & Leckovich (2020) that reported that the feelings of fear and numerous concerns about the potential exposure to the virus led to self-isolation and avoidance of in-person health care services, which meant thatproper care for some diseases might not have been provided.

In response to COVID-19, however, a rapid and widespread use of telemedicine was prompted all over the world (Madigan et al., 2021). For example, in Portugal, a growing of 101% was registered from 2019 to 2020 in remote medical consultations of primary care, accompanied by a decrease of the appointments in the clinical context (-38%) and at home (-37%) (Ordem dos Médicos et al., 2021). The total number of consultations in the primary care context (considering remote, clinical context and at-home consultations) actually grew; the same did not happen in the hospital context with a decrease of 11% compared to the same period of the previous year was registered in 2020.

The same tendency was observed in remote consultations, where an increase of 50% of telemedicine appointments was observed (Ordem dos Médicos et al., 2021), with the telephone being the technology most often used and with less than 5% of the telemedicine appointments having used image transmission.

In addition other already well recognized and documented phenomena make this modality of intervention crucial, such as the need for early and accurate detection of mental disorders, the decrease of the time gap between detection and intervention, the improvement of service network coverage reaching new populations, the increase of empirical studies showing the effectiveness of the interventions regardless the model used, and the stigma associated with the issues and care in mental health.

This reality led governments to take on new strategies, as recommended, for example, by the World Health Organization (WHO, 2021b) in the Global Strategy on Digital Health 2020-2025 which stimulates Governments to move towards the universal coverage of the healthcare systems.

The impact of Information and Communication Technologies (ICTs) on the global "way of life" has been multifold and previously unimaginable solutions are now becoming possible, including how, where, and to whom mental health services can be provided to.

Therapy and counselling services in particular have been assuming in new formats, a phenomenon expected to increase in the upcoming years (Dowling & Rickwood, 2013; Haberstroh et al., 2014; Richards & Viganó, 2013). As standalone or as complementary methods ICTs are broadening accessibility to services, increasing coverage, and offering new responses. Still, the integration of ICTs in counselling and therapy remains a scarcely explored solution that poses numerous challenges (Cataldo & Bogetti, 2017) despite potential benefits of this format, and even to better understand the effects of the different modalities of remote intervention compared to face-to-face intervention (e.g., written, audio, or audiovisual support), and prepare professionals and users to use all available services, namely through the development of skills in digital literacy. The development of transversal skills, as the case of multidisciplinary work competencies, that allows successful crossing between technology and health is also required.

To structure this chapter the authors followed an approach based on data mining terms from scientific journals using VOSViewer, a software that can be used to create and analyze bibliometric networks based on data from bibliographic databases.

The global literature about digital intervention published between 2020 to 2021 were scanned in the EBSCO collection database. The search terms applied to identify the closest matching publication included "ICT" or "App" or "Apps" or "remote" or "digital" or "distance" or "telehealth" or "remote" AND "mental health" or "psycholog*" or "psychoeducation*" AND "intervention". Language was limited to English, resulting in a total of 563 scientific or academic papers, after the removal of 36 duplicates.

Understanding the most frequently used terms as well as how they co-occur in the literature enables an overall idea of the type of issues and relationships being studied and presented in the literature as hot topics, displaying the current trends. The VOS Software adds the possibility of visualizing the research field's literature.

VOSviewer (version 1.6.10), a software for scientific literature analysis by scientometricians (Van Eck & Waltman, 2014), was used to analyze the Co-authorship, Co-occurrence, Co-citation and themes.

The mapping technique used by the VOSviewer software is called VOS, where VOS stands for visualization of similarities. In this study, we asked VOSViewer to create a text-based map, using both the titles and abstracts from the papers selected, and including only the 120 most occurring terms. In the final step of the analysis we eliminated all the terms that were evidently related with methodology or scientific writing (e.g., qualitative study, surveys and questionnaires), as well as common words in the scientific writing that were too general to bear meaning to the analysis or that were somehow inadequate for this work (e.g., male, female, humans, United States, Australia).

To obtain the layout and the clustering of the terms in a term map, this software uses both a mapping and a clustering technique that jointly provide a framework (Waltman, Van Eck, & Noyons, 2010). Here, the layout (i.e., the location of the terms in the map) is determined by the mapping technique, whereas clustering technique groups the terms by color (Figure 1).

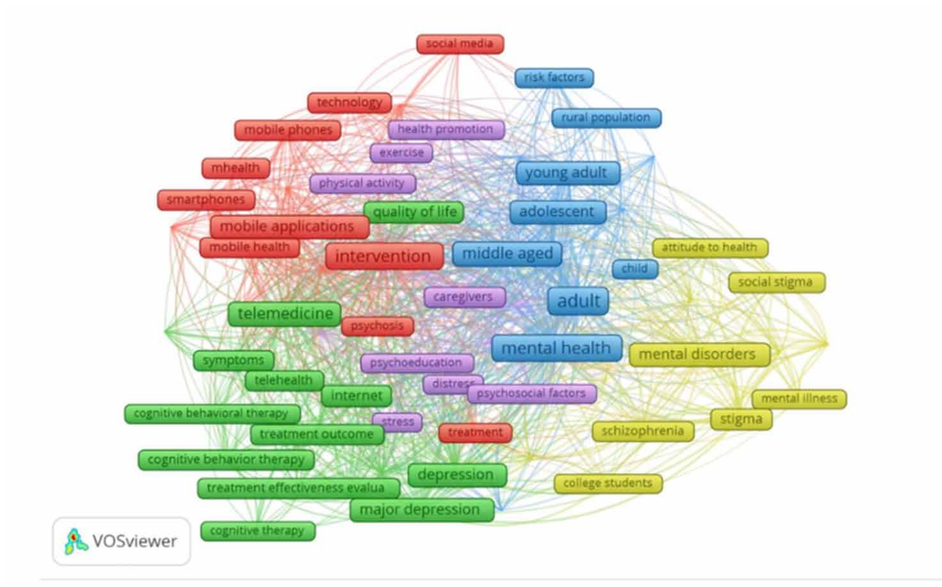
The output of this analysis allowed the identification of five clusters that can be seem in Figure 1 and are presented below:

- **Cluster 1 (in blue):** Mental health: who are the most affected populations?
  The theme of mental health and the risk factors associated with it are addressed. This cluster also refers to populations where this theme has mostly been explored: middle aged adults, adults, young adults adolescents, and children. The challenges faced by the rural populations, from diagnosis to intervention, also emerged.
- **Cluster 2 (in yellow):** Mental disorders/mental illness and their psychosocial impact
  Refers to mental disorders or mental illness (e.g., schizophrenia), as well as psychosocial aspects of mental health, such as stigma, social stigma, and attitudes face to health.
- **Cluster 3 (in green):** Digital era: the expansion of remote interventions
  In this cluster the theme of digital technology at the service of health emerged with terms like telemedicine, telehealth, internet. The potential of digital health to intervene in some of the most prevalent mental disorders such as depression is recognized, supported by cognitive therapy or cognitive behavior therapy (CBT). The potential of these interventions is also explored, with terms such as treatment effectiveness evaluation and treatment outcomes.
- **Cluster 4 (in red):** The ICT potential to overcome limitations
  In this cluster the role of the technology in intervention and treatment of mental disorders is addressed, namely mobile applications, mobile phones, smartphones, mobile health (mhealth). One of the network nodes gives a prominent place to social media.
- **Cluster 5 (in purple)**: A more positive psychology approach to ICTs
  This cluster recognizes the relationship between the stress and in particular the negative stress (i.e., distress) and psychosocial factors as a source of mental health problems. It also recognizes the role of new types of intervention, supported on the ICTs, as health promotion, psychoeducation, and the role of new actors, such as caregivers.

These clusters address key topics of the literature on mental health and ICTs use. Despite having clear identities, they seem to be somewhat entangled. This may reflect how young and evolving this area still is. For example, the keywords in cluster 5 (in purple) referring to Positive Psychology seem to connect (predictably) with plenty of other clusters, which will reflect in this chapter structure, without rigid borders.

This chapter's structure rests on this initial analysis andstarts with the development of mental health, presenting e-Health as a booming area, offering new solutions to a wider population. Some of these solutions are already being implemented, while others are under development, but many are still in the realm of imagination, benefiting from the unstoppable advancement of technology and a focus on health promotion. Challenges and potentialities of this kind of intervention, with emphasis on psychological intervention, will be identified and discussed, towards the improvement of the knowledge about an area that has peaked in the past year due to the COVID-19 pandemic. Therefore, the solutions proposed will be theoretically driven and supported by the very recent literature available, including the lessons learned from the pandemic.

Figure 1. VOSviewer results for the text-based mapping and clustering.



BACKGROUND

Mental Health: Who Are the Most Affected Populations?

Mental health problems constitute a massive burden to individuals and societies, causing human suffering and negatively affecting the economy. According to the World Health Organization (WHO), mental health is defined as:

A state of well-being in which the individual realizes his or her abilities, can cope with the normal stresses of life, can work productively and fruitfully, and can make a contribution to his or her community (World Health Organization [WHO], 2001, p.1).

This definition reinforces the commonly accepted view that (mental) health is more than the absence of disease. However, this definition has faced criticism due to lack of inclusivity and may cultural, social, and values biases. On the other hand, the correspondence between mental health and well-being/functioning is also unclear.

Trying to avoid restrictive and culture-bound statements and to consider a variety of emotional states and "imperfect functioning" complementary definitions have been proposed. This is the case of the definition by Galderisi et al. (2015) which characterizes mental health as:

a dynamic state of internal equilibrium which enables individuals to use their abilities in harmony with universal values of society. Basic cognitive and social skills; ability to recognize, express and modulate one's own emotions, as well as empathize with others; flexibility and ability to cope with adverse life events and function in social roles; and harmonious relationship between body and mind represent *important components of mental health which contribute, to varying degrees, to the state of internal equilibrium (pp. 231–232).*

If a person's mental balance is altered by a mental disorder, their decision-making ability and other behaviors can be compromised, affecting daily functioning and different areas of life, such as school or work performance, relationships, and community integration. On a larger scale, it can also affect one's family and society (WHO, 2013).

Mental health conditions affect different populations in diverse manners, including children and adolescents among the most vulnerable population (WHO, 2021c).Inthis respect, the COVID-19 pandemic has accentuated cleavages. For example, young adults, Hispanic persons, black persons, essential workers, unpaid caregivers for adults, and those receiving treatment for preexisting psychiatric conditions have been identified as particularly vulnerable (Czeisler et al., 2020). The risk for major health disorders is generally higher in the urban areas, mainly due to the concentration of low socioeconomic status, low social capital, and social segregation, and to the higher rates of pollution and more physical threats (Gruebner et al., 2017). However, an inverted tendency is observed in China, with persons from rural areas exhibiting higher levels of depression and other mental health disorders (Huang et al., 2019). Additionally, persons who live in rural areas tend to be more susceptible to social isolation and stigma and have greater barriers to accessing healthcare services than persons who live in urban areas (Douthit et al., 2015), which can be accentuated by a crisis scenario such as the COVID-19 global pandemic.

The effect of COVID-19 on the mental health of rural and urban areas has been the subject of research. One study onthe population of the United States of America reported no differences in the prevalence of mental health symptoms between the people who live in the rural areas when compared to the people in urban areas (Czeisler et al., 2020). However, the results of two studies developed in China found that urban residents tend to report more mental health problems associated with COVID-19 than rural residents, exhibiting more severe anxiety and depression symptomatology (Zhang et al., 2021; Liu et al., 2021), contrary to what was found in previous studies (Huang et al., 2019). This might be explained by several facts: a higher prevalence of COVID-19 in the urban areas, the living conditions in the rural areas (more spacious and less crowded), the fact that high population density poses greater risk for the spread of the virus, and by the fact that the persons who lived in the urban areas exhibited higher levels of knowledge regarding the virus in all aspects when compared to their rural counterparts (Zhang et al., 2021; Liu et al., 2021). Furthermore, a study focused on the mental health of a rural population with severe mental illness found that the COVID-19 pandemic and related physical distance did not significantly impact the mental health and well-being of those patients when compared to data available from before the pandemic (Riblet et al., 2020). This was attributed to previous use of telemedicine by the sample of the study, the reduction of the social stigma and the increase of social solidarity, maintenance of social supports through the stay-at-home orders, and the fact that the sample of the study lived in areas with a low prevalence of COVID-19 (Riblet et al., 2020). On the other hand, a study that measured community susceptibility and resilience to COVID-19 and compared it between rural and urban areas in the United States found that rural areas were more susceptible to COVID-19 due to older and more health-compromised populations, to the lack of mental health services, fewer physicians, higher disability and fewer insurances, and to the poorer internet access that limits telemedicine (Peters, 2020). Additionally, a study reported that women who live in rural areas started to adopt detrimental health behaviors during the pandemic, as the increase of alcohol consumption and the decrease of attending to health-related appointments, particularly the ones with children (Glenister et al., 2021). The pandemic has also been affecting more than COVID patients. Unpaid caregivers who had been providing critical aid to adultsat increased risk for severe illness as a result of the COVID-19 had a higher incidence of adverse mental and behavioral health conditions compared with others (Czeisler et al., 2020). For this reason, they recommend that caregiver workload, especially in multigenerational caregivers, should be taken into consideration during mental health assessments (Czeisler et al., 2020).

Mental Disorders/Illness and Their Psychosocial Impact

Mental disorders or mental illnesses are conditions that affect a person's behavior, feelings, thinking, or mood. They are usually associated with suffering. Mental disorders are classified and described in detail in manuals such as the International Classification of Diseases (ICD-11; WHO, 2019) and the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; APA, 2013). For a condition of this nature to be classified as a disorder, the criteria must be present continuously or be recurrent, resulting in aggravation or disturbance of personal functioning in one or more areas of the individual's life, such as employment, family, and social life (APA, 2013; WHO, 2019).

Despite the huge development in mental health witnessed in western societies. Mental health conditions are increasing worldwide, having become over the last years, the main cause of disability and one of the main causes of morbidity in societies (DGS, 2012). More precisely, 12% of illnesses worldwide are mental, a figure that rises to 23% in developed countries (Xavier et al., 2013). In Europe, 165 million people are affected by an illness or mental disorder annually (Wittchen et al., 2011). Mental illness and substance abuse are major causes of disease burden, accounting for nearly 9% to 17% of the total burden of disease in low and middle-income countries (LMICs) (Marquez & Saxena, 2016).

Among the most prevalent conditions are depression, anxiety, bipolar disorder, and schizophrenia. Five of the ten leading causes of disability and psychosocial dependence are neuropsychiatric illnesses: depression (11.8%), alcohol-related problems (3.3%), schizophrenia (2.8%), bipolar disorder (2.4%), and dementia (1.6%) (Xavier et al., 2013); depression alone has been estimated to affect 350 million persons (Marquez & Saxena,2016).

Mental health conditions may be occasional or chronic, minor - often with a minor impact on daily life – or major, being more severe and severely impact the persons' lives, such as schizophrenia, bipolar disorder, major depression, and severe forms of anxiety. Major mental disorders may sometimes require hospitalization to preserve the patient or other's safety (WHO, 2019).

Mainly due to demographic changes, there has been a 13% rise in mental health conditions and substance use disorders in the last decade (to 2017) (WHO, 2021c). Approximately one in five people in post-conflict settings have a mental health condition (WHO, 2021c).;

Around 20% of the world's children and adolescents have a mental health condition. This scourge affects large and small countries on different continents. For example, two of the most common mental health conditions, depression and anxiety cost the global economy US$ 1 trillion each year (WHO, 2021c). In the USA, more than 50% will be diagnosed with a mental illness or disorder at some point in their lifetime (Kessler et al., 2007) and 1 in 25 Americans lives with a serious mental illness, such as schizophrenia, bipolar disorder, or major depression (SAMHSA, 2016). One in five children, either have currently or at some point during their life will have a seriously debilitating mental illness (Merikangas et al., 2010).

Many mental health conditions can be effectively treated at relatively low cost (WHO, 2021c), however the global median of government health expenditure that supports mental health is less than 2%

(WHO, 2021c). It is estimated that approximately 80% of people in LMIC with severe mental disorders receive no treatment (WHO, 2013), contributing to enlarge the mental health treatment gap between those who need care and those who have access to it. Further, despite progress in some countries, people with mental health conditions keep experiencing severe human rights violations, discrimination, and stigma (WHO, 2021c).

Therefore, increased investment is required on all fronts: for mental health awareness to increase understanding and reduce stigma; for efforts to increase access to quality mental health care and effective treatments; and for research to identify new treatments and improve existing treatments for all mental disorders. In 2019, WHO launched the WHO Special Initiative for Mental Health (2019-2023): Universal Health Coverage for Mental Health to ensure access to quality and affordable care for mental health conditions in 12 priority countries to 100 million more people (WHO, 2021c). It is notable that the inclusion of mental health on the unified global agenda dates back but a few years ago, by world leaders who subscribed the Sustainable Development Goals (SDGs, 2021), in which prevention and treatment of non-communicable diseases was prioritized. The role of mental health was recognized, although indirectly, in all the 17 SDGs (2030 agenda) (Dybdahl & Lien, 2017). The goals *2 – Good Health and Well-being* and *3 – Quality Education* highlight that health and psychosocial wellbeing are important for education and school attendance. Humanitarian crises, caused by conflicts or natural disasters, and low income may negatively impact the ability and possibility to learn. High-quality education can promote and protect mental health through knowledge and life skills, provision of safety and meaningful activities, as well as social networks (Dybdahl & Lien, 2017)

These seem to be unprecedented measures to fight the level of effective treatment coverage which remains extremely low.

Arguably, the best approach had already been suggested by the 2013 WHO mental health action plan, as a multisectoral strategy, that combines universal and targeted interventions for promoting mental health and preventing mental disorders, also contributing to the reduction of stigmatization, discrimination, and human rights violations (WHO, 2013). This strategy, although still pertinent, might be somewhat insufficient.

Digital Era: The Expansion of Remote Interventions

Cognitive-behavioral models or therapies still play a prominent role in the provision of health services today; however contextual therapies have emerged, with new guiding principles and intervention methodologies to achieve well-being and quality of life. These therapies have been the subject of empirical research, particularly concerning its application in the field of mental health (Pinto et al., 2018).

Studies using different methods have sought to document the effects of new forms of intervention, namely remote interventions, including during the COVID-19 pandemic which continues to devastate the world.

E-Health - a term that emerged during the 1990s tailored to define the provision of health services anchored in the safe and cost-effective use of ICTs (WHO, 2005) - has been used as a way of meeting the specific needs of clients while improving their independence and reducing the costs of inpatient care (Hall et al., 2012). . This construct encompasses all related terms, like telehealth, telemedicine, digital health, and remote patient monitoring, and does not define a new area of healthcare but instead a new format of delivering healthcare services (Halpren-Ruder, 2020).

Until recently the literature focused on the advantages of e-Health in using ICTs to provide healthcare services and their capability to compensate the limitations of traditional interventions (e.g., traveling requirements for both therapists and clients) as well as their role as a complementary means for in-person interventions. At this point, however, these advantages are starting to be established for totally remote-delivered interventions (Andersson & Titov, 2014; Dores et al., 2016; Feijt et al., 2018).

In the specific case of psychological services, the integration of ICTs in psychological interventions has begun it's implementation a few years ago; the development of this process is in different stages according to the region of the globe we are addressing (Dores et al., 2020; Marra et al., 2020).

With the onset of the COVID-19 pandemic, and the associated mitigating measures implemented by several countries, remote psychological interventions were often the only way to continue providing those services.

The possibility of delivering healthcare services remotely assumes a greater relevance in exceptional contexts, as crisis or catastrophes that restrict the movements of citizens, as is the case of disadvantaged groups that cannot access to in-person interventions (e.g., refugees; migrants; people that live in remote areas of the globe), and people with reduced mobility (Barbabella et al., 2016; Norris et al., 2018; Talhouk et al., 2020).

People in rural areas tend to face greater barriers to health care than people who live in urban and suburban areas, which can result in higher mortality rates and shorter life expectancy (Douthit et al., 2015; Long et al., 2018). Furthermore, a tendency for not recurring to health care services, even when needed, has been observed and seems to be related to an added difficulty in accessing health care services (Cordasco et al., 2016; Douthit et al., 2015). This difficulty is mainly due to factors directly related to the person (e.g., cultural beliefs, low reliance on health care professionals, finances, health literacy) as well as the scarcity of health facilities and professionals within the area of residence (Antezana et al., 2017; Cordasco et al., 2016; Douthit et al., 2015). The COVID-19 pandemic, and the associated mitigating measures, came to accentuate the isolation of people living in rural areas and to limit even more their access to health care services (Douthit et al., 2015). Telehealth is showing promise as one possible response to the problems associated with geographic limitations, with higher cost-effectiveness and more accessible, reliable, and affordable health care services to rural communities (Antezana et al., 2017). A study by Riblet and colleagues (2020) found that the previous use of telemedicine by the participants of the study, and the maintenance of the telehealth intervention during the pandemic, was a protective factor of the impact of COVID-19 in the mental health of persons with severe mental illness.

Similarly, digital tools seem to have added value when it comes to asylum seekers and refugees. Traditional psychological counselling may not be the best way to support this demographic group, due to some of their differentiated characteristics such as language and the physical and economic conditions in which they might live after leaving their countries (Drda-Kühn et al., 2019; Sijbrandji et al., 2017). Nonetheless, most of these people have experienced traumatic events in the past (which may lead to post-traumatic stress) and present a high prevalence of mental health disorders, including depression, supporting the need for psychological counselling during at least their integration into the new society they will live from that moment on (Drda-Kühn et al., 2019; Kröger et al., 2016; Sijbrandji et al., 2017). In Europe, experts with different backgrounds developed and implemented a project focused on the counselling and therapeutic interactions with the so-called "digital natives", raising awareness to the potentialities of the information and communication technologies for providing therapeutic and counselling processes (Drda-Kühn et al., 2019). One of the main results of this project (Therapy 2.0 – Counselling and Therapeutic Interactions with Digital Natives) was the outline of the relevance of new digital technologies, such as smartphones and tablets, in the delivery of remote psychological support, since they can help overcome the main barriers of working with this population: the language barrier can be overturned by real-time translation programs, and the uncertainty of residence barrier can be surpassed by remote-delivery interventions (Drda-Kühn et al., 2019).

It seems that traditional in-person psychological interventions are now starting to face some limitations with the new generations, due to their growing familiarity and comfort with digital technologies (Dores et al., 2021a). However, a growing need for developing psychological interventions that meet the needs of these groups of people emerge from the increase in the report of symptoms of mental health disorders among them (Beck & Wright, 2021; Canevska et al., 2019; Johnson, 2021; Lattie et al., 2019). Technologies are being widely and actively used by the last four generations (generations X, Y or Millenials, Z or iGen or Digital Natives, and Alpha), and have shaped even their communication style and preferences, with the favoured communication channels being texts, apps, and social media (Beck & Wright, 2021). This makes digital technologies a much-needed solution for the design and implementation of psychological treatments using technological devices, which seems to be viable due to widespread access to both internet connection and at least one technological device (e.g., computer, smartphone) (Curtis et al., 2019; Sussman & DeJong, 2018).

The existing scientific evidence points out the relevance of using telemedicine practices in mental health care of disadvantaged groups and new generations, as above-mentioned. New formats of psychological intervention are needed to face the specific characteristics of these populations. However, some concerns need to be addressed for remote interventions to be susceptible to being applied with these groups, mainly related to internet accessibility, to the availability of digital technologies, to digital literacy, and to ethical procedures (Antezana et al., 2017; Esteban-Navarro et al., 2020; Riblet et al., 2020; Peters, 2020; Sussman & DeJong, 2018).

Several guidelines and support documents were developed by institutions in the field of psychology, such as the American Psychological Association and the Portuguese Psychologists Association; as a result, psychology practitioners started to train themselves in the use of ICTs as a mean to provide psychological therapy and counselling (Dores et al., 2020; Hammers et al., 2020; Marra et al., 2020; Mendes-Santos et al., 2020). These efforts conducted by the institutions and the psychologists themselves were also accompanied and supported by studies reporting the positive results of remote interventions in terms of their feasibility, efficacy, and cost-effectiveness (Burton & O'Connell, 2018; Buyl et al., 2020; Ownsworth et al., 2018), with remote interventions being considered at least as effective as face-to-face interventions (Andersson et al., 2013; Berger et al., 2011; Ly et al., 2014).

The ICT Potential to Overcome Limitations

As a result of the rapid evolution of information and communication technologies (ICTs), healthcare systems have changed significantly over the past few years. These changes have contributed to the provision of better and more personalized healthcare services, as well as an increase of the clients' satisfaction as well as a greater availability, efficacy, and efficiency of those services (Maksimović & Vujović, 2017). There seem to be some characteristics of the technology-based interventions that are contributing to increase the availability and efficacy of psychological interventions, such as the total customization of both the course and the type of activities included in the intervention according to the person's needs and functioning, and the possibility of increasing the motivational aspects and ecological validity of those processes through activities closer to the person's real contexts and with more appellative designs and game elements (Brunner et al., 2017; Dores et al., 2021a; Elaklouk & Zin, 2017). In addition, expanding the autonomy of the person in their process of psychological intervention has been gaining a preponderant role to face the growing need flexibility (location as well as time-wise)and time flexibility and availability to integrate sessions into their daily routines (Bucci et al., 2019; Callan et al., 2020; Dores et al., 2020). This boot in patient autonomy is associated with the development of ways to self-monitor and self-manage their behaviors and feelings that are not possible from a face-to-face and paper-based interventions standpoint (Bucci et al., 2019). Therefore, the delivery of healthcare services that were previously delivered exclusively in health institutions, can now be provided in several scenarios, from health institutions to patients' own homes (Maksimović & Vujović, 2017).

As mentioned before, COVID-19 pandemic and the associated mitigating measures came to the enhance the development of telemedicine tools, practices, and guidelines and, at the same time, accentuate the need for those elements. A study with Portuguese psychologists has highlighted the outstanding growth of totally remote delivery of psychological interventions during the pandemic, when compared to before the global emergency, accompanied by a change in the attitude of these professionals towards the inclusion of technology-based solutions in the therapeutic processes (Dores et al., 2020).

The technology-based delivery of psychological services has been mainly performed resorting to e-mail and videoconferences through computer and smartphones (Dores et al., 2017; Dores et al., 2020); however, mobile health has gained a special strength in the past few years and is starting to become an essential part of healthcare services, due to the globalization of the smartphone's availability that improved the access and convenience on one hand and reduced the costs of those services on the other (Bush et al., 2019, Powell et al., 2017). The WHO (2011) defined mobile health (m-Health) as the use of mobile and wireless technologies to provide medical and public health services, which have the potential to change the paradigm of health services through enabling the provision of healthcare regardless of time and space. A study focused on the willingness of consumers and clinical professionals to adopt new technologies in the treatment of mental health-related issues (Dragovic et al., 2020) found that most consumers are willing to accept and support new technologies, and that people with severe mental health disorders have similar mobile device use as the general population, suggesting that mobile applications (apps) can be viable in the psychological support for mental health problems. The reported positive consumers' opinions were accompanied by an rising trust of mental health professionals on the usefulness and efficacy of mobile apps in the management and treatment of mental health disorders (Dragovic et al., 2020).

Thus, the efficacy of mobile apps in mental health has been a target of assessment in the last few years. A recent systematic literature review of the focused on exploring the effectiveness of mobile apps to the treatment of mental health disorders analyzed 12 randomized controlled studies with adult population (Akgün et al., 2019). The authors outline that an important feature of these tools is the possibility of self-monitorization and notice changes at earlier stages, which increases the person's awareness of their symptoms; this contributes to earlier diagnosis and earlier search for help, and, consequently, to improve the efficacy and effectiveness of the treatment (Akgün et al., 2019). Similarly, a review from Donker and colleagues (2013) examined the effects of mental health apps within eight different studies that targeted symptoms of depression, anxiety, and substance use, and found significant reductions of those symptoms both from pre- to post-intervention assessments and between experimental and control groups. In these cases, four of the five mobile applications provided support from a mental health professional.

An even more recent approach is the use of social media to serve mental health services, due to their massive incursion into the daily life of the world population (Bush et al., 2019). The content analysis of social media are contributing to encounter risk factors for suicidal ideation and depression, for example (Bush et al., 2019), leading to the earlier detection, and consequently intervention, of those triggers. For example, a program developed in Taiwan used Facebook to assess suicidality risk among adolescents who used this social network through the analysis of their personal information and their response to a five-item questionnaire about suicidal risks. This program identified the high-risk adolescents, who were later contacted and supported by mental health professionals and were given informative and support material (Chiang et al., 2011). Similarly, a study used different social medial platforms and online depression forum to reach out to persons who posted about depression-related topics and were able to identify and somewhat assess depression symptoms, to analyze their interest in treatments, and to identify barriers for seeking and accessing treatment (Szlyk et al., 2019). Thus, social media seem to have a special role in mental health education and literacy, improving population awareness for these problems and enabling earlier diagnosis and intervention. Additionally, studies are pointing towards the use of these privileged channels of communication for providing mental health interventions (Dewa et al., 2019; Napoli, et al., 2015; Naslund et al., 2016; Niu et al., 2020, Szlyk et al., 2019).

A More Positive Psychology Approach to ICTs

Although cognitive-behavioral models or therapies assume the main role in health services, a new conceptual framework labeled “third wave” seems to be at the origin of a new type of interventions. These interventions do not have the sole goal of reducing impairment and distress, but also intend to generate opportunities for meaning and enhanced wellbeing in people living with mental disorders and chronic conditions in order to improve their quality of life.

Positive psychology focuses on creating a context for wellbeing rather than mere symptom reduction as its main aim (Andrewes et al., 2014; Cullen et al., 2018; Tulip et al., 2020), arguably sowing the foundation for more sustainable healthcare. It is also described as second and third-wave (Lomas et al., 2020), which focuses on emotional balance, meaning and purpose, social ecology, and interdisciplinarity.

This evolution is also described in the well-known proposal by Hayes (2004), which organizes the process into three generations of therapies, which we seek to summarize below. According to this classification, first-generation therapies are associated with behavioural therapy that would be consolidated in the 1950s and 1960s. In its favor, the basis for intervention are empirically validated techniques derived from the principles of conditioning. However, the exclusive focus on observable behaviors turned out to be insufficient for understanding human functioning and consequent psychopathology which led to this approach being considered reductionist. The need to consider both the cognitive and affective dimension (Dowd, 2004; Hayes, 2004), opened the door to the cognitive revolution and the emergence of second-generation therapies (Pinto et al., 2018). These place their focus on irrational thoughts and beliefs, which can be identified and modified in therapy (cognitive therapy), but can also value the cognition-affection-behavior relationship, i.e., the interconnection between thoughts-emotions-behaviour (Hayes et al., 2004), and in this case os referred to as cognitive-behavioural therapy. Despite being one of the therapies with a larger body of empirical support, it is also the target of criticism, with some authors considering, for example, the evidence of modest efficacy (e.g., Wampold et. at., 2017). This circumstance, along with a growing evidence of mindfulness-based and acceptance therapies, constituted the ideal conditions for the emergence of third-generation therapies. Contextual cognitive-behavioral therapies (Hayes et al., 2012) are generically characterized by having an experiential nature; the use mindfulness exercises; emphasis on contextual and functional change in cognitions; promoting empowerment through a constructivist approach; reduction of psychopathological symptoms as a side effect of the intervention rather than it's main objective; integration of elements from other approaches/philosophies, some millenary; further, the principles are applied to both the patient and to the therapist, who must incorporate the principles and practice the techniques regularly (Pinto et al., 2018).

Cognitive-behavioral therapies today gather extensive empirical support resulting from their application in various areas of mental health (see Butler et al., 2006; Dobson & Dobson, 2009), namely in schizophrenia and other psychotic disorders (Wykes et al., 2007), in various anxiety disorders (Bandelow et al., 2007; Bisson & Andrews, 2013; Choy et al., 2007; Hope et al., 2010; Mitte, 2005), in major depressive disorders, being even recommended by the National Institute for Health and Care Excellence, (NICE, 2019). These therapies have also collected empirical evidence on populations at various developmental stages, including children and adolescents (Ost & Ollendick, 2017). In relation to contextual cognitive-behavioral therapies, of which mindfulness-based therapies are an example, empirical support is also growing. In the case of mindfulness-based therapies, there seems to be a positive relationship with quality of life, good immune activity, and good indicators of psychological and interpersonal functioning (e.g., Creswell, 2017; Khouury et al., 2013). Similar to cognitive-behavioral therapies, mindfulness-based therapies have been included in international guidelines (e.g., NICE, 2010), given the empirical evidence of application to disorders such as mood and anxiety disorders (Baer, 2014; Eisendrath, 2016). There is also evidence of the application with positive results in mental health of other approaches such as acceptance and commitment therapy (Hayes et al, 2019), with evidence shown in several meta-analyses (a-Tjak et al., 2015; Ost, 2014); even compassion-based therapies have been recommended, although in this case a meta-analysis has shown moderate results in reducing psychopathological symptoms and improving indicators of well-being (Kirby et al., 2017). It is still possible to find differentiated results according to the approaches and mental disorders in which they are applied to, but additional studies are needed to corroborate the preliminary results (Pinto et al., 2018)

It is worth noting that CBT is effective in a wide range of emotional problems in children, adolescents, and young people, including post-traumatic stress disorder (PTSD; Gutermann et al., 2016; Morina et al., 2016; Smith et al., 2019); anxiety (Bennett et al., 2016) among others, whereas with some of the new models the evidence is more limited and stricter methodological rigor is required in order to confirm the preliminary results. For example, the majority of mobile apps are sustained in the principals of Cognitive Behavioral Therapy, with psychoeducation being the most frequently used strategy, and self-help applications being the most common type. Regarding the efficacy and effectiveness of these tools, mobile apps seem to have contributed to the reduction of the symptoms related to the targeted mental disorders in general, including post-traumatic stress disorder, depressive disorder, suicidal ideation, bipolar disorder, psychosis, eating disorders, schizophrenia, and agoraphobic disorder (Akgün et al., 2019).

The internet and social networks can also play an important role in promoting health, from a more positive perspective. For example, the practice of physical exercise is among the activities that can contribute to improve health and that can be promoted through these means. Physical health benefits are well documented in the literature, such as those related to cardiorespiratory, metabolic, musculoskeletal, and functional health (WHO, 2010). More recently, additional benefits have been added the ones previously mentioned, such as improvement of cognitive health, health-related quality of life, and mental health, and sleep (WHO, 2020). The solid scientific evidence around the physical exercise benefits led to the recommendationof this practice by the WHO, which also made available specific recommendations on the amount and types of physical activity for various age groups, pregnant and post-partum women, and people living with chronic conditions or disabilities (WHO, 2020).

The dissemination of this kind of information through digital communication channels reaches a broad audience. However, this path is not without risks. If the internet and social networks can play a strong psychoeducational and health literacy promotion role (Centers for Disease Control and Prevention, 2021), they can also misinform and promote risky behaviors and even behavioral addictions that can harm individuals. Social pressure to have a perfect body especially in Western societies, is transforming the value and meaning attributed to the practice of exercise (Dores et al., 2021b). Exercise is being increasingly used to boost appearance, rather than to promote health, or be just a pleasurable activity in of itself (Corazza et al., 2019; Mooney et al., 2017). Social media have been disseminating this "fitspirational" trend, namely through the continuous displaying of "perfect bodies," (Barry et al., 2017; Simpson et al., 2017). This content might negatively impact adolescents and individuals with mental health problems (Giorgetti et al., submitted), which makes it a future target of psychological interventions.

MAIN FOCUS OF THE CHAPTER

Issues, Controversies, Problems

Despite the timeliness of the present topic, the lack of clear guidance about the efficacy of the mental health interventions delivered via digital tools is still a big issue (Petrovic & Gaggioli, 2020) in the sense that it might enable the marketing of commercialized, unproven treatments that may be counterproductive (Gooding, 2019). In line with this argument, the numerous unregulated apps and platforms for delivering this type of interventions are emerging rapidly, which raises the question of quality, effectiveness and legitimacy of this approach (Shrivastava et al, 2020).

The risk of a technology push where apps may be developed by for profit commercial companies, and therefore suiting their own requirements and agendas more than those of the people with mental health issues cannot be ignored (Shrivastava et al, 2020).

Thus, the expansion of the use of digital technologies in mental health is creating the need for clearer legal and regulatory frameworks, especially since the development of these technologies encompasses both long-standing practices (e.g., online counseling) as well as more novel ones (e.g., AI powered tracking of patients regarding intake of psychiatric medicine or accounting for the risk of suicide via AI assisted social media trailing) (Gooding, 2019). The use of generalized tracking as a form of prevention as well as treatment has been raising issues regarding generalized public control which may easily be misappropriated (Gooding, 2019).

There seem to be barriers to the effectiveness of digitally driven mental health interventions, such as the severity of mental health issues that may hinder engagement, technical issues, and a lack of personalization from the programs and apps (Borghouts et al., 2021). Trust and engagement with digital technologies can be harder to attain especially with certain mental health conditions, such as depression, paranoia, or psychosis, a critical issue in interventions where the rapport and therapeutic relationship is a key element (Hollis et al, 2018).

Another consequence that might occur is the generation of a digital divide, where the exclusion of those unwilling or unable to access technology, due to cost, age group, geographic location, social status, or lack of knowledge about digital media is unavoidable (Shrivastava et al, 2020).

Thus, there is insufficient evidence about the privacy, safety, accuracy, and clinical benefits or cost-effectiveness of digital interventions in mental health (Shrivastava et al, 2020).

SOLUTIONS AND RECOMMENDATIONS

Digital mental health tools have the power to address specific needs in an inexpensive, accessible, and time-saving manner for a diverse number of populations from caregivers (Petrovic & Gaggioli, 2020), to trans and gender diverse people (Strauss et al, 2019), children and young people (Bergin et al, 2020), college students (Lattie et al., 2020), marginalized and underserved populations (Schueller et al, 2019), etc. During extended crises such as COVID19, these technologies allow us to provide mental health services when other options are unavailable, due to confinement issues as well as a shortage of qualified human resources (Sorkin et al, 2021).

These interventions tend to create a sense of social connectedness, amplified insight into personal issues, and feeling in control of one's health (Borghouts et al., 2021).

The interventions these tools facilitate may include topics like coping skills, emotional self-regulation for caregivers (Petrovic & Gaggioli, 2020), depression, and anxiety (Garrido et al, 2019), among other psychological and psychiatric issues. The potentially unrestricted geographic reach and scalability, as well as the inclusion of big data and algorithms to help optimize mental health interventions gives digital mental health the potential for paradigm shifting change in service delivery and the development of new treatments while reducing costs (Gooding, 2019).

The creation of well-defined guidelines (e.g., clear checklists) and the inclusion of follow-up results in studies (Petrovic & Gaggioli, 2020) as well as double-blind testing (Garrido et al, 2019) are of paramount importance. The development of regulations and legislation regarding these technologies is indispensable, requiring a profound reflection on major legal and ethical issues (Gooding, 2019). Relevant actors should come together to prioritize matters and recommend legislative and regulatory options that support responsible public governance on the manifold digital mental health interventions (Gooding, 2019), thus setting universal standards for mental health app quality control, including at a minimum the assessment of data security, intervention effectiveness and usability (Torous et al, 2019).

Game-based interventions seem to be an option that appeals to a young cohort, but the creation of these games must be created with the synergy of healthcare professionals and videogame/app developers to be successful: fun and user experience must be considered as well as the therapeutic purpose (Martins & Dores, 2020; Strauss et al, 2019).

People are increasingly using technology as a whole; this is enabling the surgency of digitally driven healthcare interventions and the exploration of various ways people can use technology to self-manage their mental health, which means there is consumer interest in this type of products/services (Borghouts et al., 2021). This reality is attractive for private investment that may enhance the effectiveness, availability, and usability of these types of tools. The synergy between healthcare professionals and entrepreneurial parties is key to the full potential development of these types of interventions.

FUTURE RESEARCH DIRECTIONS

Although the use of ICTs in Psychology is not so recent, COVID-19 boosted remote sessions in an unprecedented way. This was accompanied by a significant growth in available guidelines to address the lack of knowledge and reduced practice regarding totally remote-delivered interventions that were transversal to most professionals.

Nonetheless, the American Psychological Association had already published their first guidelines for helping professionals in the provision of telepsychology in 2013, encompassing considerations from the psychologist's competence to the inter-jurisdictional practice (APA, 2013).

Considering the standard and evidence-based practices in Psychology, remote sessions should also incorporate the main ethical considerations associated with the provision of psychological services, such as obtaining informed consent, the need for continuous professional training, and the respect for the privacy of the person who is attending to the session (APA, 2013; OPP, 2019).

The need for getting informed consent of the person who is attending psychological services as well as the need for assuring their privacy (APA, 2013; OPP, 2019), already so important in in-person psychological practice, becomes even greater with internet-associated risks, such as being hacked. This highlights the importance of using appropriate software to both deliver and store information regarding clinical processes and to get appropriate training for using these tools.

Yet, the larger gap in the provision of remote psychological services is the lack of psychology-related assessment instruments that can be applied remotely, as well as the reduced number of validation studies of the ones that can be delivered via internet. Future research projects should then focus on developing, validating, and testing the efficacy of assessment instruments on the remote-delivered modality, in order to provide professionals with the opportunity to plan and design customized psychological interventions based on their results.

The need for continuous professional training is associated with updating the theoretical knowledge regularly, namely regarding the new evidence-based practices. This now includes the need for the professionals to update their knowledge about the use of new technologies to the provision of psychological services, including both the level of efficacy of these practices, and the numerous platforms and instruments available, their characteristics, and different client fit. Future research projects might be relevant for developing or testing the efficacy of the different instruments, methodologies, and platforms, applied to different problematics and functioning profiles, that psychologists might use for the provision of psychological services, as well as literature reviews of the already existent studies for the establishment of evidence-based guidelines.

The relevance of considering the cultural background of the person who is attending psychological services is now accompanied by the need to bridge different jurisdictions (APA, 2013; OPP, 2019). Working with the people from all over the world means that psychology professionals need to adjust their practice not only to the cultural traditions of the person, but also to the jurisdiction of the country they are living in. Future research projects focused on reviewing the main jurisdiction associated with the provision of psychological services across the world might enable psychologists to make informed decisions about the best procedures to adopt when working in international settings.

As demonstrated throughout the chapter, ICTs involve devices, networking components, applications, and systems enabling communication in the digital world. Thus, they comprise the internet sphere, the mobile powered by wireless networks and older technologies such as landlines, radio, and television, as well as cutting-edge technology such as artificial intelligence and robotics. With these characteristics, ICTs can be an important instrument serving health promotion, providing support for different types of mental health care, and make healthcare available when access to face-to-face interventions are either difficult or impossible. Thus, the potential contribution in overcoming longstanding obstacles that hamper access to services, such as those caused by limited clinical resources, reduced mobility, high costs, and the stigma associated with traditional health services in this area is undeniable (Farrington et al., 2014). Activities like assessment, diagnosis, monitoring, treatment, or even training (e-learning), can be conducted remotely through platforms and mobile devices. In addition, interventions may be customized and contextualized, especially if access to the information by the professionals is timely, allowing for informed decision-making (Aboujaoude et al., 2015). ICTs applied to mental health may support specialized care and community mental health care, potentially enhancing and enabling informal approaches and self-care as well, in a psychoeducational logic (Marquez & Saxena, 2016).

To be able to make sustained progress in the construction of global e-mental health, it is important to carry out further research with stronger methodological rigor on the efficacy and effectiveness of the interventions using technology, especially digital. The systematic collection of information and its analysis, namely through machine learning, may enable to access to knowledge that was unavailable up to this point. This will certainly impact positively the quality and diversity of the services provided. However, compliance with the European data protection regulation, universal ethical principles, and ethics code must be followed closely to safeguard the participants' right to privacy. Towards the construction of a high-quality solution, everyone must be included. Governments, private and public health sectors, academia, and patients might be involved in the enhancement and prioritization of e-mental health, putting it on the global agenda, and working on new solutions for old and emerging questions.

CONCLUSION

Recent circumstances have exponentially accelerated remote healthcare intervention. Therefore, there is an urgent need to understand whether the rapid incorporation of technology in the business world and our lives, in general, can be replicated at the same pace in the health area and realize its effects. This seems like a no-return process, but we are navigating a potentially paradigm shifting, brave new world. A growing number of studies have analyzed the efficacy and effectiveness of interventions supported in new formats, with promising results that support a revolution in the delivery of healthcare services. As the motivation for the use of new formats increases, it is important to understand if it is accompanied by a growing investment of the professionals in the training for its correct use or if a false sense of familiarity creates shortcuts that should be avoided. The training of professionals with skills in the confluence of these two areas, health, and technology, is crucial to achieve high-quality solutions. These solutions must be developed with high respect for ethical, deontological, and scientific implications of venturing into innovative paths in health, particularly in mental health practices.

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KEY TERMS AND DEFINITIONS

Data Mining: An automatic or semi-automatic process of extracting, analyzing, and discovering patterns in large scattered data sets involving methods at the intersection of machine learning, statistics, and different software enabling companies to convert raw data into useful information (e.g., patterns, anomalies) that can be used for multiple settings and purposes.

e-Health: Is the use of internet technologies to deliver health contents and interventions.

m-Health: Is the use of mobile devices (e.g., smartphones) to deliver health contents and interventions.

Mindfulness: It translates the self-regulation of attention and an attitude of acceptance without judgment, and openness to internal and external experience; the notion of being fully present in the present moment.

Primordial Intervention: Early intervention through a set of measures that aim to preserve health potential and encourage a healthy lifestyle, namely through mass education, rather than focusing on specific risk groups such as in primary prevention or on early detection and prevention such as treatment, as seen in secondary prevention.

Telemedicine: Use of information and communication technologies to provide information and/or clinical services at a distance, in real time, to whom by necessity (e.g., remote location, inability to move) or preference choose this type of intervention.

VOSviewer: A software for creating create and analyzing bibliometric networks based on data from bibliographic databases that features the visualization of similarities (VOS) through different graphic outputs.

Chapter 4

Digital Peer Support for People With Severe Mental Illness:
Key Concepts and Findings Overview

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ABSTRACT

The literature has recognized peer support as a fundamental part of the recovery process for people with severe mental illness (SMI). These populations frequently experience barriers related to (self)stigmatization, social relationship, poor friendship quality, ostracism, isolation, and fear of being rejected or embarrassed. Scientific research suggests those individuals are more willing to share personal and sensitive details through digital technologies, building friendships and using the internet to access health information rather than their peers who do not experience SMI. The purpose of this chapter is to explore the digital-based peer programs and to analyze scientific evidence behind the alternative paradigm, related concepts, intervention designs, and results.

INTRODUCTION

This chapter aims to explore the new paradigm of digital peer support as an emergent approach in psychiatric interventions due to its potential of accessibility and ubiquity.

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As an alternative psychiatric intervention, peer-to-peer support is presented as a mutual aid provided by people who share similar experiences concerning mental health challenges. This service aims to promote hope through a path of understanding and connection, decreasing social isolation.

In the last decades, traditional face-to-face peer support has reported beneficial effects in a range of mental health dimensions such as re-hospitalization rates, illness self-management and sense of empowerment and belonging. Moreover, recent technologies and Internet-based interventions have integrated general health field with substantial impact on content updates and configurations, breaking geographical boundaries, providing more availability and accessibility as well as promoting engagement. These technologies are remarkably flexible, ranging from mobile devices, like smartphones and tablets, to computerized programs and applications.

The digital world has caused profound changes in the way health care services has been provided. Hence, digital technologies have also reached mental health landscape, trying to overcome traditional settings' barriers. It is essential to highlight that digital tools and programs do not replace traditional care services, but rather augment its capacity and spectrum.

Recently, digital peer support has emerged as a promising intervention modality that congregates technology potential with peer support approach effectiveness. Research has been done to evaluate feasibility, acceptability, and adherence of these programs, trying to expand its scientific evidence.

The body of literature has been relatively heterogeneous concerning both technological format and peer support design. Therefore, digital peer support can assume multiple forms in various contexts. Consequently, the purpose of this chapter is to expose the current evidence-based practice along with its acknowledged results and identified limitations.

BACKGROUND

The majority of people affected by Severe Mental Illness (SMI) — schizophrenia, schizoaffective disorder, bipolar disorder, or major depressive disorder — have difficulties accessing care and the largest barriers include lack of trained professionals to comply with the demand, the stigma that mitigates help-seeking and the high cost of treatment (Naslund et al., 2014; O'Leary et al., 2018). Since the demand for care is unlikely to be met by training additional professionals, alternative approaches capable of significantly expand the capacity of mental health care are necessary (Andalibi & Flood, 2021; O'Leary et al., 2018). One way to overcome barriers related to traditional psychiatric services is to provide training and mentoring to develop the capacity of peers with mental health challenges to support each other (O'Leary et al., 2018).

Mental health services have been changed to a recovery-oriented model. Rather than focusing on symptom remission, this movement emphasizes the importance of developing personal goals and values (Peck et al., 2020). Some authors have suggested a framework with five personal recovery topics: 1) social connectedness; 2) hope and optimism about the future; 3) transforming identity; 4) finding meaning and purpose; 5) and finally, empowerment in mental health self-management forming the acronym "CHIME" (Leamy et al., 2011). Within the recovery model, people with SMI have shared their personal recovery experience to help peers increasing a "sense of authenticity, trust, understanding, acceptance and support in developing adaptive self-management strategies, counteracting negative stereotypes of mental illness and making it evident that recovery is possible" (Peck et al., 2020, p. 2). Peer support can offer a culture of health and ability as opposed to a culture of illness and disability by not being based on medical models and diagnostic criteria (Mead et al., 2001).

The literature has globally recognized peer support as a fundamental part of the recovery process and central key for mental health services that aims to be person-centered by offering patients the tools for overcoming limitations of illness through coping and management strategies (Andalibi & Flood, 2021; K. L. Fortuna, Venegas, et al., 2019; Naslund et al., 2014). Through a wide range of mental health services, the effectiveness of peer support has been linked to the encouragement of information sharing and behavioral modeling that can lead to more substantial autonomy on the road to recovery (O'Leary et al., 2018; Strand et al., 2020).

Solomon (2004, p.393) defines peer support as "a social emotional support, frequently coupled with instrumental support, that is mutually offered or provided by persons having a mental health condition to others sharing a similar mental health condition to bring about a desired social or personal change." Additionally, Mead's et al. (2001, p.135) peer support definition has been widely recognized as "a system of giving and receiving help founded on key principles of respect, shared responsibility, and mutual agreement of what is helpful", where people unfold their personal experience with mental illness and/or mental health services, providing social, emotional and practical support to other patients (Penney, 2018; White et al., 2020) on how to deal effectively with adversities arising from the disease and the associated stigma (Davidson et al., 1999; K. L. Fortuna, Venegas, et al., 2019; Naslund et al., 2014).

Historically, there is evidence of its practice throughout the moral treatment era in France at the end of the 18th century and in England in the middle of the 19th century with the "Lunatic Friends' Society" being referenced as the earliest peer support group in mental health (Ibrahim et al., 2020; Shalaby & Agyapong, 2020). Although naturally occurring mutual support has been up for ages, those groups were inside the asylum context (Davidson et al., 1999). Thus, peer support as we know today has its roots in the mental health consumer movement and the human civil rights of the 1970s, in addition to the Independent Living movement. Under such circumstances, individuals living with SMI protested against discrimination and injustices — authoritarian psychiatric practices, compulsory hospitalizations and coercion to undergo unproven treatments — and started a fight for elementary human rights, mental health care reform and the power to make their own health and life choices (Naslund et al., 2014; Penney, 2018; Shalaby & Agyapong, 2020). In the 1990s, peer support was formally introduced as a service in community mental health care, and it is nowadays well recognized worldwide, although recovery-oriented services reform is yet to be systematically formulated (Davidson et al., 2012; Ibrahim et al., 2020; Shalaby & Agyapong, 2020).

Peer support is a non-clinical intervention that tries to fight against the alienation, stigma and social isolation that still inevitably follow a psychiatric diagnosis (Penney, 2018). Literature has pointed out those peer-support programs for people with long-term mental illness have the potential to deliver optimism, empowerment, and hope in a future of acceptance and opportunities according to recovery-oriented rehabilitation process (Andalibi & Flood, 2021; Davidson et al., 2012; K. L. Fortuna, Venegas, et al., 2019; Gillard, 2019; Naslund et al., 2014; Strand et al., 2020).

The advantages of this intervention are wide-ranging, as both providers and consumers can benefit from a mutual empowerment, in addition to mental health service teams and the society (Fan et al., 2018; Solomon, 2004). Research has found effectiveness evidence of peer support programs in multiple recovery dimensions such as medication adherence, reduced depressive and psychotic symptoms, increased self-care, patient activation (K. L. Fortuna, Venegas, et al., 2019), improved self-esteem (Andalibi &

Flood, 2021), enhanced sense of mastery in illness self-managing (O'Leary et al., 2018), social network and wellness, and reduced treatment costs and rates of re-hospitalization (Strand et al., 2020).

Traditionally, peer support has taken the form of a face-to-face intervention, individualized or group-based in multiple service settings such as inpatient and outpatient psychiatric units (K. L. Fortuna et al., 2020; K. L. Fortuna, Brooks, et al., 2019). Davidson et al. (1999, p.165) identified three forms in which peer support can be developed: "(1) naturally occurring mutual support groups, (2) consumer-run services, and (3) the employment of consumers as providers within clinical and rehabilitative settings." The first one develops when people "voluntarily come together to help each other address common problems or shared concerns" (Davidson et al., 1999, p. 168) with no internal standardized procedures; the second one is voluntary, intentional, and organized by people with psychiatric disorder in consumer-run services, there are some "paid staff and a significant number of volunteers" (Solomon, 2004, p. 393), although it may not be entirely mutual; finally, based on the benefits of mutual support, consumers are employed as Peer Support Workers (PSW) in conventional clinical and rehabilitative context.

Based on the recent reviewed literature, peer support can be simply categorized as being informal or intentional, depending on the setting that it is provided in (Penney, 2018). According to K. L. Fortuna, Venegas, et al. (2019, p.223-4) "informal peer-to-peer support, also referred to as patient-facilitated networks or patient networks, is defined as a support provided in a mutual relationship between people with similar life experiences." Thus, mutual relationships constitute the foundation of informal peer support, based upon people that come together and share their own experiences on SMI and/or mental health services, promoting a sense of belonging and friendship (Davidson et al., 1999; K. L. Fortuna, Venegas, et al., 2019; Naslund et al., 2014; Repper & Carter, 2011). Intentional peer support has emerged as an evolution of informal peer support. It is distinguished from naturally occurring peer support since it is more structured and there is a focus on skill-building to promote engagement in peer support relationships (Penney, 2018). Hence, consumer-run services and consumer as providers in rehabilitative settings as defined earlier by Davidson et al. (1999), is framed in intentional peer support concept.

Digital Peer Support

The evolution of recent technologies, applied to mental health care services, has been initiating a shift in the way that interventions might be delivered. Traditional psychosocial services have experienced barriers related to the lack of resources and accessibility of services and some researchers are optimistic about the digital technology potential to overcome some of these adversities, due to its low cost and ubiquity (Kaplan et al., 2011; Simões de Almeida et al., 2018). According to Berry et al. (2016, p.122), the "levels of Internet use among people with mental health problems are similar to those of the general population" and some studies have found participants were already embracing digital technologies and felt receptive to accept interventions through online and mobile framework (Ben-Zeev et al., 2013; Berry et al., 2016; Simões de Almeida et al., 2018).

Furthermore, the public stigma about mental illness has not decreased in the past few years, sustaining prejudice and discrimination upon SMI population (Sangeorzan et al., 2019). Overall, people with SMI present more social isolation, in contrast to the general population, correlated with stigma, alienation and loneliness (K. L. Fortuna, Brooks, et al., 2019). Notably, research has revealed one-third of this population preferred internet support compared to face-to-face support, since they could keep their anonymity and be more sincere about the illness and feeling confident sharing and asking sensitive questions on the Internet (Strand et al., 2020). Naslund et al. (2014, p.2) states that people with SMI establish the "online relationship at the same rate or higher when compared to individuals without a mental illness", which supports other results claiming that people with SMI would be willing to find a peer supporter specialist in digital platforms, creating an alternative to traditional treatments (K. L. Fortuna, Brooks, et al., 2019; Kaplan et al., 2011).

Peer support workers are adapting to the modern era of electronic (eHealth) and mobile health (mHealth), using technology to deliver peer support services augmenting the extension and availability of traditional face-to-face interventions (Andalibi & Flood, 2021; K. L. Fortuna, Venegas, et al., 2019; Strand et al., 2020). Therefore, a new paradigm has been created and recognized throughout the literature as digital peer support (K. L. Fortuna, Venegas, et al., 2019).

Regarding the increasing popularity of social media and its growing role of importance as a mean to interact with others, it is essential to consider that technologies such as support forums, groups and mental health-focused mobile apps contain the potential to simplify finding social and peer support and coping with SMI (Andalibi & Flood, 2021; Naslund et al., 2014; Strand et al., 2020).

Digital peer support may be defined as peer support mediated through technology in which health interventions are digital, including live or automated consumer interactions with a peer-support specialist or a professional as moderator or simply as a non-moderated online support group or community which might be defined as "any virtual social space where people come together to get and give information or support, to learn or to find company" (Andalibi & Flood, 2021; K. L. Fortuna et al., 2020; K. L. Fortuna, Venegas, et al., 2019; Preece, 2001, p. 348; Strand et al., 2020).

Digital peer support might take several configurations and features being either public and open or closed and private or ranging from the local or small to international or large groups (Preece, 2001; Strand et al., 2020). Therefore, the adoption of digital peer support such as peer-to-peer networks on social media, peer-delivered interventions supported by smartphone apps, and asynchronous and synchronous technologies is expanding the reach of this kind of mental health service (K. L. Fortuna et al., 2020).

The Internet has been proven to be a valuable tool for developing social connections. Evidence gathered in the literature suggests that individuals with SMI are more willing to share personal sensitive details through social media and blogging, building friendships and using the internet for accessing health information rather than their peers, that do not suffer from SMI (Andalibi & Flood, 2021; Naslund et al., 2014; Strand et al., 2020). Naslund et al. (2014) suggested that this could happen because social media might be perceived as a "non-threatening" environment that provides opportunities for the population with SMI to identify and connect with their peers within a safe context (Naslund et al., 2014).

Literature suggests that patients with SMI involved in peer-interventions supported by digital technology can benefit from a general quality of life improvement (K. L. Fortuna et al., 2018). Decision-making, healthcare utilization, self-management and patient's overall experience are some of de domains that are evidence-based improved (K. L. Fortuna et al., 2020).

Additionally, this emerging line of investigation has highlighted digital peer support effectiveness in reducing feelings of loneliness and self-stigma, enhancing medical and self-efficacy skills and encouraging individuals to become more active and informed throughout their recovery process. There has also been evidence that self-disclosure of personal information through social media has been linked to positive findings regarding social connectedness and functioning, coping strategies, hope and empowerment, individual behavioral control and psychological well-being (K. L. Fortuna, Venegas, et al., 2019; Naslund et al., 2014; Prescott et al., 2020; Strand et al., 2020).

Previous research indicates that anonymity and the option to use pseudonym might remove some barriers to seek support when facing stigma, increasing the social interaction opportunities and the accessibility to a broad range of coping and support tools. This feature also promotes a feeling of belonging to a positive and supportive community of individuals sharing the same challenges and possibly the same tools to overcome them (Andalibi & Flood, 2021; Naslund et al., 2014; Strand et al., 2020).

Distinctly, digital social network platforms simplify natural community building by reducing anxiety and fear concerning face-to-face physical interaction, since social media communication seems to be more flexible (Naslund et al., 2014). Digital peer support interventions also allow participants to have an autonomous control of their sharing and involvement (Naslund et al., 2014).

The anonymity offered by online digital peer support resources suggests being important for a welcoming and unprejudiced atmosphere which encourages disinhibition and self-disclosure, making “it easier to express ones’ ‘true-self’ online compared to offline” (O’Leary et al., 2018; Strand et al., 2020, p. 2).

Digital peer support is an expanding field of study that aims to strengthen traditional face-to-face mental health intervention. It can be provided in several technology modalities (figure 1), such as smartphone-supported interventions (e.g., apps) only digital or mixed with in person conventional setting, synchronous peer-support (e.g., videoconference), asynchronous technology (e.g., forums, videos and social media) and informal peer-to-peer support via social media (K. L. Fortuna, Venegas, et al., 2019).

By methodological choice, this chapter simplifies the technologies used in digital peer support communication in two categories: synchronous and asynchronous. Synchronous technology involves communication between peers occurring at the same time, which is typical of audio or video calls and text chat/instant messaging (K. L. Fortuna, Venegas, et al., 2019; O’Leary et al., 2018). Asynchronous technology enables peer-to-peer communication without the need for correspondence to occur in real time, i.e., people can connect to each other conveniently, providing resources and information at any time of their choice (K. L. Fortuna, Venegas, et al., 2019). Some examples of asynchronous peer support are YouTube videos (Naslund et al., 2014; Sangeorzan et al., 2019), computerized programs like CommonGround (Campbell et al., 2014), forums and social media groups on Facebook (Prescott et al., 2020), smartphone apps such as PeerTECH (K. L. Fortuna et al., 2018)

Recent Findings from the Literature

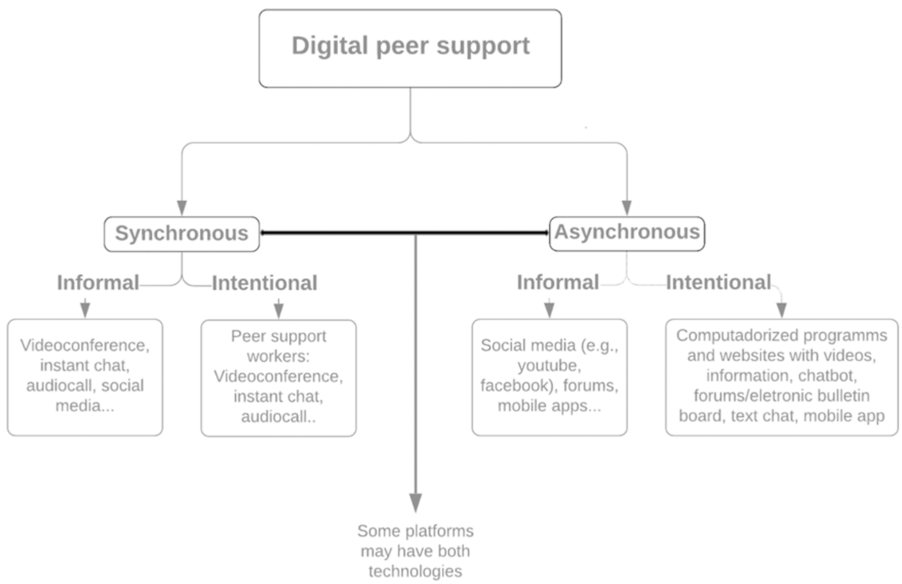
According to the heterogeneous nature of the subject that is still developing along with technology itself, the body of literature available is diffused and based on multiple theories that differ due to the distinct technologies adopted (Peters et al., 2015). Hence, a restricted number of articles was selected to clarify and expose the magnitude of current interventions being developed in digital peer support field to illustrate the overall spectrum of the theme.

The targeted population was defined as people over 18 years old, suffering from SMI and “Peer support”, “Social Support”, “Digital Intervention”, “Virtual Peer Support”, “Serious Mental Illness”, “Online Mental Health”, were some keywords used for the author’s research on PubMed, Web of Science and EBSCO databases. From search’s results, reverse and forward snowballing were used to enrich the references. There were no geographical or contextual exclusion criteria, and all study designs were considered apart from literature reviews. The included studies were published in English from 2011 to 2021.

From the articles that met the initial inclusion criteria, eight were conveniently chosen to provide a broader scope of digital peer support, especially concerning features such as peer support type intervention (informal or intentional), technology modality (synchronous or asynchronous) and digital platforms used.

The following selected studies (see Table 1 for the summary) provide a brief overview of the digital peer support platforms being currently developed as well as its distinctively features and main results.

Figure 1. Overview of the digital peer support modalities



Facebook SMI Groups (Prescott et al., 2020)

In recent years, the usage of online social networking sites (SNS) has increased globally. Some studies have indicated people have made use of SNS, such as Facebook, YouTube and Twitter to acquire and provide information about physical and mental health. In these online mental health communities, participants may read and post comments about mental illness.

Prescott et al. (2020) developed a study to increase the knowledge of how open Facebook groups are used to provide peer to peer support between UK and US groups. It included non-officially moderated groups, displaying features of an informal peer support, on a synchronous and asynchronous platform. The authors selected Facebook because of popularity and availability of opened groups addressing mental health issues, delivering peer to peer support. They carried out a systematic search with the keywords: Mental Health (n=38 groups), Anxiety (n=38), Depression (n=36), Schizophrenia (n=16), Stress (n=13), Bipolar (n=8), Psychosis (n=5), and found a total of 154 open Facebook groups. The user comments were copied, and the groups coded for study purposes. The inclusion criteria were the groups were based in the United States (US) or United Kingdom (UK), and exclusion were lack of user engagement, resulting in 14 UK Facebook groups and 11 US Facebook groups, a total of 25 groups. They made a thematic analysis of a set of 2801 pages of Facebook posts and comments, using QSR NVivo v.11. To secure personal information, demographic data were discarded. The data were analyzed from six themes: (1) Sharing Experiences, (2) Informational Support, (3) Emotional Support, (4) Direct Requests for Advice, (5) How Information is Received and (6) Benefits of Social Media.

Groups from US and UK allowed people to share experiences and stories from a personal perspective, seeking advice in numerous areas, such as therapy, coping strategies and medication. Overall, the support, advice and information were accepted with gratitude and appreciation, leading the authors to

Table 1. Characteristics of included digital peer support studies

Study	Study design (inc sample)	Informal	Intentional	Synchronous	Asynchronous
Facebook SMI Groups (Prescott et al., 2020)	Thematic Analysis (25 groups)	X			X
YouTube Video Comments (Naslund et al., 2014)	Qualitative analysis in online ethnography (3,044 comments)	X			X
Buddy Project (Andalibi & Flood, 2021)	Qualitative analysis of in-depth semi-structured interviews (13 participants)	X		X	X
PeerPlus (Peck et al., 2020)	Semi-structured interviews and edited videos (10 young individuals experiencing psychosis)		X		X
BlueBoard (Griffiths et al., 2015)	Content analysis, multiple coders and an inductive method (586 posts)		X		X
WellWave app (Mueller et al., 2018)	Quantitative: questionnaires & intake and exit interviews (10 participants)		X	X	X
ReConnect (Strand et al., 2020)	Thematic analysis – focus groups and interviews (29 participants)		X		X
YouTube Vlogging (Sangeorzan et al., 2019)	Interpretative Phenomenological Analysis (30 videos transcripts)	X			X

hypothesize that people asked for informational advice, perhaps due to accessibility and anonymity, also expressed by increased encouragement, empathetic and sympathetic responses.

The research contributed to a depth understanding of how group members relate to each other and share their personal experience with mental illness. Although, some limitations were presented: the impossibility to verify the diagnosis of mental health since the diagnoses was self-imposed; no demographic information was available; data set was limited to a determined time period. The lack of this information does not qualify the data to be generalized to wider population. The investigators suggest more research to explore the negative impact of Facebook peer support in terms of reducing face-to-face contact and increased feelings of loneliness; to discern opened and closed groups and to analyze peer support on Facebook in conjunction with other online or offline mental health service.

PeerPlus Program (Peck et al., 2020)

This study developed a web-based digital resource with videos to help guide and structure peer support sessions for people in recovery from psychosis. The aim was to develop a tool where people disclose their lived experience in mental health services and how they handled personal difficulties in the recovery process, integrated in the Peer Plus Program, a face-to-face peer intervention. Therefore, the project is an asynchronous video tool of intentional peer support inside the Peer Plus.

The authors justified the research based on previous studies, suggesting the lived experience videos are feasible and acceptable, providing sense of hope, connection, normalization and validation. However, most of these studies have been done with the adult population who has experienced psychosis. The project was developed in line with the Australian model of services designed for young people between 12 and 25 years old who are experiencing or at risk of developing psychosis. The intervention included the collaboration of Alfred headspace Youth Early Psychosis Program (hYEPP) clinicians, peer support workers (PSWs), and consumers.

The development of this resource took six steps, involving participation of the three parties delimiting the initial content framework of themes, used later to develop a semi-structured interview guide to conduct filmed interviews and editing these videos based on the pre-defined framework.

Step 1. **Collaborative planning:** this phase involved academics with experience in digital resource building, hYEPP service managers and PSWs evaluating the potential of a web-based lived experience video tool within a peer work program. They identified the need to explore the personal recovery priorities for this population.

Step 2. **Participatory Content Development Workshops:** four consumer workshops were co-designed, developed and conducted by two independent facilitators, two PSWs and ten hYEPP service users. They defined six personal recovery themes: (1) recovery, (2) relationships, (3) self-management, (4) basic needs/environment, (5) identity and (6) resources/stigma. Consequently, the six modules were renamed to be in appropriate language for a youth population and re-titled for: “My journey”, “Self-care”, “My identity”, “Connections”, “Life” and “Mental health.”

Step 3. **Development of semi-structured interview schedule:** participants helped to create a list of interview questions for each topic in the workshops. Open questions were formulated to allow the interviewees to express their personal experiences in each of the themes.

Step 4. **Recruitment and Briefing of Interviewees:** recruitment was co-designed to identify young people between 18 and 25 years old who had an experience of psychosis and would accept to share their story on film. The sample consists of ten young adults aged 18 to 31 years old (M= 23.10, SD = 3.84), due to difficulty in the recruitment, two young adults of 31 years old were included. Participants were rewarded with $200 (AUD) for the collaboration.

Step 5. **Interviewing and Filming:** The interviewer used the semi-structured interview, focusing on participants’ challenges and experiences, using the first-person perspective (e.g., “something I experienced has been…”, “I’ve found…”). They were invited to re-film their response, if the “first person perspective” or the delivery quality was required. Participants would be able to review the interviews transcriptions and inform if there was any content to be removed from the final video.

Step 6. **Editing:** video transcripts were reviewed and coded into the personal recovery themes identified in the workshops. Thereafter, they produced 16 videos using a video editor. The *a priori* parameters established the videos would be less than four minutes long each and containing at least three interviewers for diversity purpose. Respondents were invited to review the content of the final edited videos, only two did. Despite the initial choice for 16 videos, they decided to choose only 14 videos, regarding insufficient content on “My journey” and other for the “Life” theme. The average video’s length is 2.70 minutes.

The development of this project resulted in a digitally assisted program for PSWs in the Peer Plus intervention. This study is valuable because it illustrates how a digital technology can be developed in a participatory process, including the collaboration of consumers, mental health service members and PSWs. The limits of this study are based on the small sample size (reducing the generalizability of the findings), the extensive and time-consuming of the video development process did not allowed to incorporate people with mental health experience in all phases, increasing the chances of the investigator's biases on the final video clips. Furthermore, the tendency to promote a positive experience from videos, may have caused them to minimize some difficulties with mental health. Conclusively, more research is required to address the consumer involvement in the development of digital platforms, namely, in digital peer support programs.

YouTube Video Comments (Naslund et al., 2014)

There is a growing phenomenon of people with SMI making self-disclosure on social media, sharing their illness experience and seeking for advice about medication, employment and other information related to the disease. Social media is an unstructured platform where these individuals can provide and receive informal peer support. The benefits of this kind of support have been the subject of broad interest in the literature. Naslund et al. (2014) cites some studies in which they reveal that people with SMI have the same rate or higher interest in the development of online relationships.

The goal of this research is to explore the phenomenon of people with SMI uploading videos on YouTube, analyzing if the interaction between peers through the posts and answered comments. In this regard, the investigators conducted a qualitative analysis of comments to check if these videos posted on YouTube can be configured as a naturally occurring peer support. From 19 videos that met the inclusion criteria, 3.044 comments were analyzed.

The results suggest that YouTube can be considered as an asynchronous platform, where peers naturally provide informal support to each other. The leading themes recognized reinforce the idea of informal peer support: (1) minimizing a sense of isolation and providing hope; (2) finding support through peer exchange and reciprocity; (3) coping with the day-to-day challenges of severe mental illness; (4) learning from shared experiences of medication use and seeking mental health care.

These topics are congruent with naturally occurring peer support, suggesting mutual learning and rewarding relationships. However, the lack of anonymity and possible risks of being identified do not seem to be considered by these individuals. It is still uncertain to say the use of this platform delivers benefits to more extensive groups of people with SMI, since there may have been other effects on individuals who did make no comment.

YouTube Vlogging (Sangeorzan et al., 2019)

Some studies have both indicated that online social networking can negatively impact mental illness symptoms but, at the same time, others suggest that "social media platforms such as Facebook, Twitter and YouTube can create intimacy between strangers", diminishing the sense of isolation. Furthermore, the increased popularity of health vlogs has predisposed people with SMI to make self-disclosure about their mental illness on the digital platforms, like YouTube. This video platform has the potential to foster an interesting connection between vloggers and the audience, regarding the nonverbal cues.

This study aims to evaluate the impact of vlogging in people with SMI who uploaded this sort of videos. The authors searched on YouTube platform the keywords: "schizophrenia", "bipolar disorder", "major depressive disorder" and "schizoaffective disorder", using advanced filter called "channel" to find people self-identified as SMIs. A combined total of 1 228.400 videos was found, and the first 10 pages for each keyword were screened for the study's relevance. They initially chose 50 YouTube channels per search term and finally selected 30 videos by 28 distinct individuals; the total length of the videos was approximately 5 hours.

Observational study of YouTube videos does not require informed consent if publicly shared. Hence, only publicly available videos were analyzed, and the identity of the vloggers was unrevealed. An interpretative phenomenological analysis (IPA) method was chosen, to identify and compare the ways in which vloggers understand their experiences of uploading mental health videos on YouTube. The videos were transcribed *verbatim* and each transcript was read several times. This analysis yielded three global themes: (1) Minimizing Isolation –Giving and receiving peer support and Normalizing SMI; (2) Vlogging as Therapy – Helping others oneself and Empowerment: regaining a sense of competence and positive self-regard; and (3) Fighting Stigma.

This study provides empirical evidence of vlogging benefit for individuals with SMI who make self-disclosure on YouTube, encouraging a process of recovery. This research suggests that vlogging can create a sense of self-worth and self-efficacy for assuming a positive role sharing their own history and current experiences about mental health. In addition to that, these findings support previous research about the reduction of stigmatization and social isolation. Hence, vlogging may offer the potential to be used to support people with SMI in their process of recovery.

Despite the advantages of using observational method, the data collected is limited, not allowing a more in-depth analysis. This problem can be reduced in future research that use interviews and follow-up questions, to provide more in-depth data. Moreover, these investigations should focus on the possible integration of vlogging into existing programs for individuals with SMI.

Buddy Project (Andalibi & Flood, 2021)

The Buddy Project was founded in 2015 by a young person that intended to prevent suicide and self-harm, promoting mental health through support relationships between peers. The project has its mission of preventing suicide clearly stated throughout its website and social network biographies. Buddy Project is an online peer support system which the primary goal is to foster friendship, mutual assistance and general connection between people, to stimulate mental health; it is clearly specified that Buddy Project is not a replacement of traditional treatment for SMI. The study aims to explore the Buddy Project as a case study of an online peer support system of a nonprofit organization.

Since its creation, the system as paired 236,000 adolescents between 12 and 25 years old. Once the principal aim of Buddy Project is to promote connection between peers that can understand each other, rather than provide or receive professional care, there is no formal training offered to buddies, hoping for a naturally occurring or informal peer support to happen.

The unique characteristic of this system is that it does not pair peers according to its diagnosis or condition, but based on their shared interests and age difference, instead. Buddy Project uses consumers Twitter or Instagram accounts to connect them. After fulfilling a Google form that gathers information about the participant and its social media account, main interests and age, peers are manually paired by the founder, using a Microsoft Excel spreadsheet and considering their preferences. If someone does not wish to connect with the peer that has been assigned to, they can simply do so by sign up to be (re) paired with someone else.

Pairing buddies is an asynchronous task, but they are free to choose any means of connection of their preference to keep in touch – which means that their relationship might be kept through synchronous or asynchronous platforms.

The authors conducted 13 in depth semi-structured interviews with Buddy Project users. Recruitment process began through a Twitter and Instagram screening survey. Inclusion criteria were (1) to be a social media user, (2) to live in the United States of America, (3) to be at least 18 years old and (4) to be or have been a Buddy Project. Participants from diverse demographics were purposefully selected. From 63 participants that fulfilled the initial criteria, 38 were invited to participate but only 13 were interviewed; the mean age was 20.3 (range 18-25 years); six participants were current users of Buddy Project; seven were former users; the number of buddies ranged from one to 10 with a length of connection from one month to four years.

A total of 11 participants described the Buddy Project experience as positive overall, however, two had classified as both positive and negative. Typically, participants chose to connect through a variety of communication tools such video and phone calls, with social media and text messages/chats being the most common technologies referred. Analyzing the interviews, the authors have identified seven relevant themes that came up: "(1) Buddies Providing Peer Support; (2) Sense of Anonymity and Separation From Existing Known; (3) A Stated Mission to Prevent Suicide on Official Buddy Project's Online Presence (4) Matching Buddies Based on Shared Interests and Identities; (5) Shared Identity to Ensure Being Understood When Discussing Mental Health; (6) Not Matching Buddies Based on a Shared Mental Health Diagnosis; (7) Comparing Self and Severity; (8) Sharing Unhealthy Coping Mechanisms" (Andalibi & Flood, 2021).

Buddy projects' principles and its design have proved to be effective as a facilitator of new relationships between young adults that might engage them in peer support as well as learn how to cope with mental illness. There were, although some limitations identified by the authors such as the small sample that is not representative of the population using Buddy Project or all their experiences, the fact that the study does not report for all mental illnesses and the possibility of the existence of fake profiles or buddies with malicious intentions (though none has been identified so far).

Matching buddies according to their interests act to promote connection, conversation and give them a feeling of safeness to talk about mental health. The fact that buddies share an identity establishes a secure space for sharing experiences, improving the sense of commitment towards destigmatization.

BlueBoard (Griffiths et al., 2015)

Recent studies have shown that Internet support groups (IGS) are effective, particularly in stigmatizing conditions such as SMI. The mechanisms behind patients' improvements are not yet clear, but some insights might be provided, considering patients' perception about advantages and disadvantages of IGS.

The present study aimed to understand the perceived advantages and disadvantages of an online depression IGS through the analysis of spontaneous posts sampled over different periods of time. The forum is publicly available, well-stablished, moderated, open to any person over 18 years old nevertheless of the demographic background or place of residence.

The studied IGS is BlueBoard which is an online moderated peer-to-peer support group for mental health conditions like depression, bipolar disorder, anxiety among others. BlueBoard runs as a service by the National Institute for Mental Health Research with funding from the Australian Department of Health. Its moderators are trained consumers supervised by an experienced registered clinical psychologist and their task is to ensure users interact respectfully and fulfill the platform rules; however, moderators monitor posts and have the power to remove any material that does not obey the rules, but they do not participate as members. Therefore, BlueBoard is an intentional service, where consumers might asynchronously change messages/posts about any illness related subjects of their choice, such as living with mental illness experiences, self-management or general information.

The study population includes all BlueBoard consumers – people with mental illnesses over 18 years old – throughout their posts regarding perceived advantages or disadvantages of the IGS. The research comprised all posts (n=3645) for each of 3 months selected at 4 monthly intervals over the year of 2011. These publications were rated for relevance by two raters with discrepancies resolved by consensus. A total of 586 posts was found to regard to the advantages and/or disadvantages of participating in BlueBoard and 212 members contributed to the research. A totality of 103 posts was rated as relevant; mean participant age was found to be 37.2 (range 18-19 years to 60-65 years).

Using content analysis, multiple coders and an inductive method, coding categories for positive and negative experiences on BlueBoard were developed. Of the 586 posts tagged as relevant, the majority (453, 77.3%) reported advantages of board participating. Four board main themes have emerged from the posts concerning the advantages of the IGS including positive personal change, valued social interactions and support, valued opportunities to disclose/express feelings or views, and other benefits of the BlueBoard environment. Emotional and companionship support benefits were also significant throughout the posts, specifically kindness, caring, comfort, warmth, understanding, encouragement, self-esteem support, and friendship. Specific emotional, cognitive, and behavioral effects were related to the board participation. Only a minority of relevant posts (133/586, 22.7%) were identified as concerning with the disadvantages of the board and the four main themes that have emerged regarded negative personal change, perceived disadvantages of board rules/moderation, unhelpful social interactions/contact with other members, and technical and perceived obstacles in using the board.

The BlueBoard has enabled participants to express their feelings freely, and the results suggest it might be an accessible alternative to face-to-face support. The authors identified, as limitations of the study, the small number of messages posted on the support group for a short period of time, the possibility of the less relevant themes might be susceptible of changes over time as the group matures, the fact the posts of people who were dissatisfied might have been underrepresented and the fact that the analysis have focus in one country only, which does not enable more generalized conclusions. The study clarifies that consumers value and appraise the participation in an online mutual support group as an opportunity. It is considered of significant importance by the authors that further research addresses a better understanding of how the perceived advantages really turn into positive life and behavior changes for consumers and whether the perceived disadvantages might be overcome without compromising the beneficial outcomes.

WellWave App (Mueller et al., 2018)

Mueller et al. (2018) states that the management of severe and persistent mental illness is a complex and resource-intensive challenge for individuals, their families, treaters, and the health care system in general. More than ever, the idea of professionals to involve patients as proactive partners in their own health care has been fundamental. Studies have found that community support is extremely important to assist people recover from pre-morbid levels of functioning, because these, unlike psychiatric symptoms, in many people, cannot be controlled by medication and psychotherapy alone, but those rehabilitation programs are typically limited to specialty centers (Bouvet et al., 2015). Hence, smartphone apps seem to be an efficient tool to implement in order to remotely guide and support patients with mental illness continuously in a convenient and economical way.

This pilot-study is about a peer support intervention including a Smartphone App Intervention. *WellWave* app offers several relevant features for psychiatric rehabilitation, as daily task lists, activity tracking, and text messaging option with certified peer specialists, which are part of a 90-day program of activities, with objectives and content specially designed for the context of community support programs. It was based on a previous pilot study, counting on the joint work and cooperation between clinical professionals, peers, staff and researchers from the program and members of the app development team (*WellFrame*). This program was administered by a psychiatrist at McLean Hospital. In addition to the support groups provided by the program, which were co-led by staff and members, users could choose a certified peer specialist, with whom they check in on a semi-regular basis. Plus, the testimonial or motivational videos of the app and the text messages option were relative to peer support specialists (PSSs). Accordingly, this was an intentional type of peer support.

The app comprises two main components covered in the pilot study: (1) to improve patient functioning and (2) to allow program staff to confidentially monitor the well-being of patients when they are not attending the intervention. This app aims to contribute to a greater and better engagement of patients in the rehabilitation program through increasing communication with their care provider and assigned peer specialist.

The sample selection was the responsibility of the hospital's research staff (convenience sample). The study sample initially consisted of 13 adults, aged 50 years or older, with mental illness — most were diagnosed with a schizophrenia spectrum disorder or major affective disorder as a young adult — from the Waverley Place community association. However, only 10 participants installed the app, and of those 10, only 5 used it regularly. Questionnaires were applied at the time of registration and in a post-study exit interview. In the exit interview, conducted by a member of the research team, 12 questions were asked about which specific features of the app the participants liked and disliked, and whether or not they would keep using the app, if there was such possibility. There were also feedback questionnaires on the app. The peer support provided through the app was both asynchronous and synchronous through testimonial and motivational videos created by the community support program staff and by the text message option that the app provided for the users to keep in touch with the community peer support specialist.

One of the positive aspects of the application indicated by the participants was receiving messages from peers, as they claim it made them feel more connected to the team. They also suggested the addition of a way to interact with other members. The participants who regularly used it were generally satisfied with the experience, but, since only five used the app regularly as part of their daily lives for at least 20 days of the 90-day program, it was not possible to identify any specific aspects that may have affected the willingness to interact with the app. The small sample size was one of the main limitations pointed out, not allowing the generalization of the results for other clinical samples or treatment configurations, nor drawing conclusions about which characteristics of the participants most influenced the use of the app. The authors emphasize the importance of carry out more research to better comprehend the reasons and characteristics of the people who choose to or not to participate in studies with apps which would contribute to improve the know-how to design future apps to support people with SMI.

Nevertheless, this study demonstrates an app developed to promote and track the emotional well-being of people with SMI can be a very useful tool when integrated into community mental health programs. It also highlights the idea that the app should be properly adapted to individual needs and existing community interventions.

ReConnect (Strand et al., 2020)

Traditional peer support has been provided over an in-person configuration but along with digital technology evolution, online interventions have rapidly developed. Both have distinct strengths and restrictions, but a combined approach has not yet been studied which is the aim of this project.

ReConnect is a recovery-oriented Internet-based portal that comprises both permanent online and monthly offline peer-support groups, moderated by a trained service user consultant. Therefore, this is an intentional and asynchronous digital platform that also combines a traditional peer support group. The mixed exploratory and descriptive study aimed to collect qualitative data about service users' experiences through focus groups and interviews which were inductively and thematically analyzed. Participants were recruited among 29 users from two communities in Norway for 6-12 months and a total of 14 users with ages ranging from 22 to 67 years of age reporting various mental health diagnoses participated in three focus groups and 10 individual interviews. Inclusion criteria were to be over 18 years of age, to have Internet access with secure electronic identification, had received mental health care for at least six months before inclusion and expect to need services at least six months forward, at least one of their health providers to be willing to participate in the study.

Focus groups length was approximately 90 minutes and the individual interviews intended to explore deepest personal experiences about focus groups topics; both were audio recorded and transcribed *verbatim*. Two main themes were recognized: (1) balancing anonymity and openness, and (2) enabling connectedness as well as three subthemes (i) dilemmas of anonymity and confidentiality, (ii) towards self-disclosure and openness, (iii) new friendships, and (iv) networks in the local community. The principal benefits identified through the analysis included self-disclosure and openness, anonymity and a sense of a safe and trustful environment provided by the online intervention. It was also revealed that a sense of belonging could be achieved by either format, but rather strengthened by their combination.

Challenges related to transitions from online to in-person relationships as well as confidentiality and genuineness issues and were also identified. Also, a high retention rate was verified, since over a 6-months period, all the 29 users wrote and viewed online posts hundreds of times and 17 participants joined the offline meetings.

The limitations pointed out by the authors include female participants only, methodology choice that does not allow results generalization and the involvement of the authors in the platform design.

The study findings suggest that the combination of the two formats has been proven to be complementary, facilitating social relationships as well as fostering friendship and community connectedness. To allow the user the opportunity to decide which format suits its needs better appeared to be a success factor of the project. Moderation by a trained service user has also been emphasized as an essential feature in both formats. While online formats permanent accessibility regardless of location, anonymity and a secure, non-judgmental environment, face-to-face interventions promote community bonding and reduce self-isolation. The combination of these formats has been recognized as an encouraging facilitator of recovery-oriented services, and further research is recommended.

The previously explored studies offer a wide insight of the current digital peer support landscape, exposing a variety of interventions and platform modalities that can enhance the already recognized potential of this alternative approach. In addition, the exposure of each projects' distinctive characteristics has shown there is space for new protocols to be created, according to possibly different contexts, needs and goals that might still appear.

The wide-ranging applied methodologies such as the evaluation of participants' and peer support providers' perceptions, online participation content analysis and the development of a platform from scratch might represent a valuable source of new tools to analyze the existing measurements and rethink the present protocols to achieve more efficient methods.

Facilitators of social relationships have also been mentioned throughout the studies as well as latent risk factors that must be properly considered and sculpted when developing new digital peer support strategies or programs. The results mentioned through the reviewed studies validate the already stated positive findings of digital peer support interventions and suggest that discoveries might are still to be unveiled.

DIGITAL PEER SUPPORT CHALLENGES

Despite mainly described beneficial changes previously stated, some understandings still remain a challenge, regarding digital peer support programs efficacy, real-life impact and consumers motivation (Naslund et al., 2014; Prescott et al., 2020; Strand et al., 2020). Nevertheless, the literature diverges into both positive and negative aspects of online peer support (O'Leary et al., 2018; Prescott et al., 2020).

One of the most discussed concerns about Internet-based programs regards to privacy and security policy of the confidential information provided to the platforms (Simões de Almeida et al., 2018). The population with SMI oftentimes presents a set of unique characteristics (e.g., cognitive impairments, salient symptoms, limited literacy) that may affect the manner in which they interpret and construe information when there is a lack of social cues (Ben-Zeev et al., 2013; Prescott et al., 2020). Alongside with anonymity, socially inappropriate responses might arise, causing a negative impact in vulnerable people (K. L. Fortuna, Venegas, et al., 2019; Prescott et al., 2020).

Information distributed via Internet and social media has been recurrently pointed in the literature as inaccurate and a possible risk to peer support consumers mental health – with higher concern related to informal peer support or unmoderated groups (K. L. Fortuna, Venegas, et al., 2019). Exposure to misinformation could be minimized by training peer support specialists and workers to provide guidance and moderation throughout digital interventions (K. L. Fortuna, Venegas, et al., 2019; Prescott et al., 2020). Recent findings suggest that moderated groups "have higher levels of retention, engagement, acceptability, perceived social support and efficacy" (Strand et al., 2020, p. 2) and "could reduce the incidence and impact of negative experiences with emotional support online" (O'Leary et al., 2018, p. 2).

Frustration and disappointment might result from mismatched expectations related to online interventions use, particularly if the consumer perceives lack of reciprocal commitment and support, negatively influencing the trust and alliance that that characterizes therapeutic relationships (Williams et al., 2019). Additionally, several other concerns about online peer support include risks for excessive use decreasing offline interactions, difficulties shifting between anonymity and in-person relationships, limited sense of connection and community, less authenticity caused by anonymity, social avoidance and possible addiction of online support (Strand et al., 2020). Moreover, unsupportive members, negative content, conflict of beliefs (O'Leary et al., 2018), fake profiles and participants with inappropriate intentions have also been pointed out as possible hazards (Andalibi & Flood, 2021). Naslund et al. (2014), however, stated that the risk of social media use is similar between SMI and general population, with no extend beyond what it has already been described.

Finally, researches have claimed that lack of standardized digital peer support programs compromise its proper use and integration into practice as well as effectiveness measurements and results reproducibility (K. L. Fortuna, Venegas, et al., 2019; Simões de Almeida et al., 2018). For a digital peer support program to be effective, it is mandatory that, beyond standardized framework, cultural context and population needs be addressed to ensure its appropriate use and goals fulfillment (Ben-Zeev et al., 2013). The digital peer support services still lack rigorous studies to validate this intervention as a scientifically evidence based approach (K. L. Fortuna, Venegas, et al., 2019).

THE FUTURE OF DIGITAL PEER SUPPORT

The findings exposed in this chapter illustrate there are several benefits associated with the low cost of digital peer support as a non-clinical intervention for the SMI population, suggesting that efforts to develop suitable digital programs are worthwhile (K. L. Fortuna, Venegas, et al., 2019). Thus, it is clear that mental health professionals could take advantage of digital tools that bring services closer to users, following up and monitoring peer support practices.

In this respect, future investigations should involve consumers and peer support providers in the development of these programs as participatory research framework as recommended by the self-determination theory, that states people can have choices and the right to determine their own path (K. Fortuna et al., 2019).

There are thousands of digital psychiatric resources available, although the majority of them lack for rigorous scientific evidence and validity (Ben-Zeev et al., 2013; Simões de Almeida et al., 2018). It is crucially important to establish standardization and good results in terms of effectiveness, acceptance/adherence and feasibility to persuade mental health policymakers to increase investments in digital peer support resources. In addition, collaboration among mental health researchers and digital platform developers have been pointed out as an essential ingredient to expand the potential of this technology and lead to an accurate perception of the true effectiveness of such resources (K. L. Fortuna, Venegas, et al., 2019).

It would also be interesting to understand if there might be an association or correlation between the use of digital peer-support interventions and what would be its direction regarding face-to-face peer support programs. Would it be a facilitator or demotivate?

Based on the reviewed literature, future research should, inevitably, try to address the true impact of online interventions when it comes to in person relationships. It would be of critical importance to comprehend the underlying mechanisms possibly related to the development of online social skills and if those might be successfully assigned to live/in vivo relationships. Strand, et.al (2020) indicates future research will address ways to facilitate the translation of social relationships into online and offline formats. Another suggestion for future research is related to gender differences in participation in peer support groups.

Since naturally occurring peer support has a significant smaller body of literature, compared to intentional peer support, further investigation could be significant to generate a deeper evidence-based knowledge about this spontaneous support modality.

CONCLUSION

This chapter explores key concepts and the scope of existing practice in digital peer support, as well as its different formats and settings. The empirical findings were predominantly positive and similar to the already described effects of traditional peer support interventions. Even though, other outcomes have emerged, particularly linked to the technological formats in which digital peer support interventions have been provided. Some features and results that seemed to be unique to these interventions are anonymity, permanent availability, increased engagement and social connectedness.

Some aspects such as platform format, moderation feature, Internet and devices availability, digital literacy, age and general interests have been found in the literature as a key influence for digital peer support attrition rate. Furthermore, the previously mentioned characteristics as well as other cultural elements must be considered during the development of digital peer support interventions for people with SMI.

The present chapter has unveiled the potential of an alternative, powerful paradigm of peer support throughout the capacity of digital technology to promote a sense of experiencing a protected environment to individuals with SMI where they can freely express their true self. In this way, digital tools can serve as inspiration for the realization of these services by people with lived experience of mental health problems. Therefore, the vast possibilities of digital peer support can serve as inspiration for the realization of these services by people with lived experience of severe mental health illness.

Further research is necessary, including the consumer's involvement along the platform designing and conception, a long-term evaluation of the outcomes and the replication of the existing studies to confirm the generalization of the results.

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KEY TERMS AND DEFINITIONS

Asynchronous Peer Support: Peer support that happens through technology that does not requires peers to be connected at the same time.

Digital Peer Support: Peer support based on health technologies, usually Internet linked.

eHealth: Electronic health is the broader concept to health services that use digital technology and telecommunication.

Formal Peer Support: Peer support that is moderated by a peer support specialist or worker that has had training and guidance to help their peers through their sharing experience.

Informal Peer Support: Naturally occurring peer support that does not require a peer support specialist or worker that might happen in any social or private context, as long as people feel free and comfortable to share their experiences.

mHealth: Mobile health is the practice of using mobile technology, such as phone, tablets, smart watches and other devices, to manage and improve health conditions.

Peer-Support: Process of giving and receiving help, when people share their experiences with stressful situations, making social connection based on principles of respect, mutual responsibility and trustiness.

Recovery Model: Person centered psychosocial rehabilitation model focused on patients' autonomy, self-management, context and life goals to achieve a hopeful and meaningful life, rather than symptoms remission itself.

Synchronous Peer Support: Peer support that happens through technology requiring peers to be connected at the same time.

Chapter 5
Web-Based Psychotherapy and Exercise Interventions for Depressive and Anxiety Disorders

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ABSTRACT

The last decade has seen a renewed recognition of the interconnection of the mental and physical well-being of people living with anxiety and depression disorders. Research has assessed the impact of exercise and psychological interventions as monotherapy and complementary treatments to usual care and found considerable benefits to reduce psychiatric symptoms and improve better quality of life. There is growing interest in online interventions, and online counseling can be an alternative to traditional face-to-face therapies. Questions remain on the effectiveness and best practices to deliver such interventions. The authors identify and summarize research evaluating online psychotherapy and exercise interventions in individuals with anxiety and depression disorders. They address web-based psychotherapy interventions and web-based exercise interventions for anxiety and depression disorders, followed by combined web-based intervention with psychotherapy and exercise, and discuss strategies to improve adherence to treatments.

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INTRODUCTION

A WHO-led study which estimates, for the first time, both the health and economic benefits of investing in treatment of the most common forms of mental illness globally, have found that every US$ 1 invested in scaling up treatment for depression and anxiety leads to a return of US$ 4 in better health and ability to work (Chisholm et al., 2016). Recently, this situation has exacerbated; the COVID-19 pandemic, declared on March 11st 2020, and the resulting economic recession has negatively affected many people's mental health and created new barriers for people already suffering from mental diseases (Panchal, Kamal, Cox, & Garfield, 2021). For example, in comparison with a global estimated prevalence of depression of 3.44% in 2017, one recent meta-analysis estimated that the pooled prevalence of 25% appears to be 7 times higher, thus suggesting an important impact of the COVID-19 outbreak on people's mental health (Bueno-Notivol et al., 2021). In this vein, web-based interventions could help minimize the transmission of COVID-19 and may help alleviate some of the detrimental impacts of social distancing and quarantine (Middleton, Simpson, Bettger, & Bowden, 2020). Moreover, during the COVID-19 pandemic, levels of anxiety and depression increased exponentially (Hawes, Szenczy, Klein, Hajcak, & Nelson, 2021; Hou, Bi, Jiao, Luo, & Song, 2020). During this period, studies demonstrated the important protective role of physical activity (PA) for symptoms of anxiety and depression (Frontini et al., 2021; Giuntella, Hyde, Saccardo, & Sadoff, 2021).

Effective treatments are available for depression and anxiety disorders, including several types of psychotherapy and antidepressant medication (Cuijpers et al., 2014). For major depressive disorder, antidepressant medication and psychotherapy offer effective treatments for most patients, as shown in meta-analyses (Cipriani et al., 2018; Cuijpers, Cristea, Karyotaki, Reijnders, & Huibers, 2016). The largest open trial measuring the effects of pharmacological antidepressant, psychotherapy, or both, in the treatment of depression (the STAR*D study), found that the response rate following the first pharmacological attempt was less than 50% (Sinyor, Schaffer, & Levitt, 2010). Roughly 75% of patients prefer psychotherapy over the use of medication (McHugh, Whitton, Peckham, Welge, & Otto, 2013). Nonetheless, psychological therapies are less available (Olfson & Marcus, 2010), especially in low-and middle-income countries (Singla et al., 2017). Although psychotherapy and antidepressants are equally effective for the majority of anxiety and depressive disorders (Cuijpers et al., 2013), there is evidence that combined treatments may be more effective (Cuijpers et al., 2020; de Maat, Dekker, Schoevers, & de Jonghe, 2007). However, not everyone responds to those treatments (medication and/or psychotherapy) (Meyer & Schuch, 2018).

There is evidence showing that PA and exercise may be an effective adjunct to pharmacology treatment for people with depression (Krogh, Hjorthøj, Speyer, Gluud, & Nordentoft, 2017; Schuch et al., 2016) or anxiety disorders (Gordon, McDowell, Lyons, & Herring, 2017; Stubbs et al., 2017). A meta-review confirmed the beneficial effects of exercise training for depressive and anxiety symptoms (Ashdown-Franks et al., 2020). It is less clear whether web-based exercise training interventions are effective for reducing such symptoms. One systematic review addressed this question (Rosenbaum, Newby, Steel, Andrews, & Ward, 2015), and found only two randomized trials, denoting how scarce data is. The evidence concerning the effects of exercise among subjects diagnosed with an anxiety or stress-related disorder also remains limited (Herring, 2018).

It is unclear which exercise modalities are best suited for this task, and what are the "optimal" dose-response relationships. Studies on web-based exercise interventions for improving anxiety and depression symptoms have disappointing results, high rates of dropouts and low levels of compliance

(Huberty et al., 2020; Teychenne et al., 2021). Often, individuals suffering from anxiety and/or depressive symptoms have comorbidities and low socioeconomic status, which aggravate the situation (Reichert, Barros, Domingues, & Hallal, 2007). A first challenge is designing strategies that promote adherence and compliance to web-based exercise interventions (Stubbs et al., 2016; Vancampfort et al., 2021). Our purpose is to provide an overview of web-based and online psychotherapy of exercise interventions for people with depression and/or anxiety.

BACKGROUND

Before advancing, we will broadly define the main concepts. Depressive disorders are characterized by the feeling of sadness, emptiness and/or irritability, with somatic and cognitive changes that affect the person's ability for functioning, and can be classified into eight major categories, ranging from major depressive disorder (MDD) to substance/medication-induced depressive disorder (American Psychiatric Association, 2013). Anxiety disorders share features of excessive fear and anxiety, disturbing the normal behavior of the person, and can be classified into twelve major categories, ranging from generalized anxiety disorder (GAD) to specific phobias (American Psychiatric Association, 2013). Depressive and anxiety disorders can benefit from web-based interventions (Davies, Morriss, & Glazebrook, 2014), defined as "a primarily self-guided intervention program that is executed by means of a prescriptive online program operated through a website and used by consumers seeking health- and mental-health related assistance" (Barak, Klein, & Proudfoot, 2009, p. 5).

Web-based interventions are increasing and considered essential (Ross, Stevenson, Lau, & Murray, 2016), and here they will be restricted to two domains: (i) psychotherapy, defined as a treatment modality where the therapist works together with the patient to improve the psychopathologic conditions and functionality through a focus on the therapeutic relationships (Brent & Kolko, 1998); and (ii) physical activity (PA) and/or exercise, with PA referring to the movement that requires an increase in caloric requirements over resting energy expenditure, and exercise constituting a planned, structured and repetitive form of PA, focusing on the improvement of physical fitness (Caspersen, Powell, & Christenson, 1985). Web-based exercise interventions come in two flavors: (i) interventions that focus on motivating participants to engage with increased physical activity (e.g., Duan et al., 2017); and (ii) interventions where a structured exercise program is prescribed (e.g., Teychenne et al., 2021). Our focus will be on the latter.

MAIN FOCUS OF THE CHAPTER

Web-Based Psychotherapy Interventions for Depressive and Anxiety Disorders

Web-based interventions for anxiety and depression aim to treat the disease by acting in the patient's behavior, cognitions, and/or emotions (Cowpertwait & Clarke, 2013). Web-based psychotherapy interventions make psychological treatments more accessible and cost-effective (Cowpertwait & Clarke, 2013). Much work is required to understand its benefits and side effects. Web-based psychotherapy interventions may take several forms such as images, videos, audio or animations (Abbott, Klein, & Ciechomski, 2008; Hegerl & Oehler, 2020). They may be used with or without clinical and professional guidance

(Hegerl & Oehler, 2020). The supervision of a human psychotherapist is usually beneficial and useful for a patient's treatment outcome (Baumeister, Reichler, Munzinger, & Lin, 2014).

Web-based treatments for anxiety and depression have grown including online counselling or courses, social support, the use of instant messenger, chats, e-mails, and other psychoeducational information (Griffiths & Christensen, 2000). Web-based psychotherapy software simulates therapist and client interactions (Barak et al., 2009). These applications can be customized for the patient, improving adherence and increasing the likelihood of positive outcomes (Taylor & Luce, 2003). To better tailor its features and content, it is important to develop a more complete knowledge of the individual preferences (Frontini, Sousa, Dixe, Ferreira, & Figueiredo, 2020). In web-based psychotherapy interventions, treatment usually involves the person being diagnosed to match up a treatment program and then be assigned to a therapist (Carlbring, Andersson, Cuijpers, Riper, & Hedman-Lagerlöf, 2018).

Cognitive-behavioral therapy (CBT) is among the best researched treatments for depression and anxiety (Butler, Chapman, Forman, & Beck, 2006). It engages in behavioral activation and relapse-preventing interventions, changing beliefs and restructuring cognitions (Hegerl & Oehler, 2020). Because it is especially well-structured, it can easily be transformed into a web-based format (Proudfoot et al., 2003). Accessibility to health care is important, but many people do not have access and/or the possibility to engage in this treatment (Rycroft-Malone et al., 2019).

Meta-analyses found positive effects of web-based interventions for the treatment of depression, depressive symptomology, and well-being, especially those that used reminders and human-support component (Cowpertwait & Clarke, 2013; Wright et al., 2019). A recent study found positive outcomes with a web-based intervention compared to controls (Krämer, Grünzig, Baumeister, Ebert, & Bengel, 2021): for patients waiting for face-to-face psychotherapy, web-based interventions were important in reducing depressive symptoms. Usually, web-based interventions for depression work on the cognitive level, teaching patients regarding their automated thinking and teaching strategies to change and challenge negative thoughts (Hegerl & Oehler, 2020). Although CBT web interventions are easily accessible and standardized, the majority of web interventions for treating depression combine CBT with Acceptance and Commitment Therapy (ACT) and Problem-Solving Therapy (PST) (Tokgöz, Hrynyschyn, Hafner, Schönfeld, & Dockweiler, 2021).

Web-based interventions for anxiety usually also include relaxation exercises, breathing exercises or gradual and progressive exposure to phobic situations and/or objects (Taylor & Luce, 2003). Dysfunctional beliefs, avoidance, and safety behaviors may be addressed by exposure techniques and cognitive restructuring exercises (Niles et al., 2021). In a web-based intervention program for patients with GAD, 70% of participants no longer presented clinically significant symptoms (Miller et al., 2021). Studies of a web-based intervention for social anxiety disorder found effects equivalent to face-to-face interventions (Andrews, Davies, & Titov, 2011; Botella et al., 2010). The same was found in studies with web-based psychotherapy interventions for panic disorder (Bergström et al., 2010; Carlbring et al., 2005).

Drop-out rates are high in web-based interventions (Christensen, Griffiths, & Korten, 2002; Haller et al., 2018), potentially due to the lack of a therapeutic relationship (Helgadottir, Menzies, Onslow, Packman, & O'brian, 2009) or the absence of reminders (Clarke et al., 2005). We will return to this topic. There are risks and unwanted effects (Hegerl & Oehler, 2020): interventions may be utilized in an incorrect manner; guidance (when present) may be provided with inadequate intensity or quality; symptom deterioration can happen; patients could feel worried by the tight treatment schedule and the chance of detecting suicidal crises is quite small.

Web-Based Exercise Interventions for Depressive and Anxiety Disorders

Exercise is advocated for people with depressive and/or anxiety disorders (Hu, Tucker, Wu, & Yang, 2020) as reduces depressive symptoms in people without clinical depression (Bellón et al., 2021), anxiety in the elderly (Kazeminia et al., 2020) and anxiety and depression in chronic kidney disease patients (Ferreira et al., 2020). Exercise reduces depressive symptoms in patients with MDD (Seshadri et al., 2020) and anxiety in patients with GAD (Gordon, McDowell, Lyons, & Herring, 2021). Exercise is a feasible and effective add-on to CBT, especially when administered on a regular basis (Frederiksen, Stavestrand, Venemyr, Sirevåg, & Hovland, 2021). The effects of exercise on depressive and/or anxiety symptoms are small to moderate. Considering the numerous benefits of exercise for health and quality of life (ACSM, 2021; Bull et al., 2020), these extra beneficial effects for managing depressive and/or anxiety symptoms can only be regarded as positive. Many exercise modalities, such as yoga (Seshadri et al., 2020), resistance training (Gordon et al., 2021), aerobic training and sprint interval training (Gerber, Minghetti, Beck, Zahner, & Donath, 2018), produce beneficial effects in depressive and/or anxiety symptoms, so perhaps exercise is the relevant parameter, regardless of its modality.

There are challenges for performing physical exercise, especially in populations with depressive and/or anxiety disorders. Women with high-anxiety sensitivity practice less exercise than women with low-anxiety sensitivity (Sabourin, Hilchey, Lefaivre, Watt, & Stewart, 2011). Dissatisfaction with body image increases anxiety sensitivity while inhibiting engagement with exercise (Smits, Tart, Presnell, Rosenfield, & Otto, 2010). A study showed that only 37.5% of patients with MDD adhered to the exercise intervention (Kruisdijk, Hopman-Rock, Beekman, & Hendriksen, 2020). For exercise interventions with patients diagnosed with anxiety and stress-related disorders, a meta-regression showed dropouts rates >22% (Vancampfort et al., 2021). For subjects completing the programs, attendance or compliance are far from desirable (Martinsen, 2008). Multiple barriers inhibit patients with depressive and/or anxiety disorders from engaging in structured exercise. Leaving home, travel to the location where the exercise intervention is held and interacting with several known and unknown people may pose a barrier for engaging in exercise programs (Martinsen, 2008).

Web-based exercise interventions may prove extremely valuable in the context of patients with depressive and/or anxiety disorders, better supporting people who avoid health or related services owing to social stigma (J. D. Lambert et al., 2018). Web-based interventions can provide accessible, time-saving, and economic strategies (Cheung et al., 2018; Grünzig, Baumeister, Bengel, Ebert, & Krämer, 2018), motivating more people to engage with exercise (Ballin et al., 2020; Lisón et al., 2020). In the context of mental disorders, a systematic review showed discrepant results for online PA interventions (Rosenbaum et al., 2015), but only two RCTs were retrieved. The authors challenged researchers to explore the effects of web-based PA and exercise interventions on mental disorders. However, very few randomized trials have addressed this issue. One study recruited 20 patients (7 male, 13 female) with moderate to severe unipolar depression (age: 45±14 years), and applied an 8-week, individualized web-based exercise program with a mixture of endurance and resistance training (Haller et al., 2018). Although positive effects were observed in the quality of life, aerobic capacity and self-efficacy, the exercise group showed no improvements in depressive or anxiety symptoms in comparison with a non-exercise control group. There was a 21% dropout rate in the exercise group. The participants that adhered to the program had very high compliance rates, partly because subjects were recruited based on having a high interest in exercise.

Another study recruited 90 women who had experienced a stillbirth in the previous 6 to 24 months and showing post-traumatic stress disorder (PTSD) but without severe depression (Huberty et al., 2020). A home-based yoga intervention was implemented for 12 weeks. Of the 60 women integrating the intervention groups, only 34 completed the program (dropout rate of 44%). Of the women completing the program, only ~26% performed >90% of the prescribed weekly minutes of yoga. While both intervention groups improved in their depressive symptoms, they did not improve in anxiety symptoms. A third randomized trial recruited 62 mothers at risk of postnatal depression (Teychenne et al., 2021). The intervention group engaged in aerobic exercise for 12 weeks. The dropout rate was 10%, but compliance was low: only 63% of the subjects used the web app, usually only two times per month. Less than 65% of subjects had data on their logbooks. There were no benefits of exercise on depressive or anxiety symptoms in comparison with controls. One study suggested that remotely supervised exercise can positively influence self-reported depressive symptoms (Moreira-Neto, Martins, Miliatto, Nucci, & Silva-Batista, 2021), but this was a single group study and does not constitute gold-standard evidence.

Overall, data concerning the effects of web-based exercise interventions on depressive and/or anxiety disorders are scarce and contradictory, requiring much work to understand the benefits, harms, and costs, as well as the challenges and strategies to best implement these interventions. There is no clear indication of which exercise modalities best fit web-based interventions, and no basis to establish a dose-response relationship. Generic dose-response relationships can be established using usual exercise prescription guidelines (ACSM, 2021), but their effects on adherence and compliance with web-based interventions are unclear. The minimal effective dose of exercise is currently unknown. While depression and anxiety are more prevalent in women than men (Preti et al., 2021; Zhang et al., 2020), studies are recruiting <10% of men. The (reduced) knowledge that exists is mostly limited to how women respond to web-based exercise interventions.

Working the Mind in the Body: Combining Web-Based Intervention with Psychotherapy and Exercise

Only a minority of subjects with MDD receive minimally adequate treatment worldwide: 1 in 5 people in high-income and 1 in 27 in low-middle-income countries (Thornicroft et al., 2017). Data from 23 community surveys in 21 countries and the World Mental Health surveys demonstrated that of 51,547 respondents (71.3%), 9.8% had a 12-month DSM-IV anxiety disorder, 27.6% received any treatment, and only 9.8% received possibly adequate treatment (Alonso et al., 2018). Pharmacological and cognitive-behavioral therapy (CBT) target anxiety (Kaczkurkin & Foa, 2015) and the two key strategies for treating depression recommended by the American Psychiatric Association are pharmacological antidepressants and psychotherapies (American Psychiatric Association, 2013). The effectiveness of CBT is well documented and is the current treatment chosen for most anxiety disorders, with ~50% recovery rates with remission rates remaining at an insufficient level (Frederiksen et al., 2021). Despite its widespread use, there is a continued need for effective, accessible, low-cost non-pharmacological therapies for anxiety and depressive disorders, including exercise (Herring, 2018).

Exercise can reduce levels of anxiety and is recommended as a complementary intervention for anxiety disorder (Stonerock, Hoffman, Smith, & Blumenthal, 2015). Evidence supports the psychological benefits of PA, but little is understood about how combining PA with psychological therapies may influence the outcomes (Thomas, Thirlaway, Bowes, & Meyers, 2020). A meta-analysis showed that combining CBT and exercise was effective for decreasing depression, anxiety, and fatigue symptoms but not pain in individuals with chronic diseases; when compared, CBT plus exercise did not show greater efficacy than CBT or exercise alone (Bernard et al., 2018). A systematic review indicated that the combination of exercise with behavior therapy may enhance symptom reduction through neurophysiological, cognitive, and improved self-worth mechanisms (Bourbeau, Moriarty, Ayanniyi, & Zuhl, 2020). Another systematic review (Frederiksen et al., 2021) indicated that a combination of CBT and exercise therapies is feasible, and the addition of exercise does not affect treatment compliance. One study demonstrated that most patients with heart failure diagnosed with moderate-to-major depression received and accepted telephonic CBT and exercise sessions in the 12-week follow-up period (Gary, Dunbar, Higgins, Musselman, & Smith, 2010).

A meta-analysis showed that behavioral therapy plus exercise was a more effective treatment for depression than behavioral therapy alone, irrespective of exercise type, intensity, and baseline levels of depression, but the same was not verified for anxiety symptoms (Bourbeau et al., 2020). The therapeutic benefit of psychotherapy was mainly attributed to an improvement in psychological constructs, whereas the therapeutic benefit of exercise was likely due to physiological alterations. To date, the underlying mechanisms of the antidepressant effect of exercise especially in combination with cognitive behavioral therapy have rarely been studied and an investigation of their neural underpinnings is missing (Heinzel et al., 2017). Depression and anxiety occur commonly with several diseases (e.g., cardiovascular, respiratory, neurological, and metabolic) (Steffen, Nübel, Jacobi, Bätzing, & Holstiege, 2020), all of which benefit from exercise.

Klein and Cook (2010) demonstrated that people preferring online interventions had more stigmatizing beliefs, lower scores on extraversion and emotional stability, characteristics which may be more common in patients with comorbid anxiety. A study highlighted that about 38% of the patients were likely or very likely to consider internet-based interventions in case of depression, while 42% were unlikely or very unlikely to prefer internet-based interventions for depression treatment (Dorow, Lobner, Pabst, Stein, & Riedel-Heller, 2018). Younger patients expressed a stronger treatment preference for internet-based interventions than the elderly (Dorow et al., 2018). Associated factors for internet-based interventions were the patients' age, educational level and having a comorbid anxiety disorder.

E-mental health interventions have been a rapidly developing research field (Karyotaki et al., 2017; Rost et al., 2017). There is growing interest in linking internet-based CBT (iCBT) with other treatments, such as face-to-face-psychotherapy, in the form of blended care (blended treatment integrates face-to-face sessions and online therapy into one treatment protocol) (Kleiboer et al., 2016). Compared with stand-alone face-to-face psychotherapy, blended treatment can have advantages, e.g., adding online modules may enhance patient's self-management (Sander et al., 2021). The therapy structure may be more transparent and face-to-face sessions may be optimally used because they are online designed.

Little is known about combining web-based intervention with psychotherapy and exercise in people with depressive or anxiety disorders. Few studies have delivered web-based interventions promoting PA as a monotherapy for depression (Rosenbaum et al., 2015). Haller et al. (2018) developed a web-based exercise intervention for the treatment of MDD: the individualized intervention was highly accepted by the patients and led to a significant and clinically relevant improvement of depressive symptoms. The literature is more concerned with web-based trials on depression on self-help and CBT (Spek et al., 2007) and moderate effects on depressive symptoms were reported when web-based CBT was offered in an individually tailored form (Twomey, O'Reilly, & Meyer, 2017). Web exercise effects and web pharmacotherapy may be additive, not interfering with each other. A better understanding of this relationship would be important to develop optimal treatment strategies for depression and anxiety disorders.

A study (J. D. Lambert et al., 2018) assessed the feasibility and acceptability of delivering a web-based intervention combining PA and behavioral activation (an evidence-based psychological therapy) for people in the community with symptoms of depression and to explore outcomes revealed that eMotion intervention (a web-based intervention designed to treat depression while promoting PA) is an integrated solution to the two critical public health priorities of depression and lack of PA. Data-based eMotion has the potential to reduce depression and anxiety symptoms. Another study delivered the first community-based trial to compare the long-term effectiveness of exercise and iCBT, and showed that exercise and clinician-supported iCBT should be considered for the treatment of mild to moderate depression in adults (Hallgren et al., 2016). However, exercise was not prescribed as a web-based therapy, only CBT was.

It is currently not well-established whether the effects of web exercise interventions and web psychotherapy interventions are complementary or if combined treatments lead to superior effects.

Adherence and Compliance: Challenges and Strategies

Adherence reflects the extent to which the patient's behavior matches the recommendations that have been agreed upon with the prescriber (Kelders, Kok, Ossebaard, & Van Gemert-Pijnen, 2012), and implies an active role of the participants to follow the recommendations of the prescriber (Aronson, 2007). Adherence depends on the active involvement of the prescriber, the strategies used for promoting the adherence, and/or self-commitment of participants. Exercise adherence is often high in the first stages of participation and tends to decrease over time, possibly due to reduced intrinsic motivation, willingness, and contextual factors as accommodation of time for exercise in the daily life (Campbell et al., 2001). How practitioners communicate with patients is also determinant for increasing the chances of adherence and compliance (Lonsdale et al., 2017).

Considering that the use of technology for web-based exercise was boosted by the current pandemic situation (Langer et al., 2021), it is important to identify the processes that should be ensured for ensuring the successes of these interventions. Web-based interventions hold the interaction between content, interaction with patient, and technology. Interactive elements aim to improve the attractiveness of the intervention (Brouwer et al., 2011). Naturally, strategies to achieve changes in participants should be different, because lifestyle interventions may be more oriented to long-term changes, while mental health interventions are more focused on short-term treatment. These differences may interfere with the rates of adherence, comparing short vs. long-term effects (Kelders et al., 2012).

One step to ensure adherence is to avoid the traditional method of prescribing home exercise (e.g., written exercise instructions, logbooks, diagrams). A study with 305 participants comparing web-based exercise programming system (a software with individualized exercises, and instructional videos with extras as communication by alert and email, or chat) vs. control group revealed a beneficial effect of web-based group in the overall adherence (Bennell et al., 2019). A study with 80 participants using a mobile application (T. E. Lambert et al., 2017) revealed favorable effects of the web-based intervention, although remote support performed by a physical therapist (e.g., phone calls and motivational messages) was provided, thus not isolating the effect of web-based intervention from the remote assistance. These are some of the examples of how web-based intervention can promote a better efficacy than regular home-based exercise. Among the strategies, videos, individualization, and communication seem to be favorable practices for increasing adherence and compliance.

A review comparing the use of information and communication technology vs. control groups revealed that adding video-based information (e.g., online coaches, instructional videos), chats and peer forum, or follow-up phone calls meaningfully increased the PA of participants (Jonkman, van Schooten, Maier, & Pijnappels, 2018). It is admissible to suggest that a more dynamic and proximate approach using novel technologies can boost participants to adopting a healthier and more active lifestyle and increase the adherence to structured exercise interventions. A common strategy reported by the above-mentioned web-based programs was the interaction with patients, using videos, phone calls, forums. A study on childhood cancer survivors used a different approach, applying a scoring system earning "chips" for adherence with the exercise program (Gilliam et al., 2011). The use of the online token economy improved the functional capacities of the participants and increased the adherence to the exercise intervention (Gilliam et al., 2011). Additional factors should be considered, such as using objectively measured instruments (e.g., pedometers or accelerometers) that may provide feedback to the participants and prescribers.

The system used can determine the effectiveness of the web-based program. Persuasive technology in the intervention presents three main dimensions (Kelders et al., 2012): (i) primary task support; (ii) dialogue support; and (iii) social support. The primary task support had the following items: (a) reduction (reducing complexity of the behavior, into simple tasks); (b) tunneling (guiding user through the experience); (c) tailoring (directing the system to the individuality); (d) personalization (improving the proximity to the customer preferences); (e) self-monitoring (support the customer to track their own goals); (f) simulation (helps the user to establish a link between cause and effect; (g) rehearsal (providing meaning to the behaviors). The dialogue support presented the following items: (a) praise (offering praise occasionally to enhance the persuasion); (b) rewards (a system that rewards target behaviors); (c) reminders (systems that use alerts for performing specific behaviors); (d) suggestion (providing fitting suggestions); (e) similarity (providing something familiar and designed especially for the participant); (f) liking (systems with a friendly and attractive design); (g) social role (providing an actor with a social role). The third dimension (social support) presented the following items: (a) social learning (providing to the user the experience of observing others to learn); (b) social comparison (providing comparators with their own behaviors); (c) normative influence (providing normative information on the target behavior); (d) social facilitation (providing an opportunity to observe that other are doing the same); (d) cooperation (giving opportunities of cooperation to achieve the target behavior); (e) competition (providing some challenges that drive the participant through competition to achieve the target behavior); (f) recognition (by offering public recognition for an individual or group).

Briefly, the following strategies can be used to enhance the adherence to web-based exercise programs:

- Individualization is key: providing orientation to exercise based on the patients' needs and expectations.
- Dynamic and interactional systems: providing videos and tutorials that may help to visualize the exercises or even doing exercise while observing the prescriber.
- Monitoring for auto-feedback: providing to the participant the capacity to observe the achievement of some goals.
- Permanent interaction: the prescriber should weekly or daily interact with the participant to ensure the conditions for a closer relationship.
- Rewarding: providing some prizes or rewards based on the achievement of specific targets.
- Community: providing options for sharing experiences, ideas, or emotions with other people in the same conditions.
- Individuals can be educated on the transition from face-to-face therapy to internet-based therapy.
- Implement strategies to decrease dropout and increase compliance, namely supervision by a trained exercise professional, access to user-friendly web apps.

- Explore how to effectively deliver interventions to low-income patients, who might struggle to access.

SOLUTIONS AND RECOMMENDATIONS

Web-based exercise interventions deliver exercise to populations that avoid *in loco* exercise or that do not have the resources to leave home and go to another location to perform the exercise. Multiple exercise modalities should be offered, so that people experiment and choose the modalities they like the most, likely increasing adherence. Progressive, individualized programs should be delivered so that the amount of exercise is just about right – not too little, not too much. Regular individualized assessments and personalized assistance to help people adjust their programs are highly recommended.

Wearable activity trackers can be used, to help individuals to monitor behaviors. Individuals can also join social media groups with other people who are trying to increase their physical and mental health.

FUTURE RESEARCH DIRECTIONS

Future research should focus on establishing the most appropriate exercise modalities and especially adequate dose-response relationships for the different depressive and anxiety disorders. This may naturally differ depending on the features of each specific population and on their previous background in terms of PA and exercise. In terms of adherence, more research is needed to understand the impact of web-based exercise to change behaviors across time performing longitudinal studies and follow-ups. Additionally, there is the need to identify the moderators that should be considered to individualize the web-based exercise strategy to specific profiles.

Caution is advised, as web-based exercise programs have the disadvantage that people must be motivated and physically able to perform exercise therapy, which is challenging in depression because this population is usually sedentary (Huang et al., 2020). Therefore, it is likely that individualized web-based exercise will be accepted only by a subgroup of depressive patients (Haller et al., 2018). Older patients may be less familiar with the internet in general and may feel that they do not have enough computer skills to conduct an online program. More research is required before stronger clinical recommendations can be provided.

CONCLUSION

Research on the effectiveness of web-based exercise and psychotherapy interventions has grown, but there is currently insufficient evidence to comment on their effectiveness, namely concerning the interventions related to web exercise as monotherapy or the combination of web exercise plus web psychotherapy. Online delivered psychotherapy treatments are better documented. Strategies must be developed to increase adherence to these interventions, to improve their effectiveness. It is important to have a multidisciplinary approach to mental health issues such which is even more important regarding web-based interventions with different subject approaches such as psychological and exercise approaches.

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KEY TERMS AND DEFINITIONS

Anxiety: The quality of being disturbed, nervous or troubled by the circumstances, the present and the future. Anxiety causes uncertainty and lack of sureness on personal and social issues and generates concern.

Depression: A negative mental state, the incapability to assess the good side of life, with an imbalance towards life and particular situations. The subject tends to be always discouraged and low-spirited.

Dose-Dependent: Reports the effects of a drug treatment or exercise period. The effects might be dose-dependent when they change according to stimulus dose change.

Exercise: A systematically planned and structured subcategory of physical activity that aims at the improvement and maintenance of physical fitness components.

Major Depressive Disorder: Presents symptoms (e.g., fatigue, hypersomnia or insomnia, concentration difficulties and feelings of worthlessness) occurring for two weeks. It is characterized by depressed mood or lower pleasure or interest in almost all the daily activities.

Mental Disorders: Distinguished by psychological dysfunction which triggers psychological and/or physical distress or impaired functioning. Denotes unexpected societal or cultural standard behavior.

Online Therapy: Internet conducted individual or group counseling/debates-popular designation "online".

Psychotherapy: The aid to a subject/s to accept or cope with thoughts, feelings and/or emotions.

Chapter 6
Digital Technologies in Dementia Care

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ABSTRACT

Dementia is characterized by significant cognitive deterioration, behavioral and psychological symptoms, and expanding disability. The well-being of people with dementia is influenced by the support provided by caregivers and health professionals. Especially in the past two decades, advancements in digital technology have helped reshape the way care and treatment are delivered. The main goal of the chapter is to describe technological solutions aimed at supporting the independence and safe participation of people with dementia in meaningful activities, as well as promoting their involvement in engaging experiences that seek to delay cognitive decline and diminish behavioral and psychological symptoms. These technologies include distributed systems, robotics, wearable devices, application software, and virtual reality.

INTRODUCTION

Dementia is a syndrome that is characterized by a significant cognitive decline in areas such as memory, language, executive functions, social cognition, psychomotor speed, attention, orientation, and visuoperceptual abilities (Arvanitakis, Shah, & Bennett, 2019; World Health Organization [WHO], 2021). Also known as a neurocognitive disorder, it has different subtypes which are categorized according to their etiology (American Psychiatric Association, 2013). Dementia is usually caused by neurodegenerative conditions, such as Lewy body disease, frontotemporal lobar degeneration, Parkinson's disease, and Alzheimer's disease – which accounts for 60-70% of cases (Gale, Acar, & Daffner, 2018; WHO, 2017). Frequently, these conditions are accompanied by cerebrovascular disease, which contributes to the cognitive impairment (Arvanitakis et al., 2019; Gale et al., 2018). Although dementia affects each person in a different way, depending on the underlying brain pathology, cognitive reserve, among other factors, cognitive deterioration gradually increases during several months or years in most cases, starting by

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causing difficulties in recalling events and facts, learning new information, and communicating, whereas in later stages, an overall severe cognitive impairment is evident (Arvanitakis et al., 2019; WHO, 2012).

In addition to cognitive deficits, nearly all people with dementia (PwD) present neurocognitive disturbances, known as behavioral and psychological symptoms of dementia (BPSD), which, in general, worsen as dementia progresses (Gottesman & Stern, 2019; Savva et al., 2009). These include depression, anxiety, apathy, delusions, irritability, aggressiveness, hallucinations, disinhibition, eating disorders, changes in circadian rhythms, euphoria, agitation, and aberrant motor behavior such as wandering (Cerejeira, Lagarto, & Mukaetova-Ladinska, 2012; Cipriani, Lucetti, Nuti, & Danti, 2014; Savva et al., 2009). Although apathy, agitation, depression, and irritability seem to be the most frequent, BPSD are largely unpredictable and may vary from individual to individual, as well as during the course of dementia (Cerejeira et al., 2012; Gottesman & Stern, 2019; van der Linde et al., 2016). Certain factors such as environmental stressors, pre-morbid personality traits, and difficulty to communicate unmet physiological and psychosocial needs, may contribute to these neuropsychiatric symptoms (Cerejeira et al., 2012; Cohen-Mansfield, Dakheel-Ali, Marx, Thein, & Regier, 2015).

Furthermore, dementia interferes with participation and with the ability to perform activities independently. These functional difficulties usually expand to several areas of occupation over time, considering the progressive nature of the vast majority of dementias (Arrighi, Gélinas, McLaughlin, Buchanan, & Gauthier, 2013; Chung, 2004; Giebel, Challis, & Montaldi, 2015). Indeed, people in early stages of dementia may struggle to execute more complex instrumental activities of daily living – such as shopping or managing medication – and experience difficulties in social participation. However, later stages are characterized by general inactivity and complete disability in all areas, including basic activities of daily living, such as bathing or eating.

In dementia, functional problems are primarily associated with the cognitive deterioration that defines the syndrome. For example: memory deficits may lead PwD to forget appointments or tasks (e.g., feeding pets, turning off an oven); problems in spatial orientation may result in people getting lost and severely impact the ability to participate in the community; and limitations in executive functions (e.g., judgement, planning, interference control, problem-solving, cognitive flexibility, insight) affect goal-oriented behaviors, impairing the performance of complex activities (e.g. driving, managing communication technologies). However, BPSD may also impact participation and occupational performance (Cipriani, Danti, Picchi, Nuti, & Fiorino, 2020; Norton, Malloy, & Salloway, 2001; Saari, Hallikainen, Hintsa, & Koivisto, 2020; Zawacki et al., 2002). For example: apathy and depression frequently result in less motivation, initiative, and persistence regarding participation (Cerejeira et al., 2012; Cipriani et al., 2020); modifications in circadian rhythms reduce the quality of sleep which may impact occupation in several areas (Kuhn, Fulton, & Edelman, 2004; K. M. Rose & Lorenz, 2010); wandering may interfere with the involvement in daily tasks, as well as lead to falls (Ali et al., 2016; Cipriani et al., 2014; Colombo et al., 2001; Volicer, van der Steen, & Frijters, 2013); and hallucinations often impair the performance and completion of several basic activities of daily living (Mok, Chu, Chung, Chan, & Hui, 2004; Rapoport et al., 2001).

Consequently, PwD need assistance from others to fulfill basic needs and to maintain quality of life as long as possible, normally during several years. Support is primarily provided at home by informal caregivers, who are typically family members, often lacking the necessary knowledge and training to successfully perform all care-related tasks and to fully maintain their own health and well-being, in response to the challenges of the role (Chiao, Wu, & Hsiao, 2015; WHO, 2017). Indeed, it is vastly recognized that caregivers of PwD usually experience high levels of physical, psychological, social, and/

or financial burden, in result of providing care (Chiao et al., 2015; Etters, Goodall, & Harrison, 2008). Although several factors influence caregiver burden (e.g., BPSD, relationship between individuals, personal characteristics), evidence shows that it can result in higher morbidity and mortality for caregivers, limiting the ability to provide continued care during the course of dementia (Cheng, 2017; Chiao et al., 2015; Etters et al., 2008; Jessica, Cohen, & Verghese, 2016). Nevertheless, informal caregiving is crucial to facilitate personalized care and to keep PwD in a familiar setting, which may be determinant for their well-being (WHO, 2017).

In the absence of informal caregivers or when the provision of care at home is no longer possible due to the inability to cope with the increasing dementia-related symptoms and disability, institutionalization in a nursing home is normally sought, in order to ensure the safety and health of PwD (Afram et al., 2014). However, most policies regarding dementia care focus on supporting PwD and caregivers to prevent or delay the transition to a long-term care facility, due to its increased cost in comparison with caregiving in the community, as well as because of the negative outcomes associated with institutionalization (Bu & Rutherford, 2019). These outcomes include worsening of quality of life of PwD, depression and anxiety symptoms in family caregivers, and increased burden in institutional caregivers, associated with severe BPSD and disability – which in turn can affect quality of services (Gaugler, Mittelman, Hepburn, & Newcomer, 2010; Kunkle, Chaperon, & Berger, 2020; Miyamoto, Tachimori, & Ito, 2010; Nikmat, Hawthorne, & Al-Mashoor, 2015; Schulz, 2004).

Dementia challenges individuals, families, communities, and societies in general. This is particularly concerning taking into account the growing number of people living with dementia all around the world. In those aged 60 years and over, evidence suggests that the prevalence of dementia is between 5% and 7%, in most world regions (Prince et al., 2013). Indeed, although there are modifiable risk factors for dementia (e.g., reduced education, excessive alcohol consumption, obesity, smoking, social isolation, physical inactivity, air pollution), age is the strongest known risk factor (Livingston et al., 2020; WHO, 2017). Therefore, as human longevity increases globally, due to better health care and living conditions, so does the prevalence of dementia (WHO, 2012). It is estimated that there are currently around 50 million PwD worldwide, and this figure is expected to triple in the next 30 years (Alzheimer's Disease International, 2019). Importantly, this growth is not accompanied by a significant increase of younger populations, likely resulting in a progressive scarcity of caregivers, which will pressure health and social systems (Ienca et al., 2017). Consequently, the total worldwide cost of informal, social, and health care associated with dementia is enormous – around 1 trillion dollars per year – and it is expected to grow significantly in the next years (Wimo et al., 2017).

Considering the impact of dementia, research and innovation focused on supporting PwD and caregivers should be a public health priority (WHO, 2012; 2017). In the present chapter, we will address specifically how digital technologies (DT) can be useful in dementia care.

DEMENTIA CARE AND TECHNOLOGY

Dementia care is complex. It usually involves the provision of expanding assistance, so that daily activities are performed with efficacy and safety. Furthermore, as there is no disease-modifying treatment or cure for the vast majority of causes of dementia, prolonged therapeutic support is required to promote function, participation, and quality of life of both PwD and caregivers (Zucchella et al., 2018). In this regard, non-pharmacological treatments are of the utmost relevance, especially considering the side-effects and limitations of current pharmacological approaches, particularly their ineffectiveness in managing BPSD (National Institute for Health and Care Excellence, 2018; Park, Lee, Yang, Song, & Hong, 2019; Van De Glind et al., 2013; Zucchella et al., 2018). Non-pharmacological interventions can be implemented by different professionals, such as occupational therapists, psychologists, and nurses, and include cognitive stimulation, physical activity, reminiscence therapy, sensory-based interventions, environmental modifications, caregiver training, simulated presence therapy, among others (Meyer & O'Keefe, 2020; Zucchella et al., 2018). Thus, dementia care involves a vast array of actions, performed by different individuals, usually over a long period of time.

During this process, professionals and informal caregivers should consider that PwD must be involved and participate in cognitive, physical, and social stimulating activities that, preferably, have considerable personal significance. Indeed, engagement in a wide range of activities seems to help delay functional decline and promote well-being (Cheng et al., 2014; Mohler, Renom, Renom, & Meyer, 2018; Treiber et al., 2011; Woods, Aguirre, Spector, & Orrell, 2012; Yuill & Hollis, 2011). Furthermore, if activities have individual meaning, considering the person's occupational history and interests, involvement could be vital to meet the innate need for participation – which may remain in dementia, despite cognitive deterioration – and to preserve a sense of self-identity, associated with the evocation of autobiographical events (Chung, 2004; Mohler et al., 2018; Phinney, Chaudhury, & O'Connor, 2007). Also, if activity demands are tailored to the skills and capabilities of the person with dementia, engagement is enhanced, leading to positive affect and a sense of competence and autonomy (Chan et al., 2021; Gitlin et al., 2009; Mbakile-Mahlanza et al., 2020; Phinney et al., 2007; van der Ploeg et al., 2013). However, the capabilities of PwD are often devalued by others, who frequently act in a condescending or overprotective way, limiting the active participation of the patient (Alzheimer's Disease International, 2019; Yates et al., 2019). An adequate dementia care involves an environment that facilitates safe participation in meaningful activities, adjusted to the capabilities and skills of the person with dementia.

PwD also need validation, affection, and reciprocity to maintain psychological well-being and quality of life. Evidence highlights the importance of positive social interactions in dementia care (Adlbrecht, Bartholomeyczik, Hildebrandt, & Mayer, 2020; Amino, 2020; Jao, Loken, Macandrew, Van Haitsma, & Kolanowski, 2018; Lee, Boltz, Lee, & Algase, 2017; O'Rourke, Duggleby, Fraser, & Jerke, 2015). However, interactions between formal and informal caregivers and PwD may be hindered by communication difficulties, BPSD, and by the workload and time limitations associated with providing task-oriented care (Ellis & Astell, 2017; Fauth et al., 2012; Paudel, Resnick, & Galik, 2020).

Considering the challenges associated with dementia care, technological solutions play an important role in the support of PwD, caregivers, and providers of health and social services. Undeniably, technological innovations, especially in the past 20 years, have helped reshape the way treatment and care are delivered. Advances in areas such as artificial intelligence (AI), machine learning algorithms, robotics, pervasive and ubiquitous computing, wireless networking, and miniaturization of sensors, combined with an increased affordability of these technologies, have expanded the availability and subsequent application of intelligent devices and technology-embedded environments in dementia care (Dahlke & Ory, 2020; Ienca et al., 2017; Zucchella et al., 2018). Technologies can facilitate aging in-place, allowing PwD to remain in their community for a larger period and delaying the need for institutional care (Bharucha et al., 2009; Dahlke & Ory, 2020). This results from the promotion of independence and safety of individuals, as well from assisting caregivers in care-related tasks. Furthermore, technological development has allowed professionals to provide treatment and support in creative new ways. For example, progress in information and communication technologies has been particularly useful for telemedicine and telerehabilitation, facilitating continuous long-term care by reducing the need for traveling and associated cost and risk, which was exceptionally important in response to the restrictions associated with the 2020 COVID-19 pandemic (Ammar et al., 2020; Dores, Geraldo, Carvalho, & Barbosa, 2020; Neal et al., 2021).

DT are, in broad terms, electronic systems and devices that produce, store, and/or handle data in the form of binary computational code (Hadlington & Scase, 2018; Ibem & Laryea, 2014; Moreira dos Anjos-Santos, El Kadri, Gamero, & Gimenez, 2017). These technologies have advanced more rapidly than any innovation in history and include AI, robotics, the internet of things (IoT), augmented and virtual reality (VR), cloud technologies and big data, among other innovations (Hoosain, Paul, & Ramakrishna, 2020; United Nations, 2020). In the context of care and assistance provision to people with disability, digital tools are characterized by several authors as intelligent assistive technologies (Bharucha et al., 2009; Dahlke & Ory, 2020; Ienca et al., 2017). These include self-contained devices (e.g., tablets, wearables, robots), distributed systems (e.g., smart homes, integrated sensor systems), and application software (e.g., mobile or web-based apps) (Ienca et al., 2017). A systematic review by Ienca et al. (2017) has found that, between the years 2000 and 2016, the number of intelligent assistive devices that were used in dementia care increased exponentially, more than doubling every five years, with the most common being distributed systems to support monitoring and independence at home, as well as robots for domestic and social assistance. However, in the rapidly expanding field of DT, it is reasonable to consider that much has changed since 2016, particularly considering progresses in wearable and VR devices, as well as in application software. Indeed, a scoping review by Palmdorf et al. (2021) highlights the increased importance of applications and web-platforms, accessed via computer, laptop, or tablet, for PwD and caregivers. Also, a recent research by Neal et al. (2021) has found that, in the past years, the DT used for improving self-management and social participation of individuals with dementia mostly fit in the wearable, VR, and application domains.

TECHNOLOGY TYPES

Distributed Systems

A distributed system refers to a set of sensing and/or processing components, connected through a computer network, usually integrated in the individuals' home environment (Ienca et al., 2017). Such technologies are mostly non-intrusive, not requiring ongoing purposeful human interaction, which is particularly important considering cognitive decline in dementia, as well as caregiver burden (Lynn et al., 2019). In dementia care, these resources are largely used for monitoring behavior and environmental factors to ensure safety, as well for supporting the performance of daily activities, especially in situations of early stages of dementia (Bharucha et al., 2009; Lynn et al., 2019). This constitutes a form of ambient assisted living as it corresponds to the needs of the residents of the household in order to compensate for multidimensional difficulties, promoting independence and well-being for as long as possible, which could delay institutionalization (Helal & Christopher, 2019; Zucchella et al., 2018). Advances in smart home technologies (i.e., household equipment that is connected through the internet and can be managed and supervised with a control hub such as a computer or a smartphone) and domotics (i.e., automated functioning of devices at home) have contributed to an increased affordability and accessibility of these tools (Lynn et al., 2019).

Integrated ambient sensors (e.g., cameras, infrared, and pressure sensors) allow for monitoring, which is crucial for enhancing the safety of PwD, as they can detect abnormal behaviors or possibly dangerous conditions in the home environment, prompting responses from caregivers or emergency services, as well as from other connected equipment (Ienca et al., 2017; Lynn et al., 2019; Wang, Ellul, & Azzopardi, 2020). These sensors can measure activity and mobility indicators such as time spent in certain locations or in certain positions, opened doors, and irregular changes in body position that could characterize a falling motion (Lariviere, Poland, Woolham, Newman, & Fox, 2021; Lynn et al., 2019; Wang et al., 2020). This is particularly important for PwD considering cognitive deficits in areas such as executive functions, orientation, and visuoperceptual abilities, as well as BPSD related with wandering, apathy, and agitation. Additional symptoms, particularly regarding cognitive decline in functions such as memory, can also contribute to hazardous situations as result, for example, of forgetting to switch off a stove or to turn on the lights. Sensors can detect smoke and trigger an alarm, detect gas and switch off its supply, detect motion in a room and prompt adequate lighting, among other functions. Indeed, sensors can be connected with several devices and generate proper automated responses. Consequently, these technologies can contribute to the well-being of PwD, but also of family caregivers, considering that they may lead to a sense of safety and relieve some of the workload associated with supervision (Ault, Goubran, Wallace, Lowden, & Knoefel, 2020; Zucchella et al., 2018).

These technologies are also useful to support the completion of daily activities and to promote participation in different areas of occupation (Ienca et al., 2017; Lariviere et al., 2021; Moyle, 2019). Automation allows for certain tasks (e.g., adjusting room temperature and lighting, opening window coverings, and activating domestic appliances such as robot vacuum cleaners) to be executed without active engagement of individuals with dementia and their caregivers. This is important as it enhances safety, assists in house management and facilitates the participation of PwD (e.g., automatic lighting can provide environmental cues that may guide individuals to a certain section of the house) (Ault et al., 2020). Also, as certain tasks become automated, caregivers can have more time to participate in other activities that may contribute to their occupational balance and well-being, reducing burden and possibly leading to positive outcomes in the person they care for. These tasks can be scheduled and start automatically at a specific time, but also activated with certain prompts. In this regard, the affordability and utilization of voice activated assistants have increased significantly in recent years, changing the way people interact with technology (Dahlke & Ory, 2020; Ermolina & Tiberius, 2021; Masina et al., 2020). These assistants, such as Google Home and Amazon Alexa, mimic natural human communication and allow users to interact with several home appliances simply by uttering voice commands (Dahlke & Ory, 2020; Ermolina & Tiberius, 2021; Masina et al., 2020). This is particularly useful for caregivers as it becomes easier to activate certain household equipment but also to set alarms, schedule events and reminders, manage a shopping list, listen to music, contact other people, among other possibilities. Regarding PwD, these resources may be helpful in early stages of dementia, but as cognitive decline progresses in areas such as memory, language, and executive functions, purposeful interaction with voice activated assistants becomes limited, as specific sequences of words are necessary to operate the system (Masina et al., 2020). However, these assistants can be programed to provide auditory and possibly visual cues – directly or through connected devices such as smartphones or tablets – that can aid both PwD and caregivers. External cueing can help by reminding individuals to perform a task at the appropriate time (e.g., taking medication or preparing for a visit), by providing guidance through an activity (e.g., describing the location of objects necessary to certain steps of an activity), and by promoting participation in leisure or social activities (e.g., suggesting to read a book or to call a family member) (Zucchella et al., 2018).

Robotics

The role of robots in dementia care has expanded significantly in the past few years (Ienca et al., 2017; Palmdorf et al., 2021). In this field, domestic robots can help PwD and their caregivers by assisting in daily activities, either by performing them autonomously (e.g., a robot vacuum cleaning the house) or by facilitating certain tasks (e.g., a kitchen robot helping prepare a meal, from providing a shopping list to giving sequential cues according to a specific recipe). These technologies, which have the potential to enhance the independence of individuals with mild cognitive decline and ease the workload of family caregivers, are growing in diversity and are available at increasingly affordable prices (Garcia-Haro, Oña, Hernandez-Vicen, Martinez, & Balaguer, 2020; Zhong, Ling, Cangelosi, Lotfi, & Liu, 2021). On the other hand, there are robots which were specifically developed to meet the needs of individuals with disability and social problems: socially assistive robots. These machines are autonomous, mobile, and capable of developing and maintaining social interactions (Abdi, Al-Hindawi, Ng, & Vizcaychipi, 2018; Arthanat et al., 2020). They can perform physical tasks, monitor for safety, seek emergency assistance, provide prompts and reminders, engage the person with questions and stimulating activities, facilitate contact with other persons, and/or offer companionship and affection (Abdi et al., 2018; Hung et al., 2019).

Socially assistive robots can be organized in service robots – tasked with supporting daily activities – or companion robots – focused on improving the psychological status and overall well-being of its users (Abdi et al., 2018; Iancu & Iancu, 2017). There are several robots, with multiple complex functions, applied to dementia care. In this regard, PARO is the most researched socially assistive robot, being used in dementia care since 2003 (Hung et al., 2021; Kang, Makimoto, Konno, & Koh, 2020; Palmdorf et al., 2021). PARO is a commercially available robotic baby harp seal with 2.8 kg and 45 cm long, specifically designed for PwD (Hung et al., 2021; Hung et al., 2019; Shibata & Coughlin, 2014). It has light, tactile, posture, temperature, and audio sensors, as well as AI which allows PARO to behave like a domestic pet and act with the goal of promoting positive interactions with the user (Hung et al., 2019; Kang et al., 2020). It moves its head and tail, blinks, and makes sounds in accordance with the user's actions, even learning to respond to its name (Abdi et al., 2018; Ienca et al., 2017). Furthermore, it has its own rhythms, with varying levels of playfulness and activity, mimicking a real animal (Abdi et al., 2018). The application of animal-like robots in dementia care is based on the therapeutic effects of the human-animal interaction, namely in the affective and social domains, with the assumption that robotic pets require less care and are safer to use than real animals (Hung et al., 2021; Hung et al., 2019). There are several other companion robots (e.g., AIBO, JustoCat, NAO, Bandit, Nodding Kabochan) mostly with pet-like or humanoid appearance, supported by varying levels of research (Abdi et al., 2018; Gustafsson, Svanberg, & Müllersdorf, 2015; Martín, Agüero, Cañas, Valenti, & Martínez-Martín, 2013; Osaka et al., 2017; Tamura et al., 2004; Tapus, 2009). However, PARO is the socially assistive robot with a greater body of evidence supporting its positive outcomes, which include: diminishing BPSD such as anxiety, depression, agitation, and apathy; improving communication and the quality of social interactions; reducing the usage of psychotropic and pain medication; and promoting quality of life (Abdi et al., 2018; Hung et al., 2019; Kang et al., 2020). Indeed, studies show that the experience of interacting with PARO benefits people in different stages of dementia-related cognitive decline, helping individuals to become more active, smiling, and relaxed (Hung et al., 2019; Kang et al., 2020). Besides improving the overall mood of users with dementia, PARO promotes more spontaneous communication, acting several times as an icebreaker for social interaction with surrounding persons, mostly based on the characteristics of the robot and animal-related positive memories (Hung et al., 2021; Hung et al., 2019).

The positive outcomes associated with companion robots such as PARO may result from fulfilling the need of individuals with dementia for meaningful occupation, expression, attachment, affection, closeness, and comfort (Hung et al., 2021). However, improvements in service robots have also allowed this type of socially assistive technologies – which typically have the ability to recognize and synthesize speech – to create engaging social interactions with PwD, besides helping in daily activities or monitoring for safety and well-being (Moyle, 2019; Salichs et al., 2020). Thanks to AI and multiple sensors (e.g., cameras, microphones), several service robots (e.g., RAMCIP, Care-O-Bot, GrowMu, Pepper) are able to find individuals within the household and either engage them in simple conversations, or present them with diverse activities displayed in a visual interface (Bedaf et al., 2013; Georgiadis et al., 2016; Gerłowska et al., 2018; Paletta et al., 2018). Machine learning algorithms enable robots to adjust conversation topics and activities to the users' interests and needs, allowing these machines to, for example, ask PwD about their favorite stories and memories, using visual and auditory prompts that can facilitate moments of reminiscence (Felzmann, Beyan, Ryan, & Beyan, 2016; Moyle, 2019; Salichs et al., 2020). Also, this allows robots to offer meaningful activities that can promote cognitive stimulation or moments of relaxation, entertainment, and leisure (Felzmann et al., 2016). These functions are particularly important as they can potentially help reduce BPSD and delay cognitive decline in PwD.

Furthermore, service robots usually have the necessary tools for videoconferencing, which promotes social contact, monitoring, and the delivery of telehealth services (Ienca et al., 2017; Moyle, 2019). Nevertheless, monitoring is also performed autonomously by several service robots, which are able to analyze several parameters, including motion, behavior, and speech patterns and content, in order to generate proper responses, such as contacting family members or emergency services (Felzmann et al., 2016; Moyle, 2019). Finally, as evidenced by their definition, service robots also support the performance of daily activities by executing specific tasks (e.g., picking up and transporting objects, switching off domestic appliances) or by providing reminders about appointments, medications, and hydration. Consequently, these machines may have an important role in promoting the independence and participation of PwD, as well in reducing caregiver burden (Law et al., 2019). However, there is no widespread use of multifaceted service robots due to many reasons, but primarily because these products often do not reach the market for which they are intended, in result of high production costs and of still being developed in universities and research institutes, which do not necessarily seek immediate commercialization opportunities (Bedaf, Marti, Amirabdollahian, & De Witte, 2018; Moyle, 2019).

Wearable Devices (WD)

WD are technologies incorporated into items of clothing or accessories worn by an individual (Ienca et al., 2017). Although these devices have been around for many years, only recent progress in miniaturization, micro-computing, cloud platforms, and in the IoT has led to a considerable development of wearables for commercial and medical purposes (Haghi, Thurow, & Stoll, 2017; Moyle, 2019; Ray, Dash, & De, 2019). Common WD used in dementia care include electronic tracking chips and global positioning systems (GPS) locators (e.g., embedded in a shoe) that can help find a person if they get lost, as well as alarm pendants and bracelets that aim to facilitate calling for assistance in an emergency (Lynn et al., 2019). As PwD frequently wander, become disoriented, or are faced with problems that they cannot solve, these technologies are crucial to enhance their safety and to possibly soothe caregivers to a certain extent (Nijhof, Van Gemert-Pijnen, Woolrych, & Sixsmith, 2013; Sriram, Jenkinson, & Peters, 2019).

Mostly in the past decade, the diversity, affordability, and utilization of technologies that include a variety of sensors, such as smartphones, smartwatches, electronic wristbands, and chest straps, have increased significantly (Stavropoulos, Papastergiou, Mpaltadoros, Nikolopoulos, & Kompatsiaris, 2020). These devices can be used to measure various parameters without much discomfort or interruption, including motion (e.g., steps, travelled distance, abrupt changes in position), sleep quality (e.g., overall sleep time, hours of light and deep sleep, sleep interruptions), social interaction (e.g., proximity to devices of other people, overall phone and social network interactions), and physiological indicators (e.g., heart rate, electrodermal activity, oxygen saturation) (Cote, Phelps, Kabiri, Bhangu, & Thomas, 2021; Kourtis, Regele, Wright, & Jones, 2019; Stavropoulos et al., 2020; Teixeira et al., 2021). This data can be collected and managed passively, and its analysis seeks to inform family members and health professionals regarding the person with dementia's overall health status, falls and other significant events, cognitive decline, and BPSD such as depression, anxiety, aggression, or agitation (Anghel et al., 2020; Husebo et al., 2020; Kourtis et al., 2019; Lai Kwan et al., 2019). Particularly considering communicational difficulties of PwD, the information collected by WD may empower caregivers and ameliorate care decisions (Lai Kwan et al., 2019).

Besides monitoring the individual's condition and location, and facilitating responses in emergency situations, wearable technologies have additional functions, resulting mostly from advances in software applications. These devices, which often are interconnected and linked with distributed systems, may provide reminders and warnings that may help perform daily activities and maintain health and safety (Hackett et al., 2020). Furthermore, some devices are used to facilitate non-pharmacological therapies, such SenseCam, which is a wearable camera that collects photographs during the day that are subsequently used for cognitive training and reminiscence therapy with PwD (Seamon et al., 2014; Silva et al., 2017). Indeed, as technologies become increasingly mobile, the application of WD in dementia care is likely to expand.

Application Software and VR

There is a myriad of applications useful for dementia care, available in several devices such as computers, tablets, and smartphones. These encompass vastly widespread programs for videoconferencing (e.g., Skype, Zoom), which can be used with several goals, including the provision of non-pharmacological interventions by health professionals, facilitating peer-support programs for caregivers, and monitoring the well-being of PwD and their family members (Banbury, Parkinson, Gordon, & Wood, 2019; Bossen, Kim, Steinhoff, Strieker, & Williams, 2015; Cheung & Peri, 2021; Cuffaro et al., 2020; Zamir, Hennessy, Taylor, & Jones, 2018). This is particularly important in situations of social isolation, as it reduces the cost and time spent with travelling, which can be an encumbering task not only for individuals with dementia and caregivers, but also for community health professionals, which are often faced with an increasing number of dementia patients (Banbury et al., 2019; Martínez-Alcalá, Pliego-Pastrana, Rosales-Lagarde, Lopez-Noguerola, & Molina-Trinidad, 2016). There are also several games (e.g., Luminosity, Wii Sports, Big Brain Academy) that were developed for entertainment purposes but that have been used for non-pharmacological treatments, assuming the characteristics of serious games (McCallum & Boletsis, 2013). Although this area is still in expansion, there is considerable evidence that game-based interventions can have positive outcomes in PwD, improving physical health (e.g., balance, gait, motor control), cognitive function (e.g., attention, memory, visuospatial abilities), mood, and sociability (Narme, 2016; Zucchella et al., 2018). There is additionally a group of application software specifically designed for clinical purposes, with application in dementia care. These include numerous programs for computerized cognitive training, stimulation, and rehabilitation (e.g., CogniPlus, GRADIOR, COG-PACK, NeuronUP), which also have positive outcomes (Fiatarone Singh et al., 2014; Franco-Martín et al., 2020; Hill et al., 2017; Irazoki et al., 2020; Marques, Virgílio, Silva, Lino, & Ribeiro, 2016; Mendoza Laiz, Del Valle Díaz, Rioja Collado, Gomez-Pilar, & Hornero, 2018). Several other applications are available, associated with different outcomes and varying levels of evidence, including: Alzheimer Master, which supports the performance of daily activities with reminders, among other functions; CogniCare, which was developed for caregivers of PwD, providing information regarding the syndrome and helpful resources, also allowing for events and behaviors to be recorded; Social Support Aid, which aims to facilitate social interactions by facial recognition and providing prompts regarding the name and relationship of other individuals; and InspireD, an application to promote reminiscence activities (Macaden et al., 2021; McCarron, Zmora, & Gaugler, 2019; Moyle, 2019; Mulvenna et al., 2017; Neal et al., 2021; Yousaf et al., 2019).

Computerized non-pharmacological treatments for PwD frequently involve VR. This technology can be defined as computer-generated simulation of a three-dimensional environment that can be interacted with by a person using specific electronic equipment, providing the user with a sense of presence in the environment (Damian, 2018; Kardong-Edgren, Farra, Alinier, & Young, 2019). This experience can range from the non-immersive (e.g., the virtual environment is presented on a computer monitor) to the fully immersive (e.g., using a head-mounted display to achieve a surrounding experience with reduced stimuli from physical reality) (T. Rose, Nam, & Chen, 2018; Slater & Sanchez-Vives, 2016). VR has mostly been used in dementia care to improve cognitive skills, physical fitness, and emotion of patients (D’Cunha et al., 2019; Kim, Pang, & Kim, 2019). This technology has also been employed for educational purposes, with the goal of increasing knowledge and empathy for dementia, predominantly in caregivers, professionals, and students (Campbell, Lugger, Sigler, & Turkelson, 2021; Hirt & Beer, 2020; Jütten, Mark, & Sitskoorn, 2018; Strong, 2020). Considering recent advances in head-mounted displays and cave-related technologies, the use of immersive VR with PwD has been increasing significantly. Indeed, these technologies have been used with different goals, such as promoting reminiscences or cognitive training, and evidence suggests that immersion is safe, does not result in significant cybersickness, and allows for engaging, motivating, and pleasant experiences with PwD (Coelho et al., 2020; Eisapour, Cao, Domenicucci, & Boger, 2018; Strong, 2020; Yun et al., 2020).

FACTORS INFLUENCING THE UTILIZATION OF TECHNOLOGIES

The application of DT to dementia care is determined by factors associated with the users – PwD, caregivers, and health professionals – and with the technology itself. First, PwD may not have the necessary skills to use technological tools, due to cognitive decline or in result of aging-related physical or sensorial changes (Guisado-Fernández, Giunti, Mackey, Blake, & Caulfield, 2019; Iancu & Iancu, 2017). These difficulties are particularly prevalent when there is a lack of familiarity with specific technologies, and when the technology’s interface is highly complex (Guisado-Fernández et al., 2019; Neal et al., 2021). However, even when digital tools are easy to use, the individual may simply forget to use them (Lariviere et al., 2021; Van Der Roest, Wenborn, Pastink, Dröes, & Orrell, 2017). On the other hand, lack of awareness and denial of the syndrome – common in early stages of dementia – may lead to a rejection of any kind of help, including digital solutions (Guisado-Fernández et al., 2019). Also, individuals may not use technology if they do not consider that its usefulness outweighs the associated costs (Iancu & Iancu, 2017; Neal et al., 2021). This may be related with digital literacy but also with characteristics of the technology and associated information (Dahlke & Ory, 2020; Guisado-Fernández et al., 2019). Furthermore, previous experiences are determinant for the expectations and overall attitude towards technology, with past disappointments or difficulties with technologies acting as barriers for their adoption (Guisado-Fernández et al., 2019; Iancu & Iancu, 2017; Neal et al., 2021). Excluding dementia-related cognitive decline, these factors are also applicable in the case of caregivers, who have a key role in the implementation of technologies. Considering the limitations of PwD, family caregivers are often responsible for choosing, employing, and managing technologies (Lariviere et al., 2021; Neal et al., 2021). Therefore, their knowledge, skills, and attitudes towards technology and care, are determinant for the effectiveness of digital solutions. Finally, the health professionals' digital skills and knowledge are also decisive for the implementation of technology in dementia care, as these individuals are frequently responsible for providing information and training regarding the adequate digital tools for each situation. The ability to keep up to date with technological advances and related scientific evidence is of the utmost importance, as it empowers professionals to provide the services that most contribute to the well-being of their patients and their families.

The attributes of digital tools also impact their usage. Important aspects include cost, utilities, design, and constraints associated with installation and maintenance (Guisado-Fernández et al., 2019; Iancu & Iancu, 2017; Lariviere et al., 2021; Neal et al., 2021). For example, some houses may not fulfill the necessary requirements to support the implementation of technologies, ranging from internet connectivity to available physical space (Lariviere et al., 2021). On the other hand, some digital tools may require frequent active interaction from the caregiver, increasing the workload of a usually overburdened group of individuals, often resulting in cessation of use (Hung et al., 2019). This highlights the importance of involving users in technological development (Dahlke & Ory, 2020; Moyle, 2019; Tsertsidis, 2020). Indeed, patient and public involvement is crucial to ensure a user-centered design which corresponds to the needs and preferences of PwD and caregivers, ultimately enhancing the usability of technologies (Hassan et al., 2017; Husebo et al., 2020; Miah et al., 2019).

Finally, some ethical questions may arise when considering the application of digital solutions in dementia care, especially considering that the ability of PwD to fully understand the implications of these technologies and give informed consent regarding their implementation may be limited due to cognitive decline (Guisado-Fernández et al., 2019; Portacolone, Halpern, Luxenberg, Harrison, & Covinsky, 2020; Wangmo, Lipps, Kressig, & Ienca, 2019). First, although monitorization is used to promote safety and independence of the individual, some authors consider that this constitutes a form of continuous surveillance that may limit privacy and freedom (Guisado-Fernández et al., 2019; Lariviere et al., 2021; Yang & Kels, 2017). On the other hand, there may be concerns regarding data ownership and confidentiality, as sensitive information may be collected, stored, and analyzed (Bharucha et al., 2009; Portacolone et al., 2020; Wangmo et al., 2019). Likewise, there are issues associated with communication with a device with AI, as it may deceive PwD into thinking that they are interacting with another human being or animal (Metzler & Barnes, 2014; Moyle, 2019; Portacolone et al., 2020; Wangmo et al., 2019). These concerns, combined with the fear of "dehumanizing care" by reducing human contact in result of using technologies for certain tasks, may limit the utilization of digital solutions (Ienca et al., 2017; Lariviere et al., 2021; Yang & Kels, 2017; Zucchella et al., 2018). Consequently, it is paramount that technology is employed with the goal of complementing care, while ensuring that all the appropriate ethical standards are being upheld, considering principles such as liberty, privacy, dignity, respect, autonomy, beneficence, and non-maleficence (Ienca et al., 2017; Lynn et al., 2019; Portacolone et al., 2020; Wangmo et al., 2019; Yang & Kels, 2017).

CONCLUSION

In the last two decades, there has been a considerable growth in the application of DT to dementia care, and the potential for expansion is enormous. The goal of this chapter was to provide a brief overview of the main topics in this field and list some examples of useful digital tools. In sum, technologies can be grouped considering two major functions: (1) to promote independence and safe participation of PwD in all areas of occupation, which include digital solutions for monitoring, assistance in daily activities, and facilitation of leisure and social participation; and (2) to provide therapeutic experiences that seek to delay cognitive decline and diminish BPSD, encompassing diverse non-pharmacological interventions. In this rapidly developing area, it is important that scientific research accompanies technological innovations, in order to better understand how digital solutions can enhance the well-being of PwD and their families.

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KEY TERMS AND DEFINITIONS

Application Software: Computer program designed to perform specific tasks for end-users.

Caregiving: Providing assistance to another person in order to support daily activities and fulfill basic needs.

Cognitive Decline: Deterioration of mental functions.

Disability: Impairment that limits activity and participation.

Distributed Systems: A set of technological components that are connected through a computer network in order to achieve common goals.

Intelligent Assistive Technologies: Technologies with computation capability and the ability to share data through a network, used to provide assistance to people with disability.

Robotics: The field of technology dealing with the design, manufacture, and operation of mostly autonomous mechanical systems that are controlled by computer programs.

Serious Games: Games that are developed for a purpose beyond entertainment, such as training or education.

Virtual Reality: Computer-generated simulation of a three-dimensional environment that can be interacted with by a person using specific electronic equipment, providing the user with a sense of presence in the environment.

Wearable Devices: Technologies incorporated into items of clothing or accessories worn by an individual.

Section 3

Gamification and Serious Games in Mental Healthcare

Chapter 7
Digital Games and Mental Health:
A Scoping Review on Gaming Disorder in the Last Decade

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ABSTRACT

As more and more people worldwide play online games, identifying how games can help or harm players' mental health can be helpful for researchers and clinicians developing digital therapies through gaming. This chapter summarizes a scoping review focused on the relationship between digital games and mental health in the last decade. This type of review is designed to provide an overview of the existing evidence base on a particular topic. Of the 115 records selected after the first screening, 21 studies were included according to the inclusion criteria defined by the authors. From this scoping study, it is possible to recommend that even though video games are a real risk for addiction, they can work as digital therapies for psychosocial rehabilitation when administered with precaution in groups with mental disorders such as depression, high levels of anxiety, and ADHD. For this, a rigorous clinical assessment should be conducted that makes appropriate use of gamer typologies and evaluates the individual, emotional, and social factors that impact gamer behavior.

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INTRODUCTION

During the pandemic of COVID- 19, our entertainment and socializing habits were altered. Being forced to be at home, we had to adapt to a routine focused almost exclusively on digital media. The emotional instability generated by this *sui generis* context has been combated through human interactions mediated by digital technologies. Many of these interactions occurred in online interactive media, namely Massively Multiplayer Online Role-Playing Games (MMORPG) and Multiplayer Online Battle Arena (MOBA). In this phase, digital gaming quickly went on to have millions of new players worldwide (Statista, 2021). According to the Interactive Software Federation of Europe, playtime increased weekly by 1.5 hours among European players aged 6-64 years old, and 1 in 5 players played more video games online with friends, family, or other video game players during the lockdown. Around 30% of players said video games have helped them feel happier, less anxious, and isolated (IPSOS, 2020). Thus, these interactive entertainment media seem to have "outgrown" the stigma of harming mental health into an indispensable health promotion resource (IPSOS, 2020; Statista, 2021).

During the lockdown, the World Health Organization has teamed up with gaming companies to encourage people to keep their physical distance. Thus, in partnership with this organization, the gaming industry launched the #PlayApartTogether campaign to inform and encourage the population to follow the hygiene and safety guidelines to prevent COVID- 19 (ISFE, 2021). Paradoxically, a few years before the pandemic, the WHO had validated Internet Gaming Disorder (hereafter IGD) as an illness that can be clinically treated (WHO, 2018).

At the same time, the US Food and Drug Administration (FDA) approved the use of a "serious game" as part of the treatment for attention deficit hyperactivity disorder in 2020. It is a digital therapeutic that uses a proprietary algorithm designed to improve attention and related cognitive control processes. It is indicated for children between the ages of 8 and 12 diagnosed with ADHD. In addition, this and other digital therapeutics are currently being applied in people recovering from neurological and cognitive sequelae of COVID-19 (Jaywant et al., 2021).

Even with the visible benefits of digital games in various dimensions of human life (Johannes et al., 2021; Jones et al., 2014; Przybylski & Weinstein, 2017), gaming is classified as problematic when its use becomes no longer therapeutic and pleasurable (Ballou & Van Rooij, 2021; Gentile et al., 2011; Kiraly et al., 2020). IGD was included in the addictive disorders section in the latest edition of the International Classification of Diseases (2018). In this version of the ICD-11, gaming disorder is defined as a pattern of persistent or recurrent gaming behavior, which may be online or offline, manifested by impaired control over gaming, or increasing priority given to gaming to the extent that it takes precedence over other life interests and daily activities. The behavior pattern is of sufficient severity to result in significant impairment in personal, family, social, educational, or occupational spheres and may be either continuous or episodic and recurrent. The gaming behavior disorder and other traits are typically evident. Therefore, they can be assigned a diagnosis in over 12 months, although the required duration may be shortened if all diagnostic requirements are met, and patients show severe symptoms. In turn, the fifth revision of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) considers the IGD as a potential new diagnosis that requires further research (Carbonell, 2020).

The prevalence of problematic gaming is estimated to range from 0.7% to over 15.6% among the general population (Feng et al., 2017). However, there remains much debate in the academic community about the inflated prevalence figures for IGD and the appropriate diagnostic criteria for problematic online gaming (Kuss & Gainsbury, 2021; Markey & Ferguson, 2017). These dubious and antagonistic proprieties of digital gaming illustrate "the central role video game engagement plays as a potential public health issue" (Johannes et al., 2021, p. 2).

As more and more people worldwide play online games, identifying how evidence-based research on IGD is being conducted and what methodologies and ethical protocols are adopted can contribute to a broad understanding of pathological gaming. Furthermore, identifying how games can help or harm players' mental health can be helpful for researchers and clinicians developing digital therapies through gaming. Finally, it can help avoid the "moral panic cycle" common to all new media and the potential to amplify a real problem (Ferguson et al., 2011; Markey & Ferguson, 2017).

MAIN FOCUS OF THE CHAPTER

This chapter summarizes a scoping review that clustered twenty-one open access articles available on an online database platform. It focuses primarily on the relationship between digital games and mental health in the last decade. Note that the choice of open access articles relates to the open science principles advocated by the authors.

Overall, a scoping review clarifies, defines, and develops conceptual boundaries within a subject area. This type of review is designed to provide an overview of the existing evidence base (Arksey & O'Malley, 2005; Fitzgerald & Ratcliffe, 2020; Levac et al., 2010; Peters et al., 2015).

This chapter is divided into seven parts: introduction, research questions, methodology, results, discussion, future research directions, and conclusion.

Issues, Controversies, Problems

Gaming and Mental Health: Is it Possible that Games are Health Neutral?

In the digital era, characterized by technologies that aggregate a vast media ecology that merges analogue and digital spaces, interactive digital *medium*, such as gaming, enable a vast field of creation in Multimedia Art (Gouveia, 2020). However, it is not only in the Arts that games are beneficial. For example, Johannes et al.'s recent study (2021) on the relationships between video games and well-being suggests that playing is an activity that relates positively to mental health. Therefore, policy decisions regulating play would limit players from its benefits and restrict the human right to play.

In turn, as a cultural product consumed by both males and females around the world, digital games are still linked to the stigma of the "young male technophile" who spends too much time gaming (Kuss et al., 2014). This stigma began to be shaped in the early days of the gaming industry and was strengthened by school counselors and researchers over the 1980s and 1990s (e.g., Keepers, 1990; Soper & Miller, 1983). In 1983, Soper and Miller reported an emerging addiction behavior among adolescents and advised how excessive use of video games could result in addiction. However, it was only in 1996 that "the concept of Internet Addiction Disorder emerged for the first time, initially as a satirical hoax as a response to the perceived pathologizing of everyday behaviors" (Kuss et al., 2014, p.1). In this context, Mark Griffiths and Kimberly Young emerged as the pioneers of empirical research on internet addiction, as they were the first to empirically examine the phenomenon (Griffiths, 1997; Young, 1996).

In the last three decades, empirical research examining internet gaming addiction has increased substantially (Fam, 2018; Feng et al., 2017). However, although some scholars have shed some light on the diagnosis of pathological gaming, "the classification of Internet addiction is still controversial as no gold standard of Internet addiction assessment has emerged" (Kuss et al. 2014, p. 2).

Researchers have argued that there is insufficient evidence that gaming disorder definitions and diagnostic tools meet clinical standards, and consequently, IGD continues to risk pathologizing normal behaviors given the inclusion of too many "symptoms" that do not indicate pathology (Markey & Ferguson, 2017; Przybylski et al., 2017). In this sense, the authors of this chapter set out to answer the following question: What types of study design, sample, and variable measurement instruments are being used in empirical research on IGD over the past decade?

Engaged or Addicted Gamers?

According to Ferguson et al. (2011), a central issue to be considered in research on problematic gaming "is differentiating gaming behavior which is pathological and potentially interferes with everyday real-world activities such as schoolwork or occupation, from gaming behavior that is not" (p. 1574). In their meta-analysis, Ferguson et al. (2011) found a prevalence rate of about 6.0% for video game addiction. However, excluding those who could be categorized as engaged gamers, the prevalence dropped to 3.1%. Therefore, these authors propose to use the concept of engagement (Charlton & Danforth, 2007) in the analysis of research on gaming addiction since engagement means that a high degree of video game use can be a positive and non-interfering experience for many gamers.

In turn, the study carried out by Loton et al. (2016) examined relationships between video game addiction, engagement, and mental health. Their findings demonstrated that video game engagement was only directly connected to anxiety and a lesser extent than addiction. According to these scholars, this finding contributes to previous discussions on when intense gaming may or may not become problematic (Charlton & Danforth, 2007; Gentile et al., 2011).

Although several studies have been conducted on the relationship between mental health and video game addiction, few studies have researched gaming disorders in different types of gamers (Wittek et al., 2016). Thus, it is pertinent to identify if evidence-based research on gaming disorder and mental health published in the last decade considers the difference between engaged and addicted gamers in their analyses.

Mind the Gap: Gender Differences or Gender Stereotypes?

Until the 1990s, computer game studies were not carried out from a gender matrix, diluting the particularities of female gamers in the observation of the game consumption dynamics of the male audience (Cassell & Jenkins, 1998). However, in the last two decades, gender issues have been put on the agenda of gaming studies (Lima & Gouveia, 2020). As a result, there is extensive literature denouncing how games reinforce gender stereotypes and the effects of toxic masculinity on the invisibility and exclusion of women from gaming culture (Blackburn & Scharrer, 2019; Cote & Mejeur, 2018; Fox & Bailenson, 2009; Fox & Tang, 2014; Tang & Fox, 2016; Wilhelm, 2018).

Although we gradually see an increase in research on pathological gaming that includes data on gender differences (Elliott et al., 2012; Lucas & Sherry, 2004), analyses are often restricted themselves to stating that "males are significantly more likely to be video game addicts than females" (Stockdale & Coyne, 2018, p. 270). Furthermore, "very little research has been conducted specifically examining female gamers, and female video game addicts" (Stockdale & Coyne, 2018, p. 271), and not all studies consider the influence of other identities (e.g., race, sexual orientation, nationality) on its self-reported surveys.

Lucas and Sherry's study (2004) showed that it is more socially acceptable for males to play video games, and this social acceptance makes male video game playing more public. In turn, study results conducted by Stockdale and Coyne (2018) suggest that female video game addicts displayed hyper-masculine tendencies and gender-atypical behavior. Thus, gender-stereotypical females may be less likely to play video games. However, it is also possible that frequently playing video games changes scripts and schemes regarding gender for females. For these authors, eliminating gamer-related stereotypes may help draw attention to the reality of gaming addiction. Thus, "it may be more difficult for video game addicts to recognize their own pathology when they do not see themselves in the same light as a stereotypical video game addict" (p. 270).

According to Peck et al. (2020, p. 1945), "gender is an important demographic characteristic to consider in user research." Therefore, when conducting studies with humans, female participants must be reviewed for acceptable representation, or justification must be provided for failure to represent female participants adequately. In this sense, if we consider that about half of gaming consumers and gamers are women (Statista, 2021b, ISFE, 2021) and that more and more women are employed in the gaming industry, the gender informational deficit in empirical research on gaming and mental health is not justified. In this regard, how has empirical research on IGD addressed gender differences over the past decade?

METHODOLOGY

Database, Keywords, and Inclusion Criteria

Data were retrieved in April 2021 from the Web of Science platform, the world's leading database for published articles and citations (Goyal & Kumar, 2021). This database was used as it is more comprehensive than other commonly used databases, such as PsycINFO or PubMed; that is, WOS includes several multidisciplinary databases (Kuss et al., 2014).

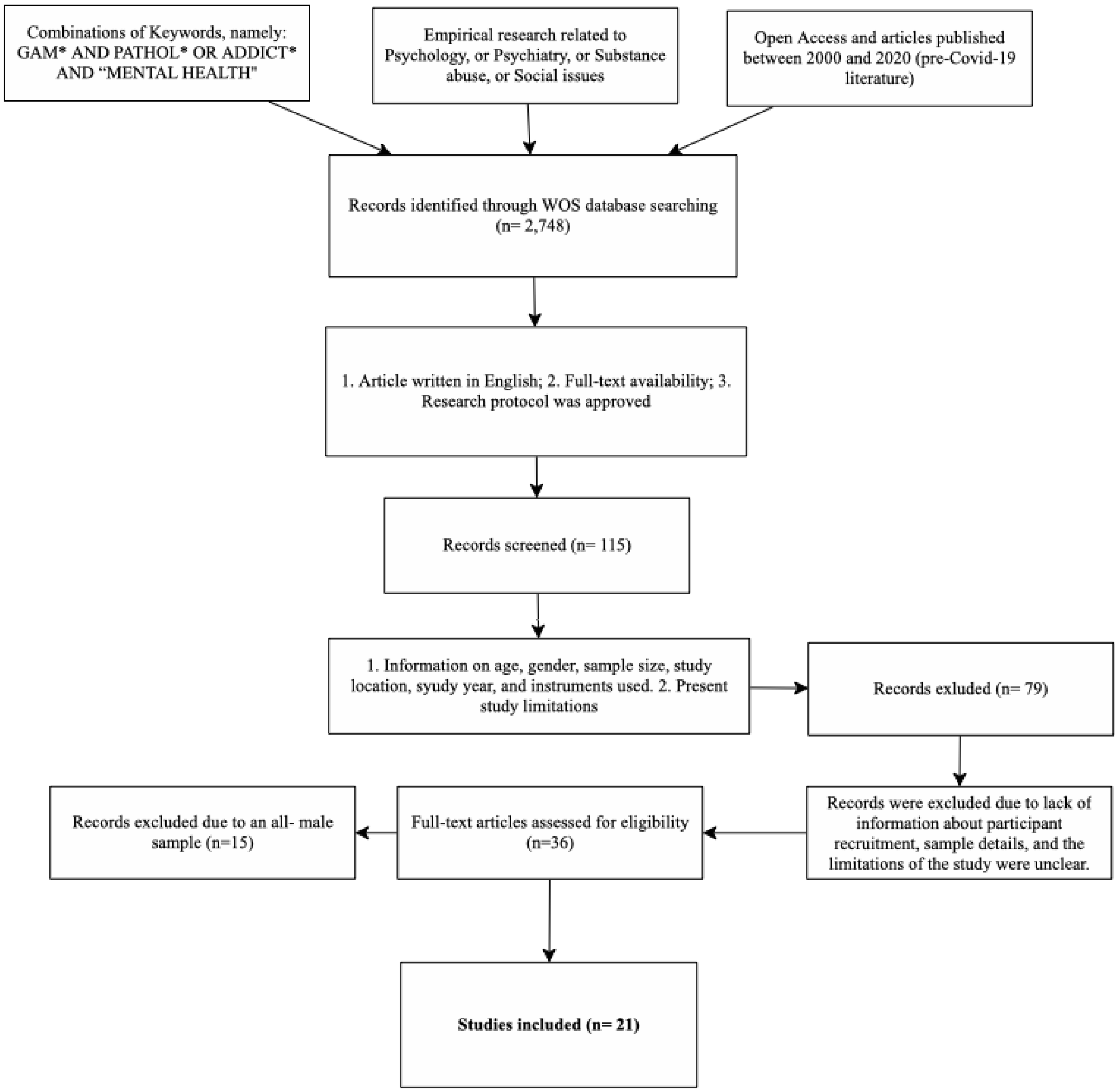
First, the following search terms (and their derivatives) were entered: GAM* AND PATHOL* OR ADDICT* AND "MENTAL HEALTH." Then, the search was refined to include i. empirical research related to Psychology, or Psychiatry, or Substance Abuse, or Social Issues; ii. open access; iii. articles published between 2000 and 2020, yielding 2,748 initial results.

Then the authors did the first screening, using the following inclusion criteria: i. contain the words (video)game, gamers, or gaming in the title or keywords; ii. articles are written in English; iii. full-text available; iv. peer-reviewed article; v. research protocol approved by an ethics committee. All articles that referred to gambling were excluded. In this stage, a total of 115 records were screened.

Records were reviewed based on reading abstracts, and even full papers were accessed if there were questions about the inclusion criteria. Next, records were imported into the authors' EndNote library.

In EndNote, information on the sample was selected, such as age, gender, sample size, study location, year of recruitment of participants, and instruments used. Outcomes and limitations of the selected records were checked as well. At this stage, 79 articles were excluded. Some articles were excluded due to a lack of information about participant recruitment, sample details, and the study's limitations were unclear. Then 36 full-text articles were imported from EndNote into the NVivo software.

Figure 1. The overall flow of scoping review search and selection



As one of the questions in this literature review involves gender differences, all articles with only men in their sample were excluded. Following these procedures, 21 eligible empirical studies remained for evaluation in the present scoping review (see Figure 1).

Analysis Method

As more authors are conducting literature reviews to integrate the results of evidence-based research, various types of reviews have evolved with their respective methodologies developing with precision and clarity (Anderson et al., 2020; Arksey & O'Malley, 2005; Levac et al., 2010; Peters et al., 2015). An alternative to the systematic review is the scoping reviews.

According to Peters et al. (2015), scoping reviews are commonly used to clarify a topic or field's working definitions and conceptual boundaries. They are helpful when a body of literature has not yet been comprehensively reviewed or exhibits a complex or heterogeneous nature that is not amenable to a more precise systematic review of the evidence. While scoping reviews can be conducted to determine the value and likely scope of a full systematic review, they can also be undertaken to summarize and disseminate research findings, identify research gaps, and make recommendations for future research (Peters et al., 2015).

Scoping study can also be conducted to determine the extent of available research on a topic and how the research was conducted. For example, a recent scoping review on serious games, gamification, and severe mental illness (Fitzgerald & Ratcliffe, 2020) aimed to identify the common characteristics of gamified interventions, the effectiveness of the interventions in promoting treatment outcomes, and the acceptability and feasibility of their use in clinical settings.

A scoping review requires at least two reviewers, and, as with all systematic reviews, an a priori scoping review protocol should be developed before conducting the review itself (Peters et al., 2015). The five stages of a scoping review proposed by Arksey and O'Malley (2005) were followed: i. identifying the initial review question; ii. identifying relevant studies; iii. selecting studies; iv. mapping the data; v. grouping, summarizing, and reporting the results.

During data mapping, thematic analysis was carried out. As a qualitative data analysis methodology, this is a method for systematically identifying, organizing, and offering insights into patterns of meaning (themes) in an extensive data set, which allows us to see and make sense of collective or shared meanings and experiences (Braun & Clarke, 2006). After recognized phases of thematic analysis, two researchers coded each article individually and then collaborated to review their results until consensus was reached. During this process, both researchers used NVivo software.

RESULTS

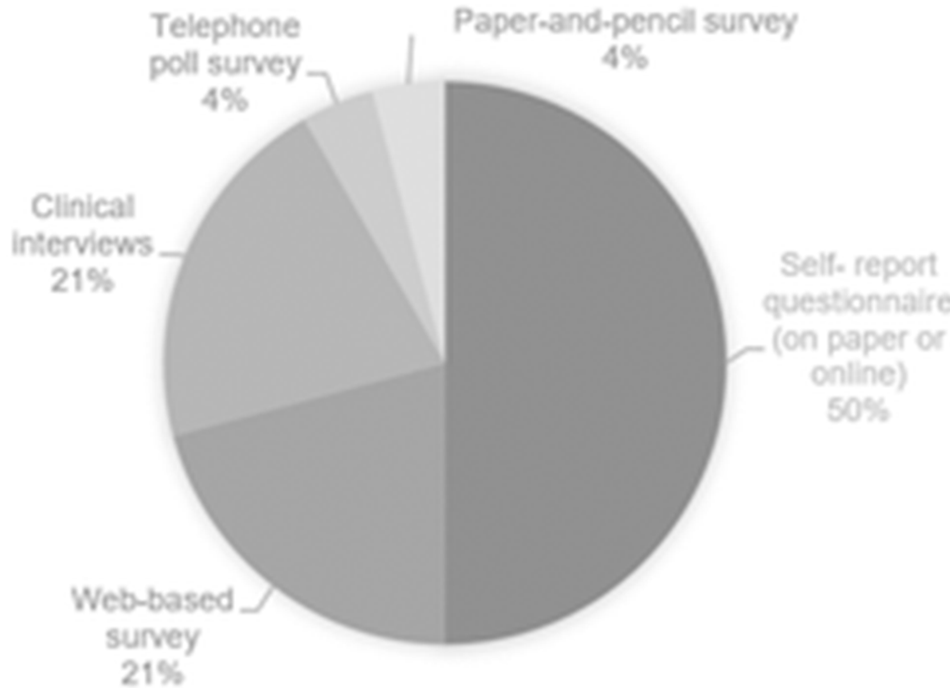
This scoping review generated twenty-one articles from eleven countries and two continents, with eleven studies (54%) conducted in Europe and ten (49%) in Asia. Six articles (28%) were from Korea, five (24%) from Norway, two (9%) from China, and one each (5% each) from Belgium, France, Netherlands, United Kingdom, Portugal, Sweden, Taiwan, and Japan. The fact that there are no records from the United States or other countries may be related to the refinement criteria used by the authors of this chapter in the WOS database, such as open access articles and search limited to some scientific areas (see Figure 1).

Regarding key methodological features of the studies, all studies were quantitative. Most of the studies (n = 13) employed a cross-sectional design, and seven adopted a longitudinal design. Additionally, a study used an experimental design with a control group (Wang et al., 2020).

Regarding the sampling procedure, 50% of the studies used self-report questionnaires (n=12). The least used method was paper-and-pencil (Lemmens et al., 2011) and telephone poll surveys (Wu et al., 2018) (see Figure 2). As to the sampling methods adopted, most of the studies used convenience sampling or self-selected sampling to recruit participants.

The number of study participants ranged from 105 to 23,533. Most studies had more than 500 participants. However, seven articles had fewer than 500, and two had robust samples (Andreassen et

Figure 2. Sample procedure of the 21 articles analyzed



al., 2016; Wittek et al., 2016). Most studies included samples of adolescents and recruited more male participants than females. A study included only transgender people (Arcelus et al., 2017), and one had 11% non-heterosexual people in the sample (Broman & Hakansson, 2018). Note that we excluded 15 articles from our analysis because the sample consisted only of males.

Although 2000 to 2020 is the reference year of publication in this scoping review, since pathological gaming was not consistently investigated until 2000 (Fam, 2018; Kuss et al., 2014), no records were found with publication before 2011. Most of the articles included in this scoping review (7) were published in 2018, five were published in 2020, and two in 2019. In the 2016-2017 biennium, we had six articles published and only one published in 2011. Recruitment of participants was usually conducted two years before the article's publication (see Table 1).

Only one article was written individually (Pontes, 2017). Most of the articles were co-authored. Jeong (2020; 2018) and Krossbakken (2018a, 2018b) signed two studies included in this scoping review. Kim, N. (2016), Lee, S. Y, and Jeong, H. are the authors writing with the most significant number of researchers. Regarding the interconnection between the authors of the analyzed articles, Mark Griffiths writes with Asian and European authors. The partnership between researchers of different nationalities is increasingly conducted in a consortium, and, consequently, intercontinental research is increasing.

Although it was not possible to identify the gender of four Asian authors, most of the articles are signed by male first authors (n= 8). Most articles were published in the Journal of Behavioral Addictions (n= 8) and Frontiers in Psychology (n= 4). Except for Chiu, all first authors are researchers from universities (see Table 2).

Table 1. The main characteristics of the 21 studies analyzed

Author (s)	Type of study	Study location	Participant recruitment	Sample size	Sample (mean) age	Gender distribution
Andreassen, C. S.; Billieux, J.; Griffiths, M. D.; Kuss, D. J.; Demetrovics, Z.; Mazzoni, E.; Pallesen, S. (2016)	Cross-sectional	Norway	March and May 2014	23,533	35.8 (SD= 13.3)	65% female
Arcelus, J.; Bouman, W. P.; Jones, B. A.; Richards, C.; Jimenez-Murcia, S.; Griffiths, M. D. (2017)	Cross-sectional	Nottingham (United Kingdom)	June 2015 to June 2016	245	27.34 (SD= 12.48)	40.4% female gender at birth
Broman, N.; Hakansson, A. (2018)	Cross-sectional	Sweden	April and June 2017	605	30-39 years	51% female 1%transgender 11% non-heterosexual
Chiu, Y. C.; Pan, Y. C.; Lin, Y. H. (2018)	Cross-sectional	Taiwan	August 2016 to June 2017	8,110	13.17 (SD= 1.79)	17.5% (female with IGD) 41.4% (female non-IGD)
Finseras, T. R.; Pallesen, S.; Mentzoni, R. A.; Krossbakken, E.; King, D. L.; Molde, H. (2019)	Longitudinal	Norway	2012-2014	1,258	17.5 (2012) 19.5 (2014)	61.8% female
Gros, L.; Debue, N.; Lete, J.; van de Leemput, C. (2020)	Exploratory/ Cross-sectional	Brussels (Belgium)	2019	105 (61 final sample)	24.28	45.9% female
Jeong, H.; Yim, H. W.; Lee, S. Y.; Lee, H. K.; Potenza, M. N.; Kwon, J. H.; Koo, H. J.; Kweon, Y. S.; Bhang, S. Y.; Choi, J. S. (2018)	Longitudinal cohort	Seoul and Uijeongbu (Gyeonggi Province, Korea)	2015-2017	1,732	Adolescents	44.7% female
Jeong, H.; Yim, H. W.; Lee, Seung-Yup; Lee, H. K.; Potenza, M. N.; Jo, Sun-Jin; Son, Hye J.; Kim, G. (2020)	Longitudinal cohort	Seoul and Uijeongbu (Gyeonggi Province, Korea)	2015-2019	273	12.8 (SD=0.2)	43% female
Jo, S. J.; Jeong, H.; Son, H. J.; Lee, H. K.; Lee, S. Y.; Kweon, Y. S.; Yim, H. W. (2020)	Longitudinal cohort	Seoul and Uijeongbu (Gyeonggi Province, Korea)	2015/2016	273	12.6 (SD= 1.1)	45.1% female
Jo, Y. S.; Bhang, S. Y.; Choi, J. S.; Lee, H. K.; Lee, S. Y.; Kweon, Y. S. (2020)	Longitudinal cohort	Seoul and Uijeongbu (Gyeonggi Province, Korea)	August 2015 to August 2019	194	13.14 (SD=2.4	24.7% female
Kim, N. R.; Hwang, S. S. H.; Choi, J. S.; Kim, D. J.; Demetrovics, Z.; Kiraly, O.; Nagygyorgy, K.; Griffiths, M. D.; Hyun, S. Y.; Youn, H. C.; Choi, S. W. (2016)	Cross-sectional	Korea	2016	3041	20-49	40% female
Krossbakken, E.; Pallesen, S.; Mentzoni, R. A.; King, D. L.; Molde, H.; Finseras, T. R.; Torsheim, T. (2018)	Longitudinal	Norway	2012-2014	3,000	17.5	50% female (2012) 58.7% female (2013) 61.7% female (2014)
Krossbakken, E.; Torsheim, T.; Mentzoni, R. A.; King, D. L.; Bjorvatn, B.; Lorvik, I. M.; Pallesen, S. (2018)	Cross-sectional	Norway	2015	1,657	10.1	759 girls
Lee, S. Y.; Lee, H. K.; Jeong, H.; Yim, H. W.; Bhang, S. Y.; Jo, S. J.; Baek, K. Y.; Kim, E.; Kim, M. S.; Choi, J. S.; Kweon, Y. S. (2017)	Cross-sectional	Seoul (Korea)	September to October 2015	330	Adolescents	50.6% female
Lemmens, J. S.; Valkenburg, P. M.; Peter, J. (2011)	Longitudinal survey	Amsterdam (Netherlands)	December 2008 to June 2009	1,024 (1st wave) 851 (2nd wave)	13.9 (SD= 1.4) (1st wave) 14.3 (SD= 1.4) (2nd wave)	49% female (1st wave) 33% female (2nd wave)
Phan, O.; Prieur, C.; Bonnaire, C.; Obradovic, I. (2019)	Cross-sectional	Paris (France)	November 2013 to December 2014	2,400	14.81	n.r.
Pontes, H. M. (2017)	Cross-sectional	Algarve (Portugal)	May to June 2015	509	13.02	46.5% female
Tateno, M.; Teo, A. R.; Shiraishi, M.; Tayama, M.; Kawanishi, C.; Kato, T. A. (2018)	Cross-sectional	Sapporo (Japan)	2014/2016	1,005	18.9 (SD= 1.3)	626 females
Wang, Z. L.; Dong, H. H.; Du, X. X.; Zhang, J. T.; Dong, G. H. (2020)	Experimental/control-group	Zhejiang (China)	2018	202	21.06 (SD= 2.35)	54 females
Wittek, C. T.; Finseras, T. R.; Pallesen, S.; Mentzoni, R. A.; Hanss, D.; Griffiths, M. D.; Molde, H. (2016)	Cross-sectional	Norway	During the autumn of 2013	10,081	32.6	37.3% female
Wu, A. M. S.; Chen, J. H.; Tong, K. K.; Yu, S.; Lau, J. T. F. (2018)	Cross-sectional	Macau (China)	October to November 2016	1,000	40.0 (SD= 15.3)	56% female

Source: Authors

Although many different research instruments and analyses were identified as being used in the studies considered (53 in total), there appears to exist a clear preference in terms of use when considering the

Table 2. Gender overview of the first authors and their institutional affiliations

Gender first-author	Journal published	Institution	Department
Andreassen, C. S. (female)	Psychology of Addictive Behaviors	University of Bergen (Norway)	Department of Psychosocial Science, Faculty of Psychology
Arcelus, J. (male)	Journal of Behavioral Addictions	University of Nottingham (UK)	Institute of Mental Health
Broman, N. (female)	Frontiers in Psychology	Lund University (Sweden)	Department of Clinical Sciences Lund, Psychiatry
Chiu, Y. C. (male)	Journal of Behavioral Addictions	MacKay Memorial Hospital (Taiwan)	Department of Psychiatry
Finseras, T. R. (female)	Frontiers in Psychology	University of Bergen (Norway)	Department of Clinical Psychology
Gros, L. (male)	Frontiers in Psychology	Maastricht University (Belgium)	Department of Psychiatry and Neurosciences
Jeong, H. (female)	Scientific Reports	Catholic University of Korea	Department of Preventive Medicine
Jo, S. J.	Journal of Behavioral Addictions	Catholic University of Korea	Department of Preventive Medicine
Jo, Y. S.	Psychiatry Investigation	The Sung-Shin Women's University (Korea)	Department of Psychiatry and Neurosciences
Kim, N. R.	Journal of Behavioral Addictions	Catholic University of Korea	Laboratory of Addiction Policy
Krossbakken, E. (female)	Psychiatry Investigation	University of Bergen (Norway)	Department of Psychosocial Science
Lee, S. Y. (male)	Frontiers in Psychology	The Catholic University of Korea	Department of Psychiatry
Lemmens, J. S. (male)	Journal of Behavioral Addictions	University of Amsterdam (Netherlands)	School of Communication Research
Phan, O. (male)	Psychiatry Investigation	Université de Paris (France)	Centre Pierre Nicole
Pontes, H. M. (male)	Journal of Youth and Adolescence	Nottingham Trent University (UK)	Department of Psychology
Tateno, M. (male)	International Journal of Environmental Research and Public Health	Sapporo Medical University (Japan)	Department of Neuropsychiatry
Wang, Z. L.	Journal of Behavioral Addictions	The Affiliated Hospital of Hangzhou Normal University (China)	Center for Cognition and Brain Disorders
Wittek, C. T. (female)	Psychiatry and Clinical Neurosciences	University of Bergen (Norway)	Department of Clinical Psychology
Wu, A. M. S. (female)	Journal of Behavioral Addictions	University of Macau (China)	Department of Psychology

Source: Authors

study design. Longitudinal studies showed a clear preference for the Buss-Perry Aggression Questionnaire (BPASQ), being used in four different papers and once in its shortened form (BPAQ-SF). The Game Addiction Scale (GAS) was most used by the articles with a cross-sectional design, being present in four different articles (see Figure 3).

The Hospital Anxiety Depression Scale (HADS) (n= 4), the Game Addiction Scale for Adolescents (GASA) (n= 3), and Young's Internet Addiction Test (YIAT) (n= 2) were found to have been used in both Longitudinal as well as Cross-sectional studies, whereas the IGD DSM5 criteria (n= 8) was the only instrument shared by all three of the identified study designs.

Other noteworthy mentions are the Internet Game Use-Elicited Symptom Screen (IGUESS), the Roberts UCLA Loneliness Scale (RULS), the Child Depression Inventory (CDI), the DIA[1], and the Korean version of the Adult ADHD Self-Report Scale (K-ARS), all present in two different occasions each in papers with a Longitudinal design, as well as the Adult ADHD Self-Report Scale (ASRS), the Internet Gaming Disorder Scale-Short Form (IGDS9-SF), and the Depression Anxiety and Stress Scales-21 (DASS-21), which also were used in two separate occasions in the Cross-sectional design papers. All the remaining identified instruments were only mentioned by one article each.

Themes

After carefully reading the studies included in the analysis, each theme was generated and referred to the main groups of meanings identified according to our research questions. For this purpose, some codes were identified (units of analysis) and were grouped into three themes, namely "Internet Gaming as (dis) order," "Addicted Gamers X Engaged Gamers," and "Gender Differences."

DISCUSSION

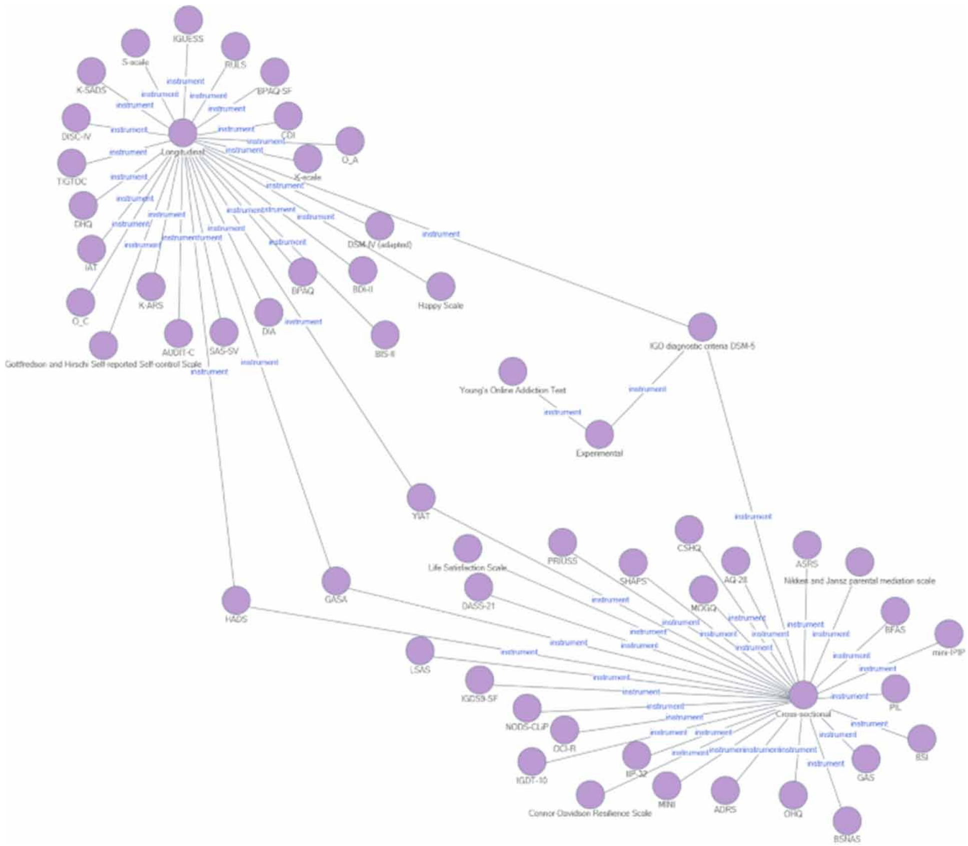
Internet Gaming as (Dis)order

This theme relates to the ethical and methodological criteria adopted by the investigators in the selected studies. We included in this analysis only empirical research that followed the ethical principles of the Declaration of Helsinki and/or had approval from local ethics committees, thus ensuring the reliability of the study and considering the laws and regulations of the country where the research was carried out.

Not all articles defined gaming disorder as a construct for analysis. Two studies (Andreassen et al., 2016; Tateno et al., 2018), for example, focused on correlations between mental disorder and IA (Internet Addiction) symptoms and the prevalence of IA in Japan, respectively. In turn, the longitudinal studies by Krossbakken et al. (2018a) and Lemmens et al. (2011) assessed PG (Pathological Gaming) as a unidimensional construct, "where the symptoms were collapsed, and gaming pathology was measured on a continuum ranging from low to high severity" (Krossbakken, Pallesen, et al., 2018, p. 3).

Although most studies have recruited adolescent participants, some research has shown that adults are also susceptible to pathological gaming (Arcelus et al., 2017; Broman & Hakansson, 2018; Kim et al., 2016; Wittek et al., 2016; Wu et al., 2018), and suggest that anyone, regardless of age, can develop problematic digital game use. Furthermore, they consider it essential to examine the prevalence of IGD in the general adult population. Wu's study, for example, provided evidence that IGD is a threat to mental health in the Chinese adult population and suggested that its prevention should be addressed in the community at large, not just in schools.

Figure 3. Instruments actioned by type of study design



The present theme also refers to the precautions one should take when reading research findings on IGD or pathological gaming to avoid pathologizing normal gamer behaviors. Several types of limitations were determined across all 21 studies and can be grouped into two types: i. sampling procedure with exclusive use of the self-report measures (e.g., Finseras et al., 2019; Kim et al., 2016), and sampling homogeneity due to including adolescent students (e.g., Chiu et al., 2018; Jeong et al., 2020; S. J. Jo et al., 2020; Krossbakken, Pallesen, et al., 2018; Phan et al., 2019; Pontes, 2017); ii. lack of longitudinal studies, limiting the possibility of making casual inferences (e.g., Andreassen et al., 2016; Arcelus et al., 2017; Chiu et al., 2018; Wittek et al., 2016).

In general, the studies reviewed consider that the risk of developing pathological gaming exists to the extent that some individual (such as impulsivity, escapism, depression, and anxiety) and social (e.g., unemployment, immigration, living alone) factors are considered in the assessment of the player's clinical picture. Moreover, these studies also suggest that gaming is not health neutral. Thus evidence-based research should provide reliable and reproducible information, so there is consensus on the factors that impact pathological gaming and the appropriate tools for its diagnosis.

Addicted Gamers X Engaged Gamers

This theme relates to the importance of differentiating pathological players from those who are not, as mentioned earlier. In the studies analyzed in this scoping review, eight records were identified that mentioned the typology engaged players.

Arcelus et al. (2017) and Wu et al. (2018) used this typology to classify information about gaming behavior, namely "information about whether or not they engage in gaming behaviors and whether they have engaged in gaming behavior in the past" (Arcelus, p. 23), and about "recent gamers who engaged in online games in the past 12 months" (Wu, p. 64). Jo et al. (2020) used the term to refer to the amount of time the player is "engaged" in the game and highlight the importance of distinguishing between non-problematic and problematic gaming. In turn, Gros et al. (2020) do not directly mention the term "engaged" but explore the perceived emotional states (pleasure/happiness) associated with pathological gaming and conclude that "from a cognitive therapeutic perspective, it shows the potential benefits of reappraising emotions as a means to contribute to the emotional distortion reduction" (p.16).

Only Finseras et al. (2019), Krossbakken, Pallesen, et al. (2018), and Wittek et al. (2016) used the typology of engaged players in a well-rounded way in their studies. Finseras founded that "categorization of addicted gamers based on GASA emphasized only core symptoms and excluded engaged gamers as well as problem gamers from this category" (p. 7). In turn, Krossbakken (2018a) founded that depression is an antecedent of "problem" and "engaged" gamers and suggested that the probability of becoming addicted due to engaged gaming is small. Finally, the results of Wittek's study showed the prevalence of addicted gamers to be 1.4%, problem gamers to be 7.3%, and engaged gamers to be 3.9% and suggested that problem and engaged gamers have a lower degree of education.

Therefore, as concluded by Krossbakken et al. (2018a), "viewing gaming problems from a typological perspective might be useful in further assessment and conceptualization of video game addiction, both in research and in clinical settings" (p. 11).

Gender Differences

Researchers have used different methodologies to identify, explore, and explain how gender may be a predictor of gaming disorder over these past three decades of research on pathological gaming (Borgonovi, 2016; Lucas & Sherry, 2004; Shen et al., 2016). However, most previous studies are based on "self-reports, which are prone to random and systematic inaccuracies. Some inaccuracies may originate from gender stereotypes" (Shen et al., p. 324). In addition, there is a gender informational deficit in which the male gender is assumed to be a strong predictor of IGD.

This theme summarizes how evidence-based studies analyze gender differences in their findings. Of the 21 studies examined in this scoping review, thirteen addressed gender differences and can be grouped into three types: i. Male gender as a predictor of gaming disorder; ii. Gender performance gap debunked; iii. Non-binary gender.

Arcelus et al. (2017) and Broman and Hakansson (2018) were the only studies that addressed how non-binary sexual identification is a variable to consider in gaming and mental health research.

In the group considering male gender as a predictor of gaming disorder, it was observed that gender was a mere variable devoid of its social and identity significance (e.g., Chiu et al., 2018; Jeong et al., 2018; Y. S. Jo et al., 2020; Phan et al., 2019). However, other studies analyze gender differences dismantling the gender performance gap (Andreassen et al., 2016; Gros et al., 2020; Krossbakken, Pallesen, et al., 2018; Wu et al., 2018). The study by Krossbakken et al. (2018a), for example, found that "the way in which mental health factors function as antecedents and consequences of pathological gaming, is equal for males and females." In turn, Wu et al. (2018) highlighted the importance of considering the potentially increasing vulnerability of female and older gamers to IGD in this Digital era.

Beyond statistics, if we want to overcome the gender information deficit, it is essential to favor analysis and methodologies that can consider gender identity belonging, requiring the adoption of a more inclusive theoretical and empirical perspective. The influence of gender issues in research on IGD should be considered.

SOLUTIONS AND RECOMMENDATIONS

From this scoping review, it is possible to recommend that even though video games are a real risk for addiction, they can work as digital therapies for psychosocial rehabilitation when administered with precaution in groups with mental disorders such as depression, high levels of anxiety, and ADHD. For this, a rigorous clinical assessment should be conducted that appropriately uses of gamer typologies and evaluates the individual, emotional, and social factors that impact gamers' behavior.

The use of games as digital therapies is an emerging area of research. Therefore, identifying how research on pathological gaming is being conducted and the consequences of pathologizing normal gaming behaviours may be useful for clinicians and researchers to recognize the benefits and harms of digital games for mental health. As mentioned earlier, researchers have argued that there is insufficient evidence that gaming disorder definitions and diagnostic tools meet clinical standards. Consequently, Internet Gaming Disorder continues to risk pathologizing normal behaviors given the inclusion of too many "symptoms" that do not indicate pathology.

In the introduction of this chapter, the authors emphasized that one of the digital technologies that allowed for greater interaction between people was digital games during the ongoing pandemic phase. The literature reviewed here did not include studies on pathological gaming in the COVID-19 phase. Thus, scoping reviews that compare prior and post-pandemic literature on gaming and mental health will be very useful in the future.

FUTURE RESEARCH DIRECTIONS

Evidence-based research on IGD should provide reliable and reproducible information. Unfortunately, there is no consensus on the factors influencing pathological gaming and the appropriate tools for its diagnosis. Future research should make supplementary research material accessible to other researchers.

Most of the studies reviewed in this chapter examined the relationships of gaming and mental health through self-reported responses by participants (players and parents), which could have led to overestimations or underreporting of actual gaming behavior. Future research should use other data collection instruments, such as clinical interviews and telemetry data (i.e., logged game play).

Finally, very little research has been conducted examining specifically addicted and problematic female and transgender gamers. Future research on IGD should consider these audiences.

CONCLUSION

This chapter summarizes a scoping review that explored on the relationship between digital games and mental health in the last decade. This type of review clarifies, defines, and develops conceptual boundaries within a subject area. The authors conducted a scoping review to identify the current knowledge on evidence-based research that considers internet gaming disorder as a possible mental disorder diagnosis in gender and age diverse samples.

We have seen that even with the visible benefits of digital games in various dimensions of human life, games are classified as problematic when their use ceases to be therapeutic and enjoyable. However, reaching a gaming addiction diagnosis requires a careful and rigorous analysis of the patient's clinical condition. Twenty-one studies reviewed consider that the risk of developing pathological gaming exists to the extent that individual (personality traits), emotional and social factors (e.g., unemployment, immigration, living alone) are considered in assessing the player's clinical condition. Furthermore, these studies suggest that gaming is not health neutral.

Three themes were identified in this scoping review, namely "Internet Gaming as (dis)order," "Addicted Gamers X Engaged Gamers," and "Gender Differences". The first theme refers to the precautions one should take when reading research findings on IGD or pathological gaming to avoid pathologizing normal gamer behaviors. Several limitations were determined across all 21 studies and were clustered into two types: i. sampling procedure with exclusive use of the self-report measures, and sampling homogeneity due to including adolescent students; ii. lack of longitudinal studies, limiting the possibility of making casual inferences.

The second theme relates to the importance of differentiating pathological players from those who are not. In the studies analyzed, eight records mentioned the typology "engaged players," distinguishing from the typology "addicted players". Finally, the last theme summarizes how evidence-based studies analyze gender differences in their findings. Of the 21 studies, thirteen addressed gender differences and can be grouped into three types: i. male gender as a predictor of gaming disorder; ii. gender performance gap debunked; iii. non-binary gender.

Despite the comprehensive search across the WOS database, some related studies may have been missed. One of the limitations of this chapter is that relevant studies on the topic in question may not have been included according to our criteria for choosing articles.

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ENDNOTE

[1] Derived from the IGD DSM5 criteria, it is a semi-structured interview diagnostic tool (Jo et al., 2020).

Chapter 8
Gamification Applied to Autism Spectrum Disorder

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ABSTRACT

Gamification is a recent technique in software development that allows the application of game principles to non-game contexts and environments. In an increasingly technological world, gamification has now higher popularity, and it is currently used in several technologies. One of the health conditions where gamification can bring great benefits is in autism spectrum disorder (ASD), which is a persistent neurodevelopmental disorder that can be characterized briefly by deficits in verbal and non-verbal communication, difficulties in interaction, and manifestation of stereotyped movements or interests. In the case of ASD, the programs, software, or the mobile applications should focus on the development of intrapersonal (such as motivation) and interpersonal (social skills) skills. Therefore, gamification can be useful in cases of ASD, but it is necessary to increase the analysis of the potentialities and needs for improvement of technologies and applications available on the market.

INTRODUCTION

Medicine and health treatments are usually associated with live sessions as a traditional in-person approach. However, with the rapid development of digital technologies, such as the internet or communication devices, it was possible to expand the health services to other approaches, namely telehealth (Weinstein et al., 2018).

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According to World Health Organization (2010), telehealth can be defined as *"the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies, for the exchange of valid information for diagnosis, treatment, and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, in all the interests of advancing the health of individuals and their communities"*. In addition, telehealth is a term used to encompass a broader application of technologies for the application of evaluative, consultative, preventive, and therapeutic services delivered through information and communication technologies that support health care services, such as video conferencing, mobile apps and secure messaging (Brown-Jackson, 2019; Kruse et al., 2017). After some research, it is clear that sometimes the terms "telehealth" and "telemedicine" are defined differently, however throughout this paper, following the WHO line, no distinction will be made between telehealth and telemedicine, so the term 'telehealth' will be used for both (Kruse et al., 2017).

Telehealth has shown enormous potential to improve the reach and availability of treatment since it covers a variety of modalities that can be used for different conditions and populations to increase the affordability of treatment. This may be due to the lower cost usually associated with technologically based treatments and the increase the sense of confidentiality, because in nowadays some people prefer not to be seen in a healthcare setting (Granja et al., 2018; Marsch et al., 2014; Shigekawa et al., 2018). In addition to these advantages, the technology allows us to measure what the individual is experiencing in an objective, non-reactive way. Also, it allows the person applying the intervention to provide personalized feedback in real-time (Marsch et al., 2014). These advantages are due to the possibilities of communicating with a doctor or therapist, monitoring symptoms and providing therapeutic education. Literature also presents the efficiency of these technologies in the screening and treatment of several mental health pathologies (Shigekawa et al., 2018).

Even though there are many advantages of telehealth in the literature, it is necessary to highlight some disadvantages about telehealth, such as the difficulties in the palpation or use of touching on patients, which in a different point of view could be considered beneficial for the patient, since that, in some instances, this lack of proximity may increase openness to specific issues, such as sexuality and family problems (Weinstein et al., 2018). Beyond these, the literature indicates that there may be a breakdown in the relationship between health professional and patient. The risk of bad network connection, device breakdown or even lack of skills for using the digital tool may also be a disadvantage for the users (Daragó et al., 2013; Hjelm, 2005). In addition to this, the adherence rates to the use of health technologies are not as expected, so it was necessary to develop some strategies that can enrich this type of interventions (Cheng, 2020).

Telehealth also shows some difficulties to be implemented due to bureaucratic and ethical issues, such as problems with existing policies, rules or laws for remote health care delivery, problems to ensure the quality of the care provided, problems with malpractice liability and, finally, problems with data protection and confidentiality, due to the increased risk of unauthorized access to patient's personal and medical information (Daragó et al., 2013; Hjelm, 2005).

GAMIFICATION'S STATE OF THE ART

Today, there is no doubt that technology can facilitate the creation of various interventions, whereby this chapter will focus on Gamification and its applications (Marsch et al., 2014).

Currently, there are already several technology-based interventions such as computer-assisted modules and exposure-based interventions where virtual reality is used to simulate certain situations that may be difficult to experience in real life (Bickel et al., 2008; Bordnick et al., 2008; Carroll et al., 2008; Marsch et al., 2014; Rothbaum et al., 2012). Furthermore, there are applications and/or games that seem very attractive to make interventions in certain age groups, such as children and adolescents (Arzone et al., 2020; Bickel et al., 2008; Carroll et al., 2008; Dennison et al., 2013; Marsch et al., 2014; Sheehan et al., 2012).

In the middle of the 21st century, the generations are highly dependent of technologies. They have grown up with the influence of technology, which has had a significant impact on how they communicate and socialize and engage with each other. The gamification technique arises to respond to the changes imposed by new generations in several contexts (Gupta & Gomathi, 2017).

Gamification consists of "*the use of game design elements in non-game contexts*.", which popularity has been increasing over the years (Cheng, 2020; Deterding et al., 2011). But there are many definitions in the literature of gamification, like the one defended by Huotari and Hamari (2012), *"a process of enhancing a service with affordances for gameful experiences in order to support [a] user's overall value creation".* The essence of gamification is not found in technology but the environment; it promotes the diversity of learning paths and individuals' decision and reward systems (Busarello, 2016).

The term "gamification" is often used associated with a serious game; nevertheless, Deterding et al. (2011) go further on this association and defends that gamification is a concept that is included in serious games, which consists in the *"use of games, but with a serious background*". The primary purpose of this type of game is more than entertainment, and they aim to promote learning and behavioral change (Sardi et al., 2017; Tolks et al., 2020; Wouters et al., 2009). Often the serious games approach conveys serious and relevant content/information, such as health and/or education issues. This approach is attractive as it is fun, immersive, and engaging (Arzone et al., 2020; Sardi et al., 2017; Tolks et al., 2020; Wouters et al., 2009). They are widely used to promote learning, especially in health and education; however, they are designed to solve various problems more engagingly (Lau et al., 2017; Sardi et al., 2017; Tolks et al., 2020; Wouters et al., 2009). The main aim of serious games is to generalize the learning achieved through play and that this improves a person's wellbeing and quality of life in everyday life. In comparison with games built for entertainment it is possible to observe differences, since it is not expected that with those games skills are acquired or knowledge is generalized beyond that context. In entertainment games the motivational strategy used is points as a form of reward, in the case of serious games the strategy used is based on intrinsic motivation so that learning is acquired in a more sustainable way. Serious games can only achieve these goals if they include in their construction basic concepts of video games, which allow the creation of immersive and comfortable environments. It should be noted that this type of game is always based on theories of learning and development theories (Whyte et al., 2015).

Usually, gaming is considered a leisure activity for people to engage in during their free time, leading people to understand it as just a hobby (Gupta & Gomathi, 2017). Initially, gamification emerged to use people's interest in engaging in gaming activities and combining it with painstaking work to apply the results in education, marketing, employee engagement, and other business and management activities. Overall, what has been attempted to do is to merge the concept of work and play (Gupta & Gomathi, 2017).

In order to promote or increase certain skills during serious games, it is necessary that the goals set are challenging, i.e. not too complex, but achievable in a safe and supportive environment. As already mentioned, the game should not be expected to be so difficult that it frustrates the participant or makes them want to give up (Whyte et al., 2015).

When this kind of element is used in games, it is always based on some theoretical model, i.e. models that relate challenge to learning (Whyte et al., 2015). These theoretical models that relate to providing achievable challenges in learning can be Vygotsky's Zone of Proximal Development (Barab et al., 2005; Vygotsky, 1980) and the concept of 'flow' theory in task involvement (Shernoff et al., 2014). In the case of 'flow' theory, this suggests that engagement in learning increases when the challenges proposed and the skills to be acquired are balanced. Importantly, both models indicate that a mismatch between the difficulty of the game and the level of skills to be increased may result in decreased motivation, engagement and therefore learning (Whyte et al., 2015).

It should be noted that each person has different levels of what they find challenging, so in the case of serious games there needs to be individualised moments, so that the difficulty increases in a gradual and personalised way. In this way, the game slowly increases in difficulty in a way that is consistent with each player's individual ability (Whyte et al., 2015).

Serious games use game elements and structures based on gamification, such as badges, medals, leader boards, goals points, missions and records, as well as storylines and narratives, feedback and rewards, progressive challenges, avatars, collections, goals directed learning around targeted skills, increasing levels of difficulty, individualization and provision of choice (Cheng, 2020; Gobbo et al., 2018; Lee et al., 2017; Miller et al., 2016; Sardi et al., 2017; Valencia et al., 2019; Whyte et al., 2015).

In fact, badges are used when a task is completed as it motivates the individual by increasing a sense of pleasure, accomplishment and a feeling of control (Gobbo et al., 2018; Lee et al., 2017). In addition, medals usually come in three colors, namely bronze, silver and gold, which is helpful for easy visualization of the result (Gobbo et al., 2018; Lee et al., 2017). Beyond these, the questions present in the game should be simple and very objective as a way to facilitate its understanding, and the use of avatars shows great advantages, since literature finds the improvement in skills related to nonverbal social behaviours when it shows facial expressions (Barajas et al., 2017; Ern, 2014). Thus, creating a storyline or narrative that incorporates and contextualises the skills and/or objectives that need to be learned, is one of the most effective elements for increasing motivation for learning. This type of element in the construction of serious games increases enthusiasm, immersion in the context and thus learning. In general, creating an in-game storyline allows people to be willing to learn content in a context that is meaningful to them. As already mentioned, in serious games the story narrative is always constructed with a focus on learning deficit skills. (Lu et al. 2012). The use of story lines that include carefully thought out characters allows for the improvement of social skills, such as empathy, and also increases intrinsic motivation to learn skills, as participants relate to the characters, creating emotional connections, often participants identify with the characters creating empathy for them. Of note, to create an even more immersive environment, character development should be high and the creation of dialogue may be beneficial (Dickey, 2005, 2006). The use of feedback and the provision of progressive rewards throughout learning are crucial for shaping behaviour as participants try to achieve the planned goal of that serious game. In the construction or design of the serious game, rewards and feedback, try to include both intrinsic and extrinsic motivation needs. Compared to entertainment games, it can be seen that entertainment games focus mainly on extrinsic and immediate rewards, i.e. there is usually an immediate visual or auditory reward, an increase in game points or a level-up on the leaderboards, which include the points of the other players. In serious games, as the focus is on both types of motivation, what occurs is feedback, not immediate, but with the completion of long-term goals in order to reinforce the intrinsic motivation for learning, throughout the progress is given feedback with the information of the evolution. It is emphasised that serious games are designed so that there is an involvement of the player in the game and in learning the skills that are difficult to acquire, it is never expected that there is frustration on the part of the participant. Negative feedback can trigger a decrease in motivation to continue playing. It is therefore easy to understand that the continuous provision of feedback and rewards for progress towards the long-term goal is essential (Whyte et al., 2015).

According to Cheng et al. (2019), the average number of game elements included in mental health apps or programs used is five. These tools exploit the inherent interest in competition, status, achievement, self-expression and altruism. The primary strategy of this technique relies on providing rewards to players who achieve the goal of the proposed task (Gupta & Gomathi, 2017).

The playable elements allow what Huotari and Hamari (2012) defines as "*gameful experience*", which is possible with factors identified by Eppmann et al. (2018) and Högberg et al. (2019), such as enjoyment, absorption, creative thinking, activation, absence of negative effect, dominance, accomplishment, challenge, competition, guided[ness], immersion, playfulness, and social experience.

Gamification can be used in various contexts, but when relating it with the provision of health services, it is possible to mention that some of the tasks proposed by professionals are boring, repetitive, frustrating and sometimes painful (Martins & Dores, 2021). Associating this type of task with a fun game may have many benefits since people associate this type of activity with pure entertainment (Martins & Dores, 2021).

The most used technologies for gamification are associated with mobile applications, internet-based resources or immersive environments (associated with virtual, augmented or mixed reality) (Carmona-Serrano et al., 2020).

Five variables define the concept of gamification, namely learning (getting out of the routine, encouraging behaviour, adapting content and piquing curiosity), game mechanics (mechanics guide actions, dynamics are interaction with mechanics and aesthetics are emotions in interaction), narrative (living history, mastery of history and interactive elements and stories are engaging and moving media), motivation and engagement (challenge, fantasy and curiosity) and finally thinking as in games (goal, rules, feedback and participation) (Busarello, 2016).

For these reasons, gamification is experiencing an increase in its usability. It is essential to stand other factors seen as potentialities, such as current accessibility to technology, facility to increase the intrinsic motivation attractiveness and applicability, cost-benefit efficiency and ease of insertion into the daily routine (Arzone et al., 2020; Johnson et al., 2016). Through these, it is easily understood that this approach is applied to healthcare settings, such as inpatient monitoring, physical or cognitive intervention or in modifying risk behaviours that may interfere with the patient's wellbeing and health (Christie et al., 2019; Johnson et al., 2016; Lee et al., 2018). For the healthcare provider to achieve the patient's complete state of wellbeing, it is relevant to keep the patient motivated throughout the process. Currently, it is already known that the use of game elements can provide an increase in intrinsic motivation, the expressed commitment and higher performance, both in qualitative and quantitative terms, which suggests the potentialities of gamification and its beneficial impact on health (Arzone et al., 2020; Johnson et al., 2016).

It is essential to highlight the creation of a model that regulates the interventions on the Internet (named Internet Interventions Model), which reveals the characteristics of users that influence the interaction with the intervention, such as disease type and severity; demographics; psychological traits; cognition; attitudes and beliefs; physiological factors; and skills (Cheng, 2020; Ritterband et al., 2009). As these characteristics differ from person to person, it is essential to adapt each app or serious game to the individual to enhance the potential of self-satisfaction and clinical improvements (Arzone et al., 2020). That can be possible with simple customization and adaptation according to interests and/or individual needs (Cheng, 2020).

However, gamification tools should be used with care as their implementation can damage the intention to contribute to the community and the quality of the members' experiences (Leclercq et al., 2020). It is crucial to understand some aspects that need to be considered when clinicians suggest the use of gamification in therapy, such as suitability, the use of technology as a coherent system, acceptability, impact and comprehensive documentation and description of the game (Cheng, 2020).

Hereupon, the knowledge about gamification's advantages and potentialities in the health field allows the expansion of its use in multiple pathologies and clinical presentations (Lokhorst, 2014). One of these is Autism Spectrum Disorder (ASD), which benefits from the use of digital technologies in several ways (Carmona-Serrano et al., 2020).

AUTISM SPECTRUM DISORDERS (ASD)

The ASD are persistent behavioural disorders that deficits can briefly characterize in terms of verbal and non-verbal communication and interaction, being observed stereotyped movements, without an obligatory intellectual commitment (Brewer et al., 2017; Geretsegger et al., 2014; National Collaborating Centre for Mental Health, 2013; Strunk et al., 2017; Weitlauf et al., 2014).

There is no consensus regarding data and statistics due to methodological issues and differences between the population of countries. However, according to Lyall et al. (2017), the prevalence of ASD is estimated at approximately 1.5% in developed countries worldwide.

Despite these data, it is well known that the prevalence of ASD has increased dramatically. (Martins & de Melo, 2020; Newschaffer et al., 2007; Thompson et al., 2018). Regarding the prevalence of the condition by gender, it is higher in males, corresponding to one woman for every four men (Maenner et al., 2020; Martins & de Melo, 2020; Murphy et al., 2016). The ASD occurs with no distinction between race, ethnicity and socioeconomic group (Maenner et al., 2020).

The term "spectrum" refers to the diversity of symptoms and clinical manifestations across individuals with ASD, which ranges from low to high-functioning Autism (Andreou & Skrimpa, 2020; Arzone et al., 2020; Carmassi et al., 2019; Davidson & Orsini, 2013; Hendricks, 2010). Besides Autism's disorder, the spectrum includes Asperger's disorder, Rett's disorder, pervasive developmental disorder not otherwise specified, and childhood disintegrative disorder (American Psychiatric Association, 2014).

ASD is a heterogeneous condition since its clinical presentations are varied both in terms of symptoms and severity (Andreou & Skrimpa, 2020). Therefore, the functional consequences associated with ASD can go from mild impairments to severe impairments in academic, social and personal life (Carmassi et al., 2019).

Individuals with ASD show deficits in socialization (sharing interests, for example) and in non-verbal communication (use of inappropriate gestures and facial expressions or even lack of its use, lack of eye contact); manifest lack of social and emotional reciprocity; present restricted and repetitive patterns of behaviour, including stereotypies (such as flapping and balancing, stereotyped speech and echolalia); show difficulties to maintaining appropriate relationships (creating friendships, adapting behaviour to the context and situation); express excessive adherence to routine and atypical sensory interests or responses (more than 40%); do not share their pleasure; react atypically in response to the display of anger, affection and other emotions, show lack of imitation games; show little cognitive flexibility and prefer predictability, having difficulties in performing several tasks at the same time; may present cognitive impairments, which can vary across the spectrum (occasionally, the intellectual level ranges from superior intellect to profound intellectual disabilities, which is closely related to the concept of spectrum); and, as a core feature, social and communication deficits, with a language delay (American Psychiatric Association, 2014; Chojnicka & Wawer, 2020; Gyawali & Patra, 2019; Mahajan & Mostofsky, 2015; National Collaborating Centre for Mental Health, 2013; Navan & Khaleghi, 2020; Weitlauf et al., 2017). Statistics show that about 40% of children with ASD do not speak at all, 25% to 30% of children say just a few words between 12 and 18 months of age and then stop saying and other children can speak but not before childhood (Maenner et al., 2020). The above characteristics are the most obvious and evident in this condition and stand out specifically in social situations present in everyday life, compared to neurotypical children (Kinsell et al., 2015).

ASD is related to the concept of the Theory of Mind, which tries to explain the social interaction difficulties in individuals with this pathology. This concept is associated with mentalization deficit, which prevents them from inferring mental states, beliefs, and behaviours (Baron-Cohen, 1999). This deficit is observed at the brain level, since this affection can be seen in changes in the brain circuit responsible for empathy, involving structures such as the amygdala, cingulate gyrus, prefrontal cortex, among others. The connection between frontal and parietal lobes is also affected, which will condition the cognitive part - deficient development of the theory of mind, executive functions, subjectivity (National Collaborating Centre for Mental Health, 2013).

ASD is associated with other pathologies, which are not part of the diagnosis, but which contribute to the individual's functional impairment, wherein statistics show that about 70% of individuals meet the criteria necessary to be diagnosed with at least one comorbidity (Gotham et al., 2015; National Collaborating Centre for Mental Health, 2013). The most common comorbidity is intellectual disability, corresponding to approximately 30% of cases and historically estimated to be approximately 70% (Lewis, 2018; Lyall et al., 2017). In addition, there are others, such as anxiety, depression, oppositional defiant disorder, tics, epilepsy, gastrointestinal abnormalities, sleep disorders, immune deficits and attention deficits, which occur in about 30-40% of cases (Gyawali & Patra, 2019; Lyall et al., 2017; Mahajan & Mostofsky, 2015; Oliveira, 2009). Moreover, up to 15% of cases of ASD may be related to another clinical disorder or syndrome (Fragile X Syndrome, for example) (Lyall et al., 2017).

Even if ASD are frequently seen as childhood disorders, nowadays, it is well known the persistent character of the individual's symptoms (Evans, 2017). The symptoms are permanent and impact adulthood of those who have ASD. However, as the development occurs, it is common to experience the decline of symptomatology due to the normalization of brain size (Mahajan & Mostofsky, 2015; Shattuck et al., 2007). Furthermore, it is essential to highlight the fact that many adults manage to hide their symptoms, finding some compensation strategies to implement in their daily routine, both to social and non-social skills, which also justifies the lower than expected number of diagnoses in this age group (Lewis, 2018; Livingston et al., 2019).

The features in adulthood are similar to those observed in childhood. However, they are sometimes more conditioning since adults have more significant demands and needs for personal development, such as looking for professional and educational opportunities, community participation and in-home care activities. A substantial percentage of individuals with ASD need personal support in adulthood due to this condition (Enner et al., 2020; Tromans et al., 2018).

For a better understanding of this condition, it is essential to stand the origin of the characteristics associated with ASD (Lyall et al., 2017; Sandin et al., 2017). The etiology of the genetic contribution to the disorder of the autism spectrum is strongly supported by studies of families and twins, contributing to some estimates of heritability varying between 50% and 95% (Lyall et al., 2017; Sandin et al., 2017).

Nowadays, knowing the relevance of epigenetics in gene expression allow us to accept that the child's experience may influence anatomical and physiological alterations in brain functions identified as possible markers and expected in this medical condition (Carmassi et al., 2019; Mahajan & Mostofsky, 2015). Therefore, in ASD, this relation between genetics and epigenetics is considered the most validated theory (Carmassi et al., 2019).

The brain anatomy in ASD starts to change in the early development (that is why ASD is considered an early-onset condition), during the peak synaptogenesis and the maturation of neural networks (Carmassi et al., 2019; Mahajan & Mostofsky, 2015). That means that changes in the neurotypical development in specific structures may influence other structures' development, which directly affects the neural circuits required for the typical development of the child (Mahajan & Mostofsky, 2015).

At the moment, there is no knowledge about specific biomarkers for the diagnosis, which is usually made after observing the individual's behaviour (Vargason et al., 2020; Yahata et al., 2016). However, it is possible to find abnormalities in susceptible genes so it is common to also find abnormalities in cerebral areas related to symptoms observed (Enner et al., 2020; Vargason et al., 2020).

Nonetheless, it is well known that the hemispheric asymmetries found in autism spectrum disorders, with impairments in the left hemisphere are associated with social communication, language, and motor-related skills (Peterson et al., 2015; Wilkinson et al., 2016). It is postulated in the literature that this can be due to the more considerable susceptibility of this hemisphere to suffer the influence of the environment during neurodevelopment (Floris et al., 2020; Geschwind et al., 2002; Peterson et al., 2015; Stroganova et al., 2020).

Even if the literature is not consistent and clear about all the mechanisms associated with the heterogeneous manifestations of autism, it is known, or at least considered, that the brain experiences a precocious development during the first year of life, however this development delays as the child gets older (Amaral et al., 2008; Tunç et al., 2019). In fact, the statistics show that up to 10% of children with autism evidence brain enlargement (Amaral et al., 2008).

Similar to what is observed in the cerebral cortex, other brain structures seem to be enlarged in Autism, such as the cerebellum, amygdala (which experience differences in the developmental process in Autism and is mainly associated with the deficits in social and communication skills), but also basal ganglia, thalamus, corpus callosum and caudate nucleus (which is associated with repetitive behaviours) (Amaral et al., 2008; Postema et al., 2019; Wilkinson et al., 2016).

With these being said, as structures affected in ASD, the literature highlights the frontal, temporal and cerebellar cortices, which are directly associated with alterations in the "social brain" and in structures associated with sensory processing and attention mechanisms, which are features impaired in ASD, as mentioned before (Carmassi et al., 2019; Mahajan & Mostofsky, 2015).

Even with all of this knowledge, it is not easy to stand out precisely the anatomical differences because of all the heterogeneity of characteristics, presence of diverse comorbid conditions, differences among studies and methodologies used, and reduced sample sizes (Amaral et al., 2008; Peterson et al., 2015; Postema et al., 2019; Wilkinson et al., 2016). Beyond that, some factors influence the generalization of the findings regarding neuroanatomy, such as age, sex and the taking of medication (Yahata et al., 2016).

It is essential to also stand environmental risk factors that, allied with the genetic and epigenetic factors mentioned above, play a role in determining the risk of Autism and appears to be transgenerational (Dietert et al., 2011; Modabbernia et al., 2017).

The most frequent risk factors identified so far fall into drugs, environmental chemicals, infectious agents, dietary factors and other physical or psychological stressors. (Dietert et al., 2011; Modabbernia et al., 2017). It is further highlighted some prenatal factors (threatened abortion, hypertension, drug abuse, mental health conditions and obesity); perinatal factors (pre-term birth, cesarean section, pregnancy complications) and postnatal factors (hypoxia, neonatal jaundice, pallor, routine vaccine, low birth weight) (El-Baz et al., 2011; Guisso et al., 2018; Hisle-Gorman et al., 2018; National Collaborating Centre for Mental Health, 2013). Beyond these, the increasing age of parents is also one of the most identified risk factors for disturbance of the autism spectrum. Higher ages can independently influence the risk of autism spectrum disorder (National Collaborating Centre for Mental Health, 2013; Oliveira, 2009).

The diagnosis of ASD is made according to the existing classification systems. In recent years, and after the publication of the Diagnostic and Statistical Manual of Mental Disorders - Fifth Edition, children are diagnosed with ASD, rather than subclassifications of the spectrum, such as autistic disorder, Asperger's syndrome, or invasive developmental disorder - not otherwise specified, as already mentioned (American Psychiatric Association, 2014).

The evaluation process, as a rule, is based on several evaluation stages, among which the historical record where parental concerns, neonatal history, birth, family history and socioeconomic condition are ascertained; the examinations; the observation, where play is used to identify specific behaviors and check the interaction, speech and gestures of the individual; the indication of the developmental profile and finally the determination of the diagnosis through the DSM-V (Mukherjee, 2017). Sometimes the assessment also allows for an evaluation of comorbidities that may occur in Autism (Mukherjee, 2017). Thus, there is no marker or diagnostic test for Autism, so the diagnosis is based on behavioural attitudes. The manifestations are not all observed initially but are assumed over time (Garland et al., 2013; National Collaborating Centre for Mental Health, 2013).

In Autism spectrum disorder, similar to other medical conditions, it is crucial to have a team with training and experience in this disorder to provide the best service and follow-up (Martins Halpern et al., 2021). The multidisciplinary team may include professionals from the fields of paediatrics in the area of neurodevelopment, psychiatry, psychology, nursing, social work, speech therapy, occupational therapy, special education and rehabilitation, those that should be carried out individually in order to provide a specialized service and consequently improve the best outcomes (Dillenburger et al., 2014; Martins Halpern et al., 2021). It should also be noted that, as ASD intervention is also carried out with the adult population who have this condition, the multidisciplinary team remains with a similar composition and essentially aims not only to provide a transition to adulthood (in cases where the diagnosis is made in childhood) but also to guide and advise on the best path that the individual should follow, allowing for the best outcomes in terms of self-awareness, self-efficacy, self-advocacy and ultimately self-determination (Abbott, 2019; Dillenburger et al., 2014). That said, one of the common goals in multidisciplinary teams is the shared interest in improving the quality of life of individuals with ASD as well as their families, which response to the main intervention goals with this population (Dillenburger et al., 2014).

As mentioned above, deficits in social and emotional skills are the main characteristics of individuals with autism spectrum disorder (Carlier et al., 2020; Malinverni et al., 2017). Many of the studies focus on the deficit skills already mentioned, such as facial and emotion recognition, social attention bias, imitation, turn-taking, cooperation and vocalization (Carlier et al., 2020; Hillier et al., 2020; Lee, 2021; Mubin & Poh, 2019; Wendt et al., 2020). However, several studies associated with ASD comorbidities, namely anxiety, stress and sedentary lifestyles, are beginning to emerge (Carlier et al., 2020; Hillier et al., 2020; Lee, 2021; Mubin & Poh, 2019; Navan & Khaleghi, 2020; Wendt et al., 2020).

Currently, some methods and interventions to promote behavioural change in these cases have been identified and evidenced (Malinverni et al., 2017). Most of the traditional approaches are related to cognitive behavioural therapies, social skills learning programmes, natural teaching strategies, parent training and play-based interventions (Mairena et al., 2019; Malinverni et al., 2017). However, for there to be data on the effectiveness of this type of intervention, treatment needs to be fairly continuous and intensive (Mairena et al., 2019).

In fact, basic principles that support evidence-based interventions conducted with individuals with ASD stand out from those of the Applied Behaviour Analysis (ABA) method (Cadieux & Keenan, 2020; Hyman et al., 2020; Mukherjee, 2017). This methodology stands out for the importance of defining and measuring the individual's behaviour, then analyzing and presenting feedback to correct it, and in a dynamic process of adapting the individual's performance (Cadieux & Keenan, 2020).

Regarding the performance of individuals with ASD, it is imperative not only to pay attention to improving behaviour and social skills but also to generalize them to contexts other than those used in training, a skill that is also impaired in ASD (Cadieux & Keenan, 2020; Kinsell et al., 2015). In addition to this methodology, it should be noted that early intervention will be essential to develop the most affected behaviours before they worsen, so intervention during early childhood is the most effective way to decrease ASD symptoms and provide the best possible prognosis (National Collaborating Centre for Mental Health, 2013; Strunk et al., 2017; Weitlauf et al., 2014). Therefore, the intervention plan should be individualized and should address the strengths and weaknesses of the affected child; the learning situation and family environment should also be considered (Abbott, 2019; Strunk et al., 2017). However, the intervention's effectiveness is related to the age of the child at the beginning of the treatment and its intensity (regarding the duration of each session and treatment in general) (Mubin & Poh, 2019).

GAMIFICATION TO SUPPORT INDIVIDUALS WITH ASD

In recent years, with the growing interest in technology, the intervention has been evolving and developing through the potential of some computer systems (Malinverni et al., 2017). The use of technologies in people with ASD is used in several areas, such as education, communication, behaviour and sensory issues (Kim et al., 2020; Koumpouros & Kafazis, 2019; Lee, 2021; Liu et al., 2017; Valencia et al., 2019; Zakari et al., 2014). This approach is supported by the fact that children with autism as well as their typically developing peers enjoy playing computer games in their free time. In addition, computer games and the privacy that the gaming environment provides, makes it non-threatening for children who have deficits in both practice and acquisition of certain skills (Kapp, 2012; Whyte et al., 2015). Thus, since it is known that intervention in ASD can be facilitated with the use of new technologies, many of the studies based on technological interventions focus on the deficit skills already mentioned, such as facial and emotional recognition, social attention biases, imitation, turning, cooperation and vocalization, but also academic skills (Carlier et al., 2020; Gay et al., 2016; Hillier et al., 2020; Lee, 2021; Mubin & Poh, 2019; Vallefuoco et al., 2017; Wendt et al., 2020). Beyond these, there is also evident concern from the scientific community to create responses for ASD comorbidities, namely anxiety, stress and sedentary lifestyles - ABA principles are also applied in this type of intervention (Cadieux & Keenan, 2020; Lee et al., 2020).

In addition, the rapid development of technologies has increased the hope of making treatment more effective, consistent and cost-efficient, especially in social skills training (Gay et al., 2016; Liu et al., 2017). Apart from the reduced cost, the main benefit of using technology to facilitate treatment is that the stimuli produced in each treatment session can be controlled, which not only ensures consistency across different sessions but also allows focusing on a single phenomenon, which is difficult even for a trained practitioner to execute and provide stimuli according to the treatment plan (Arzone et al., 2020; Liu et al., 2017; Valencia et al., 2019).

In general, technologies aim to improve the lives of children with ASD and their parents, providing a path to independence through strategies on how to deal with the condition (e.g. behavioral intervention), it also helps them to overcome challenges (e.g. health management support) and improve their health. their well-being and daily life functions (Kim et al., 2020). Moreover, technologies can be used in several ways, as a motivating teaching tool or strategy to increase independence or even for Alternative and Augmentative Communication (AAC), which focuses primarily on issues of communication and social interactions in clinical and educational practice, as it allows to establish functional communication to meet basic wants and needs and participate in activities of daily living (Koumpouros & Kafazis, 2019; Liu et al., 2017; Mukherjee, 2017; Stephanidis, 2020; Valencia et al., 2019). Regarding this alternative form of communication, AAC approaches range from low-tech paper-based communication boards to the most current and widely used high-tech strategies, including voice generating devices (SGDS) and tablets like the iPad with corresponding tablet apps (Stephanidis, 2020). The use of applications promotes increased communication and also ideally increases the natural speech production of minimally verbal children (Stephanidis, 2020).

Technology can also be helpful to support behavior management, creating regular schedules and routines to follow each day (Koumpouros & Kafazis, 2019). Besides these, it is possible to resourt to technologies to train daily activities, such as taking the bus, doing the first aids as well and working capacities and skills (Bernardes et al., 2015). For instance, Parsons et al. (2006) used café and bus environments to train the social skills of two adolescents with ASD, whose task was to find an appropriate place to sit within the environment. Along with this, Mitchell et al. (2007), similarly, used a café environment to teach social skills to six adolescents with ASD which, after two non-immersive virtual reality (VR) exposure sessions, were able to generalize the learned skills and apply them to another context (bus environment).

In these games, which focus relies on the social interactions, it is often used in two ways possible, passively observing the conversation between characters or, in a more participatory approach, actively chatting with characters (Barajas et al., 2017).

In fact, either in a traditional approach or in a technological one, the main focus of the intervention in children with Autism is the removal of barriers that can prevent the achievement of essential aspirations for this, such as a good quality of life, the achievement of independence and decision making (National Collaborating Centre for Mental Health, 2013; Weitlauf et al., 2014).

With this being said, the learning of emotional, cognitive and social skills by people with ASD mediated by digital technologies should involve much more than the computer and the Internet, as strategies that express personalization, intentionality and humanization should be used (Barroso & De Souza, 2018).

Hereupon, the use of games and gamification to educate children with ASD, particularly mild to moderate autism, has been able to have effects on the development and promotion of their abilities (Navan & Khaleghi, 2020). Actually, there are apps compatible with many mobile devices whose purpose is to facilitate the learning process for the children and the teachers, helping to gain vocabulary and aid in literacy (Gobbo et al., 2018; Vallefuoco et al., 2017). This is important since people with autism have deficits in language and communication, which influence their academic development, as speaking and listening are key components of literacy (Stephanidis, 2020).

In these cases, the adaptation of the apps includes levels with different goals for individuals with autism, such as distinguishing shapes, assisting in reading comprehension and increasing vocabulary, teaching alphabet letters and simple syllables, image association and written word (Gobbo et al., 2018). These apps also include some of the gamification elements mentioned above, such as medals, trophies and points, as well as give importance to use colors, images, interface and language (Gobbo et al., 2018).

Thus, combined with digital technology, gamification has several benefits when applied to autism intervention (Mairena et al., 2019). However, and since the spectrum and manifestations are so varied, clinicians need to assess what type of serious game or game elements are beneficial for each person, according to their needs (Collazos & Moreira, 2019). According to Wojciechowski and Al-Musawi (2017) and Lee (2021), the adherence to technology and gamification by individuals with ASD is associated with their structure and predictability, which are essential elements for this population and are assumed as beneficial for individuals with ASD (Collazos & Moreira, 2019). Many of the activities presented through traditional intervention methodologies are boring or repetitive, which compromises their execution. Thus gamification appears as a solution to this constraint, as it brings the principle that regular activity can be transformed into an exciting game, making it more dynamic (Oliva et al., 2019). Moreover, the devices used in the approach play an important role in the effectiveness of the app, since it is known that touchscreen presents more advantages in terms of interaction compared to keyboard and mouse (Zakari et al., 2014).

What has been developing and currently has been a trend is the gamification of traditional treatments. In addition, the simulation of social situations using virtual environments or robots has also been developed (Malinverni et al., 2017). Thus, playful strategies continue to be used in already frequently performed activities (Collazos & Moreira, 2019).

In general, gamification is associated with a number of benefits in emotional, cognitive and social skills (Gay et al., 2016; Sardi et al., 2017). The feeling of belonging and integration, as well as the development of positive social relationships stand out as the main benefits of this technique (Sardi et al., 2017). In fact, individuals tend to show good results through the gamification process because they are interested and inclined towards activities with a gamified purpose. In the case of children, since they show much interest in digital games, it is possible to increase motivation and produce behavioral changes (Gay et al., 2016; Lee et al., 2020). However, it is relevant that in this type of techniques (associated with gamification), certain elements are present, such as the therapeutic element, which helps children with ASD to adhere to the intervention process (Mubin & Poh, 2019). The game should have specific therapeutic goals, such as motivation, to achieve a change in behavior - motivation to be interested in the game and motivation to use gamification in therapeutic procedures (Mubin & Poh, 2019). In fact, as the interactivity increases in the game, the more motivation is observed (Barajas et al., 2017). This motivation may be enhanced with 3D and virtual reality environments, which stimulate interactivity and motivation in individuals with ASD, providing a sense of co-presence, social interaction and realism, minimizing the problems associated with learning transfer (Bozgeyikli et al., 2017; Laforcade & Vakhrina, 2016; Mesa-Gresa et al., 2018; Mubin & Poh, 2019; Parsons & Cobb, 2011). The great difficulty in turning the game into something fun and necessary since children never reject a game with fun (Mubin & Poh, 2019). Suppose the person likes the proposed activity, the more likely it is to be performed. In that case, if they do not like the activity, it is necessary to change it and mold it to their needs and expectations - for example, by turning simple activities designed for learning into games, educators get greater cooperation from children as they put more effort and attention into performing them (Mubin & Poh, 2019; Oliva et al., 2019). Furthermore, the fact that some of the gamification tactics involve competition, i.e., induce the desire to achieve at a high level in the leadership framework provided by the game, promotes skills such as self-satisfaction, self-esteem, and pride (Sardi et al., 2017). In addition to evidence on social and emotional skills, gamification also promotes cognitive development. Moreover, there is good evidence that gamification helps cognitive development as it allows players to increase or develop strategic skills, promotes improved working memory, visual attention, and processing speed (Sardi et al., 2017).

Regarding the development of games, programs and/or applications, it is highly relevant and brings numerous advantages to the involvement of individuals with ASD in their construction, only in this way is it possible to take into account the user's perspective and thus facilitate their adaptation to what are the main characteristics of the medical condition, as already mentioned (Cadieux & Keenan, 2020; Politis et al., 2017). Moreover, the involvement of each individual provides the optimal level of stimulation and training, and also the opportunity to build applications/programs that are easy to understand and that allow progress in individual intervention, noting that it is important to try to adapt the intervention program to the individual therapeutic needs and goals, just as in traditional interventions (Lee et al., 2020; Navan & Khaleghi, 2020). Thus, it is intended to overcome two of the challenges posed to the use of gamification with individuals with ASD, namely play voluntarily and not obligatorily, and allow the individual to disconnect from their own world and focus only on the game (Gobbo et al., 2018).

As noted above, the beneficial role of digital tools in promoting the development of autonomy-related skills in individuals with ASD is well known (Gay et al., 2016). However, in the case of the ASD population, there is a lack of knowledge about intervention using technologies and/or non-pharmacological interventions in the adult age group, which can be explained by the fact that it is a relatively new topic in the literature (Howlin & Moss, 2012; Murphy et al., 2016; Tromans et al., 2018). Thus, it is more common to observe the use of pharmacological interventions in this age group, which include antipsychotics, antidepressants, and stimulants (Garland et al., 2013; Howlin & Moss, 2012).

CONCLUSION

Overall, there is little relevant research in this field as there are small sample sizes, the heterogeneous characteristics among individuals with ASD, lack of control groups needed to assess whether the intervention is due to practical effects or natural development and, most importantly, the failure to include tasks designed to measure the generalization of behaviours to real life contexts (Collazos & Moreira, 2019; Navan & Khaleghi, 2020; Weitlauf et al., 2017).

Nevertheless, the use of games among individuals with ASD seems promising, even if there is not enough scientific evidence to prove significant results of using gamification in ASD intervention (Cheng, 2020). However, there are already several studies in the area of gamification and serious games that show positive results in managing ASD symptoms and associated comorbidities (Collazos & Moreira, 2019; Floryan et al., 2020; Lokhorst, 2014). More research on the effectiveness of the interventions and the design of serious games is needed to understand if this type of intervention could be an integral part of an intervention program for ASD (Collazos & Moreira, 2019; Lokhorst, 2014).

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Chapter 9
Gamification in Stroke Rehabilitation

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ABSTRACT

Stroke rehabilitation aims to improve patients' abilities to realize daily life activities and, consequently, regain their self-confidence and improve independence and quality of life. Gamification can be defined as the application of game-design elements, dynamics, and principles such as competition, narratives, point-scoring, and awards in non-game contexts, including rehabilitation. It has emerged as a therapeutic alternative or complement to traditional rehabilitation to make motor practice more intense and increase a person's motivation, interest, and satisfaction by bringing meaningful and intrinsically motivational playful experiences. Compared to the same amount of conventional therapy, gamification can increase the number of movements and involve safe and intensive rehabilitation exercises, essential for a successful rehabilitation process.

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INTRODUCTION

The main goal of this chapter is to explore the effects, advantages, and disadvantages of the use of serious games in post-stroke upper limb rehabilitation. We also aim to compare the obtained results between the use of conventional therapy and gamification. Every year, stroke affects about 15 million people worldwide and in Europe are registered close to one million new cases (de Castro-Cros et al., 2020; Elsner et al., 2017). It is considered to be one of the most common causes of death and the primary cause of adult disability around the world (Achacheluee et al., 2018; Draaisma et al., 2020; Elsner et al., 2017; Phipps & Cronin, 2020; Simonetti et al., 2017; Unibaso-Markaida et al., 2019). Given the size of this problem, the authors felt the need to study this topic. Besides that, the need for innovating rehabilitation methods that promote therapeutic compliance, clients 'involvement, and motivation throughout the rehabilitation process could lead to better results.

BACKGROUND

1. Stroke and functional impairments

Stroke is a focal neurological lesion, with a sudden onset, lasting more than 24 hours, induced by the abrupt interruption of blood flow to the brain due to either a vessel occlusion or, less frequently, an intracerebral hemorrhage (Lefebvre & Liew, 2017; Unibaso-Markaida et al., 2019). Both can induce direct damage of brain tissue at the lesion site, along with the potential for additional damage in the adjacent tissue and long-term dysfunction through the interruption of structural and functional pathways in the brain (Lefebvre & Liew, 2017). This also leads to a deregulation of cortical excitability and abnormal interhemispheric interactions (Lefebvre & Liew, 2017).

There are risk factors that increase the possibility of having a stroke that can be divided into controllable and uncontrollable risk factors (de Castro-Cros, 2019). Controllable risk factors are directly associated with a person's lifestyle and affect blood pressure, arterial fibrillation, cholesterol, diabetes, and blood circulation. These include diet and nutrition, physical activity, tobacco smoking, alcohol, and many others. Uncontrollable risk factors are intrinsic and essential to determine the overall risk. These include age, gender, race and ethnicity, family history, history of previous strokes, fibromuscular dysplasia, patent foramen ovale, and transient ischemic attack.

An ischemic stroke is a sudden loss of blood flow to an area of the brain. It can be caused by arteriosclerosis (chronic inflammation of the arteries that causes hardening and accumulation of cholesterol plaques on the walls, which helps the arteries obstruction and the formation of the thrombus), cardio-embolism (a blood clot that travels from the heart to the brain, causing an obstruction, that is caused by the disruption of the cardiac rhythm, cavity dilation, and a cardiac valve alteration) and a brain venous thrombosis (this does not allow blood to go back to the brain, reducing blood flow and making irrigation difficult). Ischemic stroke can also be caused by unusual causes, like a blood clot formed due to an arterial dissection or undetermined causes (Boehme et al., 2017; Koh & Park, 2017; Phipps & Cronin, 2020).

A hemorrhagic stroke is caused by the rupture of a blood vessel or an abnormal vascular structure in the brain. It can be classified as an intracerebral hemorrhage or subarachnoid hemorrhage (Boehme et al., 2017; Koh & Park, 2017). It can be caused by high arterial pressure, which can produce either an obstruction or arterial rupture, a degenerative process, it happens when amyloid plaques are placed over the arterial wall producing an arterial rupture, and secondary hemorrhages of cerebral vascular malformations, caused by abnormal vessels collapse (de Castro-Cros, 2019). Close to 90% of all strokes are ischemic, while the rest 10% are hemorrhagic. Although ischemic strokes are more common, hemorrhagic strokes have higher mortality rates (Unibaso-Markaida et al., 2019).

Every year, stroke affects about 15 million people worldwide, and in Europe are registered close to one million new cases (de Castro-Cros et al., 2020; Elsner et al., 2017). It is considered to be one of the most common causes of death and the primary cause of adult disability around the world (Achacheluee et al., 2018; Draaisma et al., 2020; Elsner et al., 2017; Phipps & Cronin, 2020; Simonetti et al., 2017; Unibaso-Markaida et al., 2019). It is also one of the major causes of the economic burden. There is a growing number of acute stroke treatments that led to a decrease in mortality rates. However, the number of patients that are left with impairments increased in recent years (Draaisma et al., 2020; Guillén-Climent et al., 2020).

Approximately 86% of people who have suffered a stroke have some disability (Unibaso-Markaida et al., 2019). People can suffer from a wide range of impairments intimately related to the extension of the lesion and the brain area affected. The most commonly affected brain areas are the parietal and frontal lobe, the midbrain, and brainstem structures (Gamito et al., 2017). The American Heart Association has categorized disability into six domains: motor, sensory, speech, and language, visual, cognitive, and affective. In addition to these domains, stroke survivors also suffer from psychosocial impairments which alongside with motor and cognitive impairments are among the most commonly affected and reported among stroke survivors (Elsner et al., 2017; Galeoto et al., 2019; Simonetti et al., 2017). In addition to the domains, disability from stroke has also been classified according to levels.

Motor impairments include loss of muscle strength, spasticity, hemiparesis, hemiplegia, motor incoordination, apraxia, loss of upper limb function, and abnormalities in walking, with about one-third unable to ambulate independently in the community (Charles et al., 2020; Draaisma et al., 2020; Galeoto et al., 2019; Hung et al., 2016; Kim et al., 2018; Lefebvre & Liew, 2017; Simonetti et al., 2017; Solomons & Shanmugasundaram, 2019; Unibaso-Markaida et al., 2019). About 80% of stroke survivors are left with significant motor impairments (Hung et al., 2016), and upper limbs impairments affect 60% of stroke survivors. These impairments are persistent, and 55–75% of this population (Yates et al., 2016). Cognitive impairments include attention, memory, and executive dysfunctions. (Draaisma et al., 2020; Galeoto et al., 2019; Gamito et al., 2017; Unibaso-Markaida et al., 2019). Even in patients with a favorable physical outcome, approximately 50% are cognitively impaired (Draaisma et al., 2020). Some stroke survivors may experience profound psychosocial impairments (Minshall et al., 2019), such as frustration, anxiety, or even depressive moods consequential to uncertainties regarding rehabilitation, recurrent stroke, and difficulties in regaining independence after stroke (Lo et al., 2021; Mubin et al., 2020). Depression affects 25% to 79% of stroke survivors (Allida et al., 2020; Lo et al., 2021; Minshall et al., 2019). When present in the subacute phase, depression predicts functional outcomes, suggesting a negative impact on the recovery process. The etiology of post-stroke depression remains unclear, but it is likely multifactorial, consistent with biopsychosocial models of mental illness. It is uncertain if the lesion contributes directly to depression through the deregulation of the brain´s mood regulation systems. Post-stroke depression has been associated with lesions on the left frontal lobe; however, these studies were conducted in the sub-acute phase, a period characterized by an acute adjustment to communication impairments and loss of limb function (Grajny et al., 2016).

Due to the wide range of impairments a stroke survivor can experience, some may need homecare. They often report difficulties in realizing activities of daily living, social activities, and in returning to work which results in a negative impact on the quality of life (Charles et al., 2020; Hung et al., 2016; Lim et al., 2021; Mubin et al., 2020). Given the significant negative impact on physical, cognitive, and psychosocial functioning experienced by stroke survivors, it is easy to understand why stroke has a negative impact on psychological well-being (Giachero et al., 2020).

2. Conventional therapies for stroke rehabilitation

Following a stroke, people with disabilities should go through rehabilitation in an inpatient unit. After discharge, they should be followed by a specialist team within the community. Inpatient units should be dedicated to stroke rehabilitation and include access to other services such as continence advice, dietetics and nutritional advice, liaison psychiatry, orthoptics, orthotics, pharmacy, podiatry, and a multidisciplinary education program (NICE, 2020).

A multidisciplinary team should perform rehabilitation in inpatient units with the knowledge and skills to work with stroke survivors, their families, and carers in order to manage the changes experienced. This team should comprise consultant physicians, nurses, physiotherapists, occupational therapists, speech and language therapists, clinical psychologists, rehabilitation assistants, and social workers (NICE, 2020; Winstein et al., 2016).

Stroke rehabilitation aims to improve patients' abilities to realize daily life activities and, consequently, to regain their self-confidence and to improve independence and quality of life (Almhdawi et al., 2016; Hebert et al., 2016; Mubin et al., 2020; Winstein et al., 2016). A stroke does not affect only one aspect of a person's life, and it must be seen as a whole (de Castro-Cros, 2019). Therefore, one of the main goals of stroke rehabilitation is to improve physical disfunction, regain motor physical activity, help patients' autonomy, and promote social, familiar, labor, and environmental reintegration. In order to enhance the probability to achieve better outcomes, rehabilitation should start as soon as possible, once the diagnosis is done and the vital state is ensured and be performed in the time window for motor recovery around 3 to 6 months after stroke, although this could continue up to a year after stroke. There are several treatment options available for stroke patients. All options have varying levels of evidence supporting their theory and choice. Based on motor learning theory, task-oriented, intensive, and repetitive training with cognitive participation that become increasingly more complex during the subacute stage after stroke is the critical factor for promoting neural plasticity to induce motor recovery by stimulating cortical reorganization (de Castro-Cros, 2019; Ikbali Afsar et al., 2018; Kim et al., 2018).

Conventional rehabilitation techniques, including motor relearning, perceptual and sensory interventions, passive/assistive mobilization of body structures and joints, and training for specific muscles or muscles groups in an assistive, active or resistance mode, neurodevelopmental therapy, containing postural control, fine and gross motor skills and coordination, sensory integration, including proprioception and haptic perception, or proprioceptive neuromuscular facilitation are similarly effective in maintaining and improving motor function and participation in activities of daily living (Charles et al., 2020; Hung et al., 2016; Saposnik et al., 2016; Schuster-Amft et al., 2018).

Concentional therapy includes occupational therapy interventions that can be instrumentional in addressing the main functional challenges faced after stroke. These interventions can be performed in all stages (acute, sub-acute and chronic) in a wide variety of settings, for exemple intensive care units, inpatients and outpatients units, home and community (Steultjens et al., 2003). Occupational therapists aim to improve or facilitate task performance by increasing performance skills or theaching and developing compensatory strategies to overcome the lost of performance skills (Steultjens et al., 2003). Occupational therapy interventions that stand out for the use of occupation-oriented tasks, repetitive task training, and activities to improve daily living activities (Almhdawi et al., 2016; Hebert et al., 2016; Nilsen et al., 2015; Winstein et al., 2016). Usually, this professionals uses a person´s ability to perform functional activities to measure their functional status, this being the focus of post-stroke rehabilitation. Therefore, occupational therapy professionals aim to identify the best treatment methods and routines to help patients return to their previous daily activities (Galeoto et al., 2019). The most commum strategies used with stroke patients are training of self-care activities, training of leisure activities and training the use of assistive technologies. In addition, occupational therapists provide information to families and primary caregivers on the patient´s skills and performance and how to provide assistance (Steultjens et al., 2003). However, occupational therapy is usually less than the suggested in guidelines (Kim et al., 2018).

3. Gamification in stroke rehabilitation

Motivation, engagement, active participation, and involvement are key aspects to maximize the effectiveness of post-stroke upper limb rehabilitation techniques (Fathima S J et al., 2018). Gamification can be defined as the application of game-design elements, dynamics, and principles such as competition, narratives, point-scoring, and awards in non-game contexts, including rehabilitation contexts (de Castro-Cros, 2019; de Castro-Cros et al., 2020; Lim et al., 2021). It has emerged as a therapeutic alternative or complement to traditional rehabilitation to make motor practice more intense and increase a person's motivation, interest, and satisfaction by bringing meaningful and intrinsically motivational playful experiences (de Castro-Cros et al., 2020). It can be used to guide people´s behaviour in order to achieve a specific goal (de Castro-Cros, 2019).

Therefore, it has primarily been used in upper limb rehabilitation (de Castro-Cros et al., 2020). Usually, game-based systems provide patients with an interactive interface and implement different task-oriented scenarios. They use patient's movement as input (de Castro-Cros et al., 2020; Hung et al., 2016). Users wear tracking devices (hardware) that allow patients to do specific rehabilitation movements in order to interact with a graphic gaming interface (software) while the system measures patients' movements. Gaming contexts and scenarios may be customized or selected from commercial games previously existing. The measurement of patient actions needs to be accurate, and the therapeutic goals need to be realistic, so that they can be achievable, without discouraging the patient (Burdea et al., 2019).

When developing a game for rehabilitation purposes, authors should consider various game attributes and the need to adapt the hardware to the patient's physical condition (Mubin et al., 2019).

Many different types of games can be used to support upper limb rehabilitation, such as two-dimensional (2D), three-dimensional (3D), virtual reality (VR), augmented reality games (AR), exoskeleton robotics, robotic assistive systems, and other interfaces such as Nintendo Wii, PlayStation; Xbox and Kinetic (de Castro-Cros et al., 2020; Gamito et al., 2017; Islam et al., 2020; Mubin et al., 2019). When developing games adapted for stroke rehabilitation, there are three key aspects to consider: social context, multiplayer or single-player mode, motion type, recruiting a single-muscle motion or a multiple-muscle motion, and cognitive challenge amateur or professional. Audio-visual cues and performance-related online information are essential to boost patient's motivation (Mubin et al., 2019).

Virtual reality is an enhanced version of human-computer interaction in which the person interacts with objects in a virtual environment and gets immersed (Domínguez-Téllez et al., 2020; Mubin et al., 2019). VR consists of a user-computer interface that enables real-time interaction with a scenario allowing users´ to interact through multiple sensory channels. Many devices can be used to support VR use, such as earphones and head-mounted displayers. Nowadays, virtual reality has many applications other than physical rehabilitation (Domínguez-Téllez et al., 2020). It can be used for pain management, assessment of neurocognitive impairments, and training of medical techniques. VR provides visual, auditory, tactile, and motor learning applications, creating an interactive and motivational environment where patients feel encouraged and motivated to engage in the rehabilitation process, thus enhancing post-stroke motor skills improvement (Domínguez-Téllez et al., 2020; Mubin et al., 2019).

In augmented reality, users´ interact with a virtual scenario and have control over the objects in the virtual environment (Mubin et al., 2019). It offers the opportunity to use real-world objects within the virtual environment. When combined with haptic devices, augmented reality has the potential to decrease hand stiffness.

An exoskeleton is an external mechanism that supports part of the human body. It mimics human body joints that help transmit torques from the exoskeleton to the body with the help of actuators (Mubin et al., 2019).

Commercial computer games have been adapted, and new games have been designed to enhance the rehabilitation experience (de Castro-Cros et al., 2020). These games use the movement of the patients as the input system of the game. The movement is measured through various tracking systems such as cameras and motion sensors (de Castro-Cros et al., 2020; Gamito et al., 2017; Islam et al., 2020), and it substitutes conventional devices such as the mouse and joysticks.

Motion-controlled video games such as Nintendo Wii and Xbox are some of the most common and affordable forms of gamification in post-stroke rehabilitation. Recently, they have become a common adjunct to physical rehabilitation. These systems provide real-time feedback that enhances motor learning and motivation and allowss the therapist to have an objective monitoring of patients´ performance. Furthermore, the engaging nature of a game-based approach may increase the number of repetitions and patients´ motivation. There are a wide variety of activities that allow for the practice of a wide range of physical and cognitive tasks. The use of Nintendo Wii and Xbox software and hardware have demonstrated improvements in upper limb function and balance with minimal safety concerns (Bower et al., 2015).

For upper limb rehabilitation, the most commonly used strategy is virtual reality followed by video games such as those used in Nintendo Wii, Xbox and commercial computer games (Koutsiana et al., 2020).

4. Conventional therapies vs. gamification

Conventional rehabilitation methods include repetitive tasks performed daily which may lead to a patient´s loss of interest throughout the rehabilitation process. Patients are encouraged to repeat these exercises at home in order to achieve better performance and control. However, only about 31% of stroke survivors follow the therapists' recommendations, probably due to the lack of supervision and feedback during the exercises and because of their repetitive nature (Hung et al., 2016).

In the same way, patients usually require physical contact between the therapist and the client, which can become exhausting for professionals and uncomfortable for the client (Mubin et al., 2020). Patients tend to consider the exercises boring, monotonous, and exhausting leading to decreased motivation (Kim et al., 2018). Due to the lack of motivation, clients become less involved in the rehabilitation process, which negatively impacts functional recovery (Charles et al., 2020).

Besides that, conventional rehabilitation can be resource-intensive and costly, often requiring specialized facilities not always widely available (Saposnik et al., 2016), and the center capacity is behind the number of stroke patients, forcing therapists to give rehabilitation sessions with limited rehabilitation exercises (Hung et al., 2016). The increasing number of patients creates higher demands on rehabilitation centers, making it very difficult to provide services using the traditional approach (Guillén-Climent et al., 2020). Therefore, the amount of occupational therapy sessions is usually less than the suggested in the guidelines and patient's active participation is less than expected (Kim et al., 2018).

When compared to the same amount of conventional therapy, gamification have the advantage to increase the number of movements and involve safe and intensive rehabilitation exercises, essential for a successful rehabilitation process. (Guillén-Climent et al., 2020). Additionally, game-based therapy has been applied as a tool to boost motivation, increase exercise intensity and provide objective and quantifiable outcomes to the therapist (Burdea et al., 2020). Therefore, serious games can improve upper limb function when complementing conventional rehabilitation methods (Burdea et al., 2019; Islam et al., 2020). Furthermore, gamification strategies can be used at home, allowing us to extend institutional rehabilitation and increasing and prolonging therapy (Guillén-Climent et al., 2020).

Despite the many potential uses of game-based rehabilitation for stroke patients, this method also has some disadvantages. Most commercial games lack adaptability to people with motor impairments. Games do not target the desired movements of the upper limb and lack consideration for the spasticity that patients may present (Burdea et al., 2020; Choi et al., 2016). Game designs may be to challenging leading to frustration and abandonment (Bower et al., 2015; Burdea et al., 2020). For example, individuals with stroke sequels may struggle with controller manipulation, responding to activities that are fast and visually complex (Burdea et al., 2020). It may be difficult to adjust game control, and the level of difficulty and tasks may lack functional relevance.

Furthermore, scoring systems may provide negative feedback leading to users´ frustration. Providing and selecting games that are best suited to individual patients is a big challenge for therapists (Hung et al., 2016). In addition, limitations in patient-therapist communication were observed, making it harder to implement gamification strategies and keep patients motivated (Islam et al., 2020).

5. Stroke survivors' perspective in game-based rehabilitation

Stroke survivors´ perspective in games designed for rehabilitation purposes should be considered when designing new games or intervention protocols as they are the main users. According to patients, game-based rehabilitation should respond to immediate needs, such as recording medical information and promoting motivation and engagement (Kamkarhaghighi et al., 2017). These systems should be non-invasive, safe, attractive, applicable at any time and in various places, especially at home, able to record health data and provide immediate feedback to patients and practitioners.

In stroke patients´ perspective, traditional rehabilitation exercises are more effective when performed in a hospital environment or accompanied by a therapist than performed at home. They identify as main barriers the lack of detailed therapist instructions, lack of immediate feedback to correct posture, among other aspects, the tendency to slack off, and the existence of many distractive stimuli (Hung et al., 2016). Patients´ believe that exercises performed in the hospital context are more effective because they have detailed therapist instructions and are more concentrated. Game-based rehabilitation systems could contribute to solve this problem if available at home context because they can provide instructions, corrections, incentives and support remote communication between therapists and patients.

Stroke survivors´ opinions diverge when the subject is previously existing game-based rehabilitation systems. Although they report a positive experience while using rehabilitation games because it feels more effective, it is something new and because of the audio/ visual effects. But, on the other hand, they report several limitations, for example, limited game choices, games that are not fun and easy to get bored, lengthy instructions that make comprehension harder, lack of previous gaming experience, the equipment costs, and the lack of positive reinforcement as they progress in the game (Hung et al., 2016; Morse et al., 2020). In order to face these limitations, patients report several desired features of games designed for rehabilitation. These include a wider range of games to choose from, the possibility to customize exercises to be performed at home, games more related to real-life tasks, the use of pictures and instructional videos during instructions (Hung et al., 2016; Morse et al., 2020), observing their progress through levels and real-time score feedback (Lewis et al., 2011). clear progress feedback, such as cheers or claps. To sum up, the most desired features patients report is fun, and diverse games, cost-effective game-based rehabilitation systems, easy to replicate at home or in the community and systems thar support social interaction needs into account (Hung et al., 2016).

It is also essential to understand which criteria patients consider when they can choose games provided by rehabilitation systems. Research shows that the most determinant criteria are the therapist recommendation, which shows that patients are concerned about whether rehabilitation exercises comply with the designed therapeutic plan. Therefore, stroke survivors prefer games that are intuitive, challenging, popular and related to prior experiences. All these characteristics are found in successful fun games. Although rehabilitation systems may be more specific and target the desired movements, they are not designed to be entertaining or motivational (Hung et al., 2016).

The majority of patients prefer to play serious games on large display monitors and to interact with motion and physical sensors while they perform the rehabilitation exercises sited with hand rests (Hung et al., 2016).

Finally, besides the positive effects felted in motor abilities, stroke survivors report positive effects of gamification in mental and social aspects. Serious games increase positive feelings such as self-confidence, self-esteem, and self-efficacy by increasing the feeling of independence (Lewis et al., 2011; Morse et al., 2020).

FUTURE RESEARCH DIRECTIONS

The literature founded suggests that game-based intervention has positive results. However, there is not enough evidence to make recommendations in this area, which makes investigation on how to bring gamification elements into post-stroke rehabilitation significant.

Future studies should consider having a more considerable number of participants, dividing them into at least two groups, one control and one experimental, and implementing sessions with a well-established schedule and with the same duration for both groups. These should also take into consideration patients´ factors such as age, sex, severity or extension of the lesion, evolution of stroke and stroke location. Future research would benefit from repeated standardized measures and direct comparisons of a wide range of factors, including conventional rehabilitation programs and game-based interventions, the combination of conventional therapies and serious games and other therapy combinations, commercial games, and rehabilitation-specific games and finally, comparison between the acute, subacute, and chronic phase in order to assess optimal modalities for each stage. It is crucial to design protocols that are easily replicated in order to be widely implemented in other rehabilitation centers and support the implementation of game-based interventions.

It is usually assumed that game-based rehabilitation has greater adherence and improves motivation when compared to conventional rehabilitation protocols. However, this theory has not been tested. Future research should consider these aspects and evaluate adherence and motivation in both protocols. The opinion and perspective of stroke survivors should be registered and taken into account because they are the main users.

Finally, future research should focus on the successful application of gamification strategies to increase patient's participation in the rehabilitation process at their homes. The recommended games should be in line with patients interests, and the level of difficulty should be easily adapted to facilitate patients´ involvement in the proposed tasks.

CONCLUSION

This paper explores the positive and negative aspects of the introduction of gamification systems and strategies during the rehabilitation process of stroke survivors.

Recent studies show that the use of serious games is well accepted by patients, and it is a strategy that is becoming more and more relevant when post-stroke rehabilitation is being discussed. Game-based systems can promote motivation, engagement, positive feelings, self-confidence and self-esteem, empower patients throughout the rehabilitation process, and increase the number of repetitions performed in a single session by making exercises more exciting and meaningful.

However, this intervention has some disadvantages that difficult patient access, such as the need for expensive equipment, resistance from patients to accept new forms of treatment, and lack of equipment adaptability to the physical or cognitive impairments.

Therefore, investigation in this area should be continued in order to establish treatment guidelines for the different stages of stroke evolution. Future studies should design simple, standardized, and easy-to-replicate protocols.

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Section 4
Artificial Intelligence in Mental Health

Chapter 10
Artificial Intelligence in Digital Mental Health

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ABSTRACT

The prevention of diseases considered a scourge of our society, as for example mental illness, particularly anxiety disorders and depressive states, is a primary and urgent goal today and a priority axis of the EU. Mental illness includes many clinical conditions associated with several changes that include limitations related with social interaction or several tasks such as sleeping through the night, doing homework, making friends, thinking capacity and reality understanding, deficits in communication skills, and difficulties in developing appropriate emotional and behavioural response. Artificial intelligence has gained a prominent role in the management and delivery of healthcare. There is a growth in mobile devices applied to health with high mobility, connectivity, and processing capacity. This chapter provides an analysis of the actual trends regarding the main problems that can be dealt with using AI in mental healthcare and the corresponding main techniques used to deal with these problems. Additionally, some case studies for using AI for mental health care are described.

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INTRODUCTION

Since the primordial days of Artificial Intelligence (AI), many applications in the medical area have been developed. Initially, Knowledge-Based Systems, and in particular, Expert Systems were the first AI approaches to develop applications in the field of medicine. However, the current advances in computational capacity, data acquisition and machine learning techniques have contributed to a growing interest in AI.

One of the difficulties for doctors that arise during the diagnostic process is related to the fact that interactions with the patient only offer an instantaneous image of an individual's mental state, although mental state disorders can be dynamic, changing over time. As the availability of medical teams is limited, psychiatric assessment of patients based on the observation of their mental state can only be carried out for short periods. AI can provide alternative methods, such as audio and video analysis, bringing greater objectivity and may present better predictive behaviour.

AI may be combined with smartphone applications to increase monitoring coverture, during a significative period of the patient's day. These applications can actively query users about their state of mind, sleeping periods and other relevant habits. The behaviour of patients can be tracked by these apps, such as smartphone activity, the variation of the voice, speaking rate, and voice quality. These tracked behaviours can be used as predictors of symptoms of depression and other mental disorders.

Another aspect related to monitoring is the fulfilment of drug prescriptions. This is a problem that accompanies all chronic patients and is of particular importance in mental health problems. There are several examples of applications for smartphones that aim to assist the patient in fulfilling drugs prescriptions, generating alerts about the need for taking medications. The application of machine learning techniques in this context can allow these applications to have the ability to adapt to the patient, thus improving their recommendation capabilities, always with the aim of improving the patient's adherence to medication.

AI can also have an important role in the prevention of episodes of mental disorder. Machine Learning can be effectively used to identify words and emojis that can signal a person at higher risk of suicide ideation or self-harm. Artificial intelligence can allow existing treatments to be provided through new approaches, which can increase availability and effectiveness. Virtual therapists can be powered with AI tools to avoid patients getting embarrassed to share problems with a therapist with whom they interact for the first time.

Recent improvements in conversational systems, allowed chatbots to mimic normal conversational style to increase adherence to treatments and decrease both depression and anxiety. However, these systems are still in a preliminary stage of research but already reveals great potential for improvement.

AI may contribute to providing more time for medical staff to interact with patients and improving the quality of care. Natural Language Processing (NLP) offers a set of techniques allowing the implementation of applications that can be used to save time for psychiatrists. These professionals need an appreciable time to read previous notes that allow them to build the patient's accurate history. For example, NLP techniques can be applied to get a summary of the most relevant data from a patient's health records, providing that way with a succinct summary at the beginning of a clinical visit.

The first National Mental Health Epidemiological Study, carried out as part of the World Mental Health Survey Initiative, ranks Portugal as the second European Union country with the highest prevalence of psychiatric disorders (22.9%), only surpassed by Northern Ireland (23.1%). In this study, anxiety disorders representing the group of mental illnesses with the highest prevalence in our country (16.5%) and the second highest impact in terms of disability adjusted years (daily of 1.8%), with a tendency to grow in the coming years (Direção Geral de Saúde, 2013), (Direção Geral de Saúde, 2016), (Direção Geral de Saúde, 2017).

This chapter will provide a in analysis of the actual trends regarding the main problems that can be dealt with AI in mental healthcare, and the corresponding main techniques used to deal with these problems. Additionally, some case studies for using AI for Mental Health Care will be described.

AI Applied to Mental Healthcare

A new technology may face several challenges every time it enters healthcare. Common setbacks of AI in healthcare include a lack of data exchange, regulatory compliance requirements and patient and provider adoption. AI has come across all these issues, narrowing down the areas in which it can succeed.

The most popular use of artificial intelligence in healthcare is in IBM's smart cloud, where Watson lives (IBM, 2016). The Watson platform has been used in several disciplines within healthcare including with payers, oncology, and patient risk assessment.

There are a few other applications within healthcare where AI can deliver incredible value, but healthcare executives must evaluate and see if they can adopt some or all of them to begin their journey in the AI space. Examples of areas where AI is gaining relevance include the personal health virtual assistants, personal life coach, and healthcare bots.

AI has great potential for the diagnosis and understanding of mental disorders. AI techniques can offer the ability to develop better prevention tools and formulate models to determine a predisposition or risk of developing mental illness.

Personal Assistant and User Modelling

A Personal Assistant (PA) is a tool that can contribute to improving independent living but, many times, poor and rudimentary traditional PA approaches devotes low attention to key issues such as suggesting changes in people behaviours (individual and collective), or to support the prevention of mental disorders, which often are inhibiting factors of daily activities. The use of this kind of technology can improve the quality of life and support more independent living.

In PA, the User Model (UM) has increased relevance. The UM allows changing several aspects of the system, in reply to certain characteristics (given or inferred) of the user (Martins et al., 2008).

Contextual PA can infer what the user said before, when/where/how they said matters and should influence how the conversation goes and how the recommendations are given. The use of this kind of technology can improve quality of live and support more independent live.

In (Centry et al., 2008) is presented a study to examine the efficacy of personal assistants as cognitive aids in a sample of individuals with severe traumatic brain injury. Behavioural memory deficit is one of the most often-cited complaints among individuals with acquired brain injury.

A user model is composed by a set of characteristics that adjust the content, presentation, and navigation to each user. These characteristics can be domain-dependent and domain-independent and are related with beliefs about the user, which include preferences, knowledge, and attributes, or are an explicit representation of properties of individual users and user classes (Martins et al., 2008).

Domain dependent data is related with system responses tailored according to the domain knowledge of a user (Durrani, 1997) (Martins et al., 2008). For this, it is necessary to perceive user current state and knowledge regarding concepts and relations inherent to the domain, predict how the user will interpret system responses, understand the many different goals, and plans of each user, predict and respond to different mistakes while the user is using the system and identify the most adequate way to present information to each user. Different methods can be used to measure user knowledge and expertise regarding the domain: Direct Dialogue and Indirect Acquisition.

Direct Dialogue

This type of interaction is performed directly with the user to assess his/her expertise regarding the domain. For this, the system should incorporate features to allow users to input and share their knowledge (for example, using questionnaires or forms) and mechanisms to process the inserted data to correctly measure user knowledge regarding the domain.

Indirect Acquisition

Indirect acquisition method allows the system to assess user knowledge indirectly according to how the user performs different actions. Depending on this assessment the user knowledge regarding the domain is classified in different levels which in turn are updated over time as the user works with the system.

Domain independent data is not related with user expertise regarding the domain but to his/her cognitive abilities which indicates how the user perceives, thinks, remembers, behaves, and solves different problems (Durrani, 1997). In other words, domain-independent knowledge corresponds to the phycological characteristics of the user. There are many different psychological models and tests that can be used to assess user personality such as the Myer-Briggs Type Indicator, the Eysenck's Pen Model and the Big Five Model.

Myer-Briggs Type Indicator

Myer-Brigg Type Indicator model (Myers, 1962) is a model used to identify personal characteristics and preferences. This model considers four different areas of personality based on the Carl Jung's Psychological Types (Jung, 2016) and which are perception, judgment, extraversion, and orientation. These four areas combined result in sixteen different types and the scores on each dimension represent the strength of each dimension (Figure 1).

Eysenck's Pen Model

In 1950 (Eysenck, 1950), Eysenck proposed the PEN model (Figure 2) using three dimensions to describe different personalities. These dimensions are extraversion-introversion; Neuroticism versus Emotional Stability; and psychoticism versus impulse control. According to Eysenck, individuals with high levels of extraversion are more social, talkative, and outgoing, while individuals with high levels of introversion are more quiet, shy and less social. Individuals with high levels of neuroticism experience more stress and anxiety, while individuals with low levels of neuroticism experience more stable emotional levels. Individuals with high levels of psychoticism are more likely to show impulsive, irresponsible, and miscalculated behaviour while individuals with low levels of psychoticism tend to be more controlled and organized.

Figure 1. Myer-Briggs type indicator

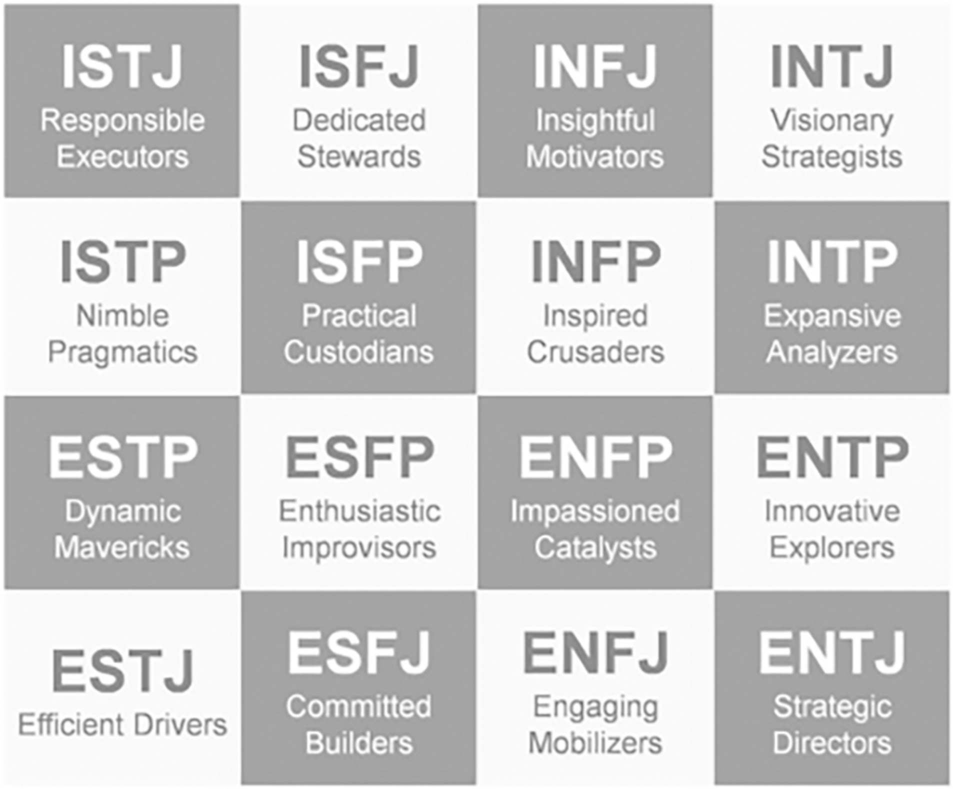
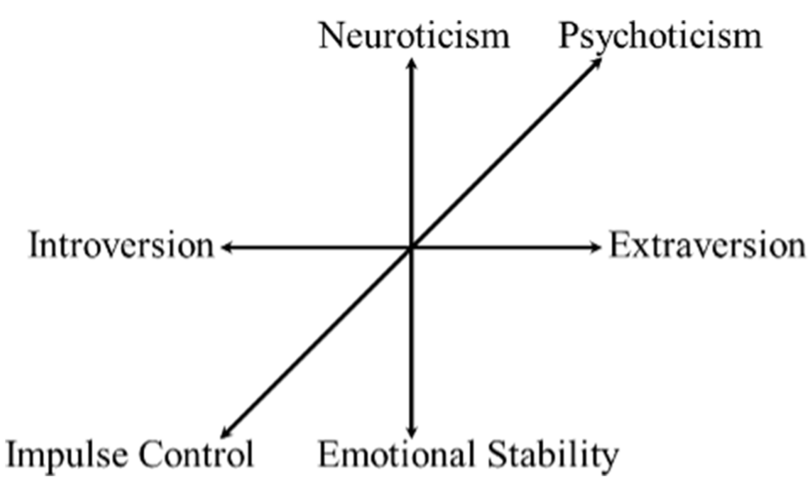


Figure 2. Eysenck's pen model



The Big Five Model

The Big Five Model (Figure 3), also known as the OCEAN model has been proposed and developed over the last century by different researchers such as Fisk, 1949 and Goldberg, 1990. This model considers the existence of five main traits of personality which are extraversion, agreeableness, openness, conscientiousness, and neuroticism.

Openness: Trait associated to characteristics such as imagination and insight. People who have high openness tend to have a broad range of different interests about the world and other people and are willing to learn new things and enjoy new experiences.

Conscientiousness: Trait associated to characteristics such as thoughtfulness, good impulse control, and goal-directed behaviour. People who have high conscientiousness tend to be organized and mindful of details.

Extraversion: Trait associated to characteristics such as excitability, sociability, talkativeness, assertiveness, and emotional expressiveness. People who have high extraversion tend to be outgoing and value social interactions.

Agreeableness: Trait associated to characteristics such as trust, altruism, kindness, affection, and other prosocial behaviours. People who have high agreeableness tend to value cooperation.

Neuroticism: Trait associated to characteristics such as sadness, moodiness, and emotional instability. People who have high neuroticism tend to experience mood swings, anxiety, irritability, and sadness.

Techniques for User Modelling

After identifying the data related to each user characteristics, it is then possible to define the algorithms that will process this data and in turn affect the computational environment. These algorithms are mainly defined using statistical and non-statistical techniques.

1. Statistical Techniques

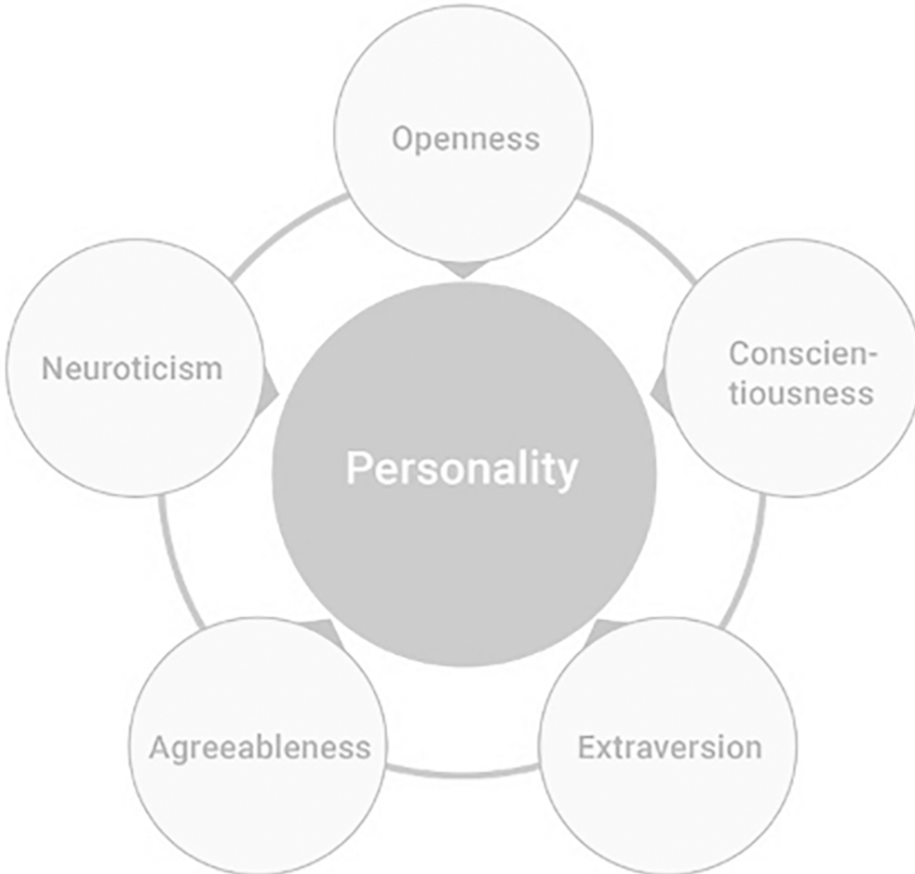
a. Linear Modelling.

Linear Modelling is a technique which takes the weighted sum of known values and predicts the value of an unknown quantity (Zukerman & Albrecht, 2001). These models are usually very inexpensive and easy to learn and understand. Furthermore, these models can be also extended and generalized without much effort. Two examples could be using a linear model to predict user's ratings of different activities suggested by the system or using linear model to assess the association between total cholesterol and body mass index.

Beta Distribution

The Beta Distribution is a predictive model which considers the number of correct predictions and the number of incorrect predictions and then generates both and estimate and a confidence level (Orwant, 1996). It is easy and cheap to calculate since it only requires two numbers (the number of hits and misses) to measure both estimate and confidence level. An example could be using a Beta Distribution model

Figure 3. Five traits of personality



to track users' preferences by the number of likes and dislikes they provide to system for any suggested activity.

b. Markov Model.

A Markov Model follows a structure very similar to a Linear Model and consists of a set of states, a set of probabilities which determine the likelihood of transition between these states and, for each state, a set of observation/probability pairs (Zukerman & Albrecht, 2001). For example, a Markov Model could be used to predict user most frequent actions while using the system by looking at his past performed actions.

c. Bayesian Networks

A Bayesian Network is a directed acyclic graph where nodes denote variables and the arcs connecting nodes represent causal links from parent nodes to child nodes (Zukerman & Albrecht, 2001). Each node is associated with a conditional probability distribution which assigns a probability to each possible value of this node for each combination of values of its parent nodes. These models are usually very flexible as they can provide a compact representation of any probability distribution, they can explicitly represent causal relations and they allow predictions regarding more than one variable (unlike many other statistical models which only considers a single variable). Examples of Bayesian Network models could be to predict the most adequate type of suggestions for a user according to the type of action being performed, or to predict error rates while the user is using the application.

d. *Rule Induction Model*

Rule Induction Model consists of learning sets of rules that predict the class of an observation from its attributes (Zukerman & Albrecht, 2001). These models can represent rules directly or represent rules as decision trees or in terms of conditional probabilities. A rule itself is not considered a model and therefore, this type of models always considers a set of rules which collectively define a prediction model, or the knowledge base.

2. Non-Statistical Techniques

a. Overlay Model

An overlay model assumes that the user's knowledge is a subset of the domain knowledge. An overlay user model can thus be thought of as a template that is "laid over" the domain knowledge base. Domain concepts can then be marked as "known" or "not known" (or with some other method, such as an evidential scheme), reflecting beliefs inferred about the user. Overlay modelling is a very attractive technique because it is easy to implement and can be very effective. An overlay model cannot account for users who organize their knowledge of the domain in a structure different from that used in the domain model, nor can it account for misconceptions users may hold about knowledge in the knowledge base (Kass et al., 1988).

The overlay model consists of (a subset of) the concepts from the underlying domain model. For each concept, the overlay model contains data that represents (an estimation of) the individual user's knowledge about or interest in this concept (or some other relationship with this concept) (Martins et al., 2008).

b. *Perturbation Model*

The perturbation model can represent user beliefs that the overlay model cannot handle. A perturbation user model assumes that the beliefs held by the user are similar to the knowledge the system has, although the user may hold beliefs that differ from the system's in some areas. These differences in the user model can be viewed as perturbations of the knowledge in the domain knowledge base. Thus, the perturbation user model is still built with respect to the domain model but allows for some deviation in the structure of that knowledge (Kass, 1988).

Perturbation model represents learners as the subset of expert's knowledge plus their mal-knowledge (Nguyen & Do, 2009).

This method considers that the knowledge and the student aptitudes are a perturbation of the specialist knowledge, and not a subset of his knowledge (as in the previous model) (Martins et al., 2008). This method can be used to represent knowledge that is beyond the Domain Model defined by the specialist.

3. Knowledge Modelling

Process of creating a computer interpretable model of knowledge or standard specifications about a kind of process and/or about a kind of facility or product. The resulting knowledge model can only be computer interpretable when it is expressed in some knowledge representation language or data structure that enables the knowledge to be interpreted by software and to be stored in a database or data exchange file.

a. Behaviour-Based Model

A very common approach to gather requirements for developing a system is to interview and observe the behaviours of users from the intended user population. System design requirements typically characterize the user as one entity with a single set of behaviours, namely expert, novice, or a composite of all the users (Bushey et al.,1999). The goal of this type of models is to develop a system that can accommodates the great diversity of the user population and improve the users' performance. For this, system users can be categorized into different groups, and then it should be described and modelled each group's behaviours, and finally, this information should be included in both design and operational processes. Users can be categorized based upon similar behavioural characteristics that are important to system interface design and use. User modelling should then describe how users within a specific user group behave in certain situations or perform certain functions.

b. Rule-Based Model

Rule-Based Models can be automatically defined using learning algorithms to identify useful rules (also known as Rule-based Machine Learning Modelling) or can depend on expert-crafted knowledge bases to make inferences about users (traditional Rule-Based Modelling). Examples of this type of models could be using a Rule-Based Model to model user's current abilities, or to predict actions and errors performed by the user. Other examples include using a Rule-Based Model to identify irregular monitoring values captured by the application regarding current user health condition and alert the healthcare professional.

c. Stereotypes

One of the easiest and most common techniques for building models of other people is the evocation of stereotypes. Stereotypes were first introduced in the literature related to User modelling by Elaine Rich in 1979 (Rich, 1979), and it was brought with the necessity to define a "useful mechanism for building models of individual users on the basis of a small amount of information about them". According to the author, to correctly define and use stereotypes it is necessary to collect and use two kinds of information. The first required information is related to the stereotypes themselves which includes the information of different collections of clusters of characteristics or facets. These facets depend on the domain and purpose of the system but may also include information related to the level of expertise while using the system or specific concepts and tasks dealt with by the system. These different facets will result and describe different groups of users. The second kind of information is related to the use of triggers which correspond to the occurrence of different events and that in turn will activate appropriate stereotypes. For example, if a user performs an advanced task while using the system, an "expert user" trigger could be activated.

4. Ontologies

Nowadays, there is a great necessity to develop systems which can reuse and share knowledge and information for all sort of areas and applications including healthcare. To support such kind of systems, new tools are being developed, also known as Ontologies. One of the most common definitions comes from Gruber which refer to ontologies as “an explicit specification of a conceptualization” (Gruber, 1993). Although it seems a very simple definition, it is widely accepted in the Artificial Intelligence domain. To sum up, an ontology describes a data model, represents concepts and relationships existing in a certain domain. These relationships should allow inferring about all different instances related to the domain. The information represented by an ontology should include individuals (or instances), classes (concepts or types of instances), attributes (concepts’ properties which can be mandatory or nor) and relationships (how concepts are related with each other). Some of the most used languages to define and instantiate ontologies are the RDF and RDFS (Brickley, 2004) and OWL (McGuinness & Van Harmelen, 2004)

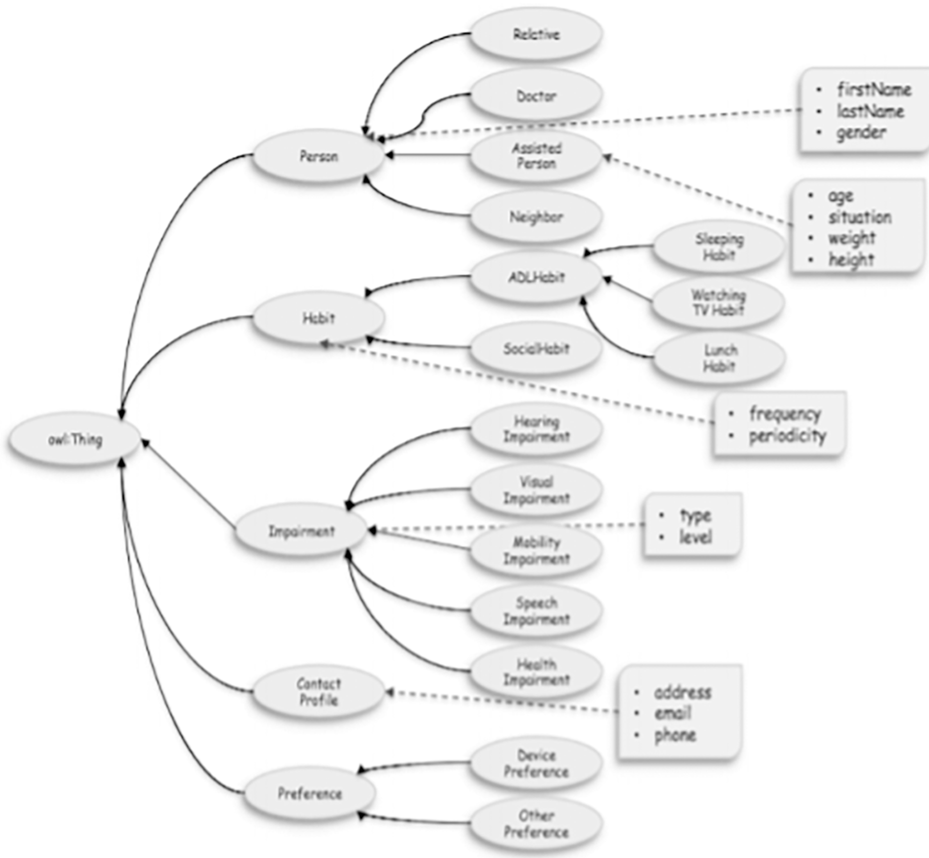
a. User Ontologies.

A user ontology classifies all the relevant characteristics and associated partitions of users into classes with corresponding associated information. In other words, a user ontology includes all the characteristics that can describe the user as a person (Andrejko, 2007). Using sharable data structures containing user’s features and preferences will enable personalized interactions with different devices for the benefit of the users (Gouardères, 2005). A user ontology can be defined using OWL description language which contains the following elements: C .– a set of concepts (entities and instances in user ontology); R .– the relationship between classes or instances in the user ontology. I .– a set of instances and A .– a set of rules and restrictions (Jiang, 2009). Several works have been proposed in the literature regarding the definition and use of user ontologies. For example, in (Zografistou, 2012) it is proposed a Person Profile Ontology model which is responsible for modelling the profile of the user using five main classes: Person (can be either the assisted person, doctor, relative, etc,), Habit (daily activities performed by the assisted person), Impairment (visual, mobility, speech and other impairments associated to the assisted person), Contact Profile (email, phone number and other mechanisms to contact the assisted person) and Preference (preferences of the assisted person such as device preferences).

In (Ni et al., 2016), it is proposed a user ontology to model information of users using smart home applications. They divided the user ontology in two main components, one component related to static information of the user (such as name and age) and the role of the user (whether the user is a resident or a visitor) and another component related to the profile data of the user (such as heart rate recorded) and preferences (preferred activities).

In (Paganelli & Giuli, 2007), it is proposed an ontology-based context modelling approach for a home care assistance scenario where it is defined a Patient Personal Domain Ontology where it is identified different relevant context items related to patient physical data (such as biomedical acquired values), location and activity. These data is then used to automatically infer patient current health status and detect and alert problematic or dangerous situations and events.

Figure 4. Person profile ontology, adapted from (Zografistou, 2012)

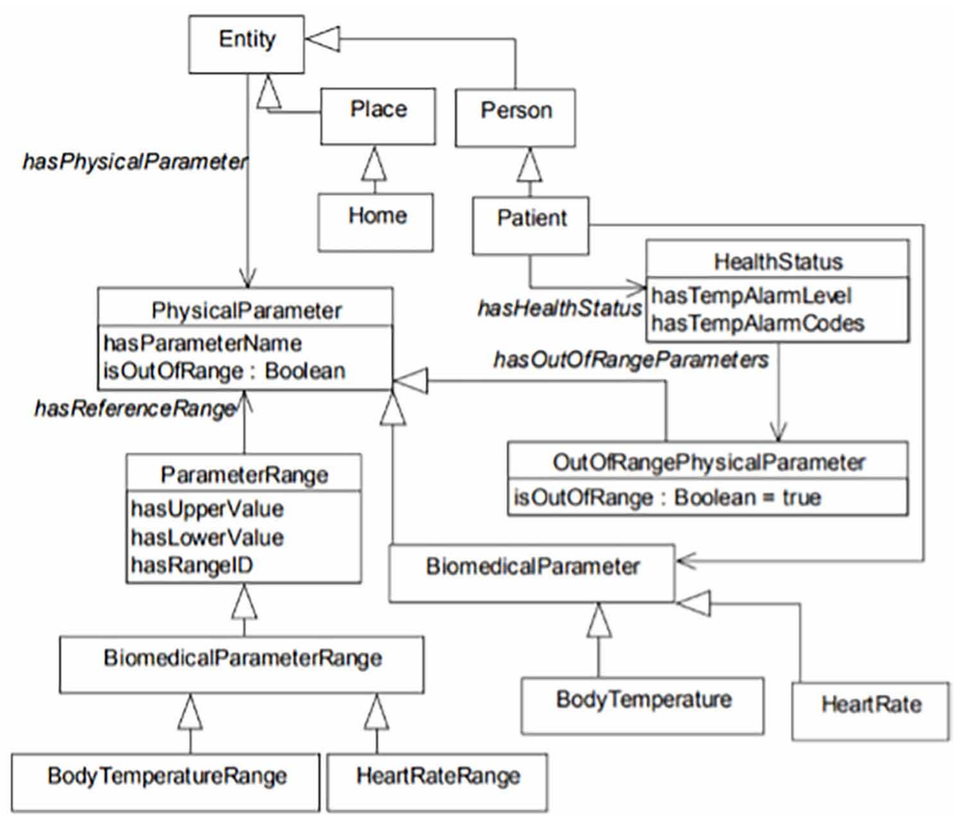


b. Domain Ontologies

Domain specific ontologies allow the user to model domain specific concepts and relations. This type of ontology usually focusses on one specific modelling target or area of application, such as healthcare or assisted living. Domain ontologies allow the reuse of complex models that usually require extensive expertise input. Furthermore, domain ontologies can be easily combined since they use same semantic model. In (Paganelli & Giuli, 2007), authors also propose the use of Home Domain Ontology which contains relevant context data related to the monitoring of environmental parameters (such as temperature and relative humidity) and then also detect dangerous environmental situations (for example, detect a gas leak or even a fire inside the home environment).

In (Zografistou, 2012), it was also proposed a Health Domain Ontology which describes all the basic concepts required to model and support the daily treatment of a disease. The authors proposed a schema for which the knowledge base keeps the information provided to identify problematic situations and detect diseases which the inhabitants may suffer. This domain ontology considers four main classes which are: Disease (it is modelled each disease the inhabitant may have and the level of gravity), Symptom (symptoms that may occur to the patient and that are relevant to identify a disease), Treatment (describes

Figure 5. Patient personal domain ontology, adapted from (Paganelli & Giuli, 2007)



the type of treatment required to deal with the disease including medication, actions and measurements), and Restriction (restrictions associated to the disease which affects activities, environmental conditions, medication and nutrition).

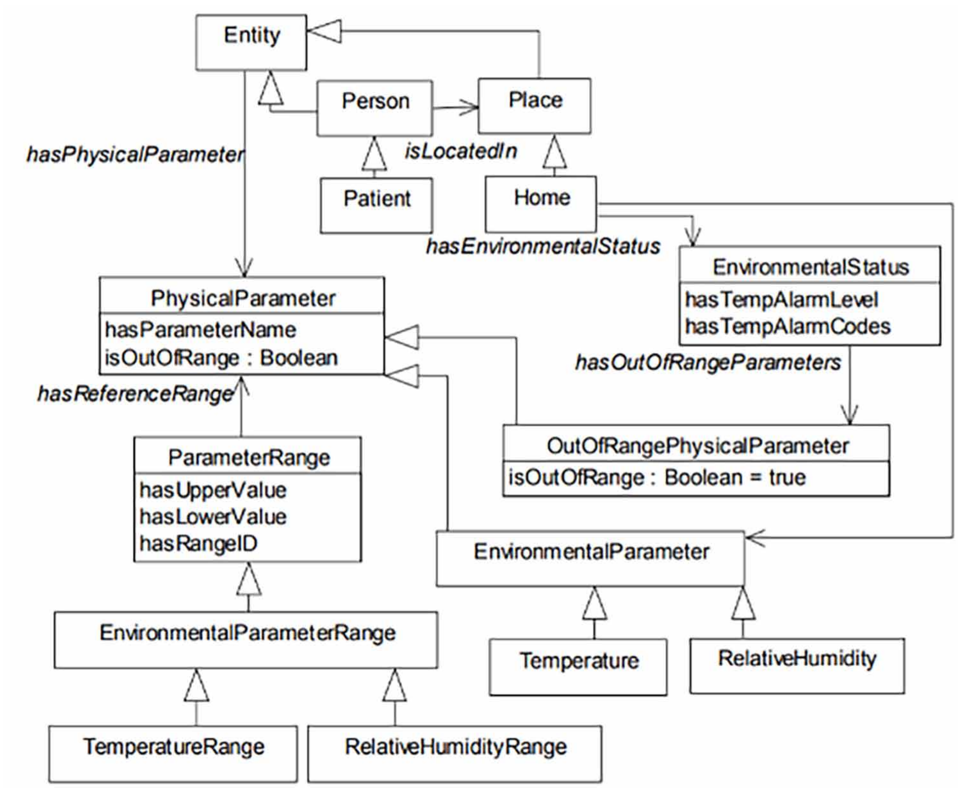
Recommendation Systems

There are numerous options of methods to be employed in recommender systems, however, they still suffer from critical limitations and drawbacks. The methods implemented in recommender systems can be divided into two main classes: collaborative filtering and content-based methods (Lucas et al., 2013). In collaborative filtering methods the recommendation process is based on products' opinions collected from other users. Content-based methods compare text documents to user profiles, where web objects are recommended to a user based on those he has been interested in the past (Lucas et al., 2013).

"Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers." (IBM Cloud Education, 2021) The typical defining essence of deep learning is that it learns deep representations, that is, it learns multiple levels of representations and abstractions from data (Zhang et al., 2019).

Recently, deep learning has been applied to recommendation architectures to bring more improvements in the performance of recommender systems based in more traditional approaches (Zhang et al.,

Figure 6. Home domain ontology, adapted from (Paganelli & Giuli, 2007)



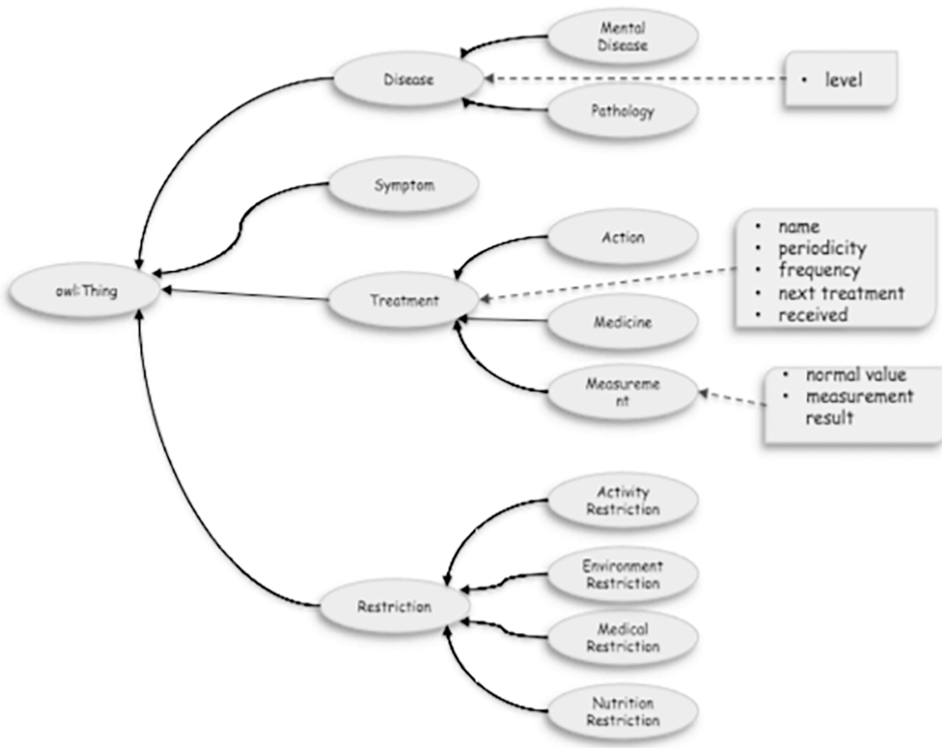
2019). Recent advances in deep learning-based recommender systems have gained significant attention by overcoming obstacles of conventional models and achieving high recommendation quality (Zhang et al., 2019). Deep learning can effectively capture the non-linear and non-trivial user-item relationships and enable the codification of more complex abstractions as data representations in the higher layers. Furthermore, it catches the intricate relationships within the data itself, from abundant accessible data sources such as contextual, textual and visual information (Zhang et al., 2019). Between the most frequent deep learning architectures applied to recommender systems we find Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), and variants of RNN, like Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU).

Natural Language Processing and Machine Learning

Natural language processing (NLP) is generally used in healthcare systems that require data from multiple sources, not always digital. The use of NLP allows capturing information that is unclear or otherwise unstructured. From this transformation, information becomes more accessible and capable of being used in a more versatile way. An example of an application is automatic report writing, in which the doctor dictates the content of the document.

NLP allows computers to analyse, understand, and derive meaning from text and speech similarly to how humans do. NLP is part of the larger artificial intelligence (AI) landscape, drawing from fields

Figure 7. Health domain ontology, adapted from (Zografistou, 2012)



including computational linguistics and machine learning in its algorithms to convert unstructured data into actionable information. (Rebhan, 2019) The unstructured sequence of tokens (word or characters) is transformed in numeric data that is then filled in diverse types of algorithms able to perform a variety of distinct types of tasks. These tasks include text summarization, sentiment analysis, information retrieval from text or speech, part-of-speech tagging, text classification, language translation, named entity recognition, among other tasks.

The application of NLP has an enormous potential in psychiatry because language-based deficits are common symptoms of depression, behavioural disorder, ASD, personality disorder, and schizophrenia (Cohen et al., 2014).

NLP has various applications in health care. These techniques can be used to assist health care professionals in tasks such as assisting with clinical documentation, obtaining diagnosis of the mental health illness, and supporting clinical decision-making. Another area where NLP can used is supporting mental health treatment. Although the evolution of NLP techniques is recent and its adoption in the mental health field is just beginning, there are studies and applications that show its potential.

In the area of diagnosis, NLP can be used for early detection of cognitive decline and mental disorders, or to detect risk situations.

Emotions and mental health influence the method of communication and the choice of words. Mental health professionals can evaluate free speech to help identify and predict psychiatric illness in patients. The NLP techniques can be explored to develop automated speech analysis systems to predict mental problems.

Several studies have demonstrated the NLP techniques con be fruitful to detect specific emotions, to detect distress/suicide ideation, to measure stigma, to measure mood valence, or to detect depression (Calvo et al., 2017).

In one proof-of-concept study (Bedi et al., 2015), researchers tested how NLP and machine learning could help predict psychosis onset in a group of teenagers and young adults. Each of the study participants had a baseline interview and was assessed quarterly for up to two and a half years. Using transcripts of the baseline interviews, researchers fed speech features into an algorithm and found that features such as semantic coherence and speech complexity had a significant correlation with eventual psychosis development - predicting psychosis onset with 100% accuracy.

Seniors can also benefit from this type of NLP functionality. The increasing senior patient population puts additional stress on health care providers to incorporate recent technologies for early identification of various geriatric health risks. One area where NLP can assist is with identifying speech alterations that signify cognitive decline (Beltrami et al., 2018) (e.g., Alzheimer's disease), as impaired speech is often an early symptom of preclinical stages of dementia.

NLP and machine learning algorithms can also evaluate free text (e.g., electronic health record notes, patient portal messages) to help predict patients who may be at risk of self-harm or psychological distress, enabling care teams or other caretakers to intervene faster. For example, health providers can evaluate patients' mental health based on what they post on social media sites or to online blogs/message boards. Given the widespread adoption of social media and mobile devices, health care providers have a wealth of new data to work with. Feeding patient-generated text into NLP and machine learning algorithms, caregivers can create predictive models that signal when a patient is experiencing deep depression, undergoing an anxiety attack, or having suicidal thoughts (Coppersmith et al., 2018).

Within health care, providers can leverage NLP to predict people's mental states to proactively reach out to patients through phone or text, or they can create "online pathways" (Calvo et al., 2017) that direct patients to digital peer groups, counselling, psychotherapy, or mental health educational websites.

Mental health conditions can often be treated with counselling and psychotherapy, and in recent years there has been rapid growth in the availability of these treatments thanks to technology-mediated counselling. Technology can be used to improve the conduction of counselling sessions by analysing many conversations and finding the most efficient strategies. The Stanford Natural Language Processing Group conducted a study (Althoff et al., 2016) through a large-scale study of crisis counselling conversations. Applying techniques such as sequence-based conversation models, language model comparisons, message clustering, and psycholinguistics-inspired word frequency analyses, the authors were able to discover actionable conversation strategies that are associated with better conversation outcomes.

NLP based systems can help health providers go through data resources in text format to be able to offer more personalized and preventive care (Xtelligent Healthcare Media, 2021). Delivering care that is personalized to the user is major goal of AI-powered chatbots. Alison Darcy, a clinical psychologist at Stanford University, created Woebot based on cognitive-behavioural therapy, which encourages people to examine how they react to challenging situations (Fitzpatrick et al., 2017). This chatbot is based on cognitive behavioural therapy principles. It has an empathy component that is tailored to the messages that the individual sends and is designed to target cravings and urges and to help the individual build self-awareness in terms of their patterns of thinking, mood-related thinking, anxiety, depression, as well as the urge and craving to use. However, the bot is not a replacement for an in-person therapist. Instead, the tool is part of a widening array of approaches to mental health, and it is fundamentally different from any other form of therapy. These kinds of systems will not take place of a counsellor, neither will directly interact with a person who might be in crisis. Instead, they are designed to work in partnership with counsellors. Another advantage of these kind of systems is its ability to detected risk situations and raise alerts sent to a mental health professional accompanying the patient.

Another advantage of AI-driven tools, such chatbots is the increased access (Xtelligent Healthcare Media, 2021). Chatbots can interact with an individual in real time. They are available 24/7, at no cost, and they reduce stigma in terms of accessing treatment. Whether these tools are used as stand-alone treatment agents or as an adjunct to more traditional counselling, chatbots provide added therapeutic content. (Xtelligent Healthcare Media, 2021).

Case Studies

ICT and AI have gained a prominent role in the management and delivery of health care and social assistance. There is a growth in AI applied to health with high mobility, connectivity, and processing capacity. But some of the features developed do not allow its users to better manage their quality of life, for example, issuing alerts with recommendations adapted to the user's profile or providing problem-solving strategies to deal with lifestyle or disease risk factors or other specific everyday situations.

ICT and AI application in eHealth, namely in mental care seem to contribute to help their users to engage in health promoting behaviours outside the clinical context (Harrison et al., 2011)(Luxton et al., 2011) or in other activities such as therapeutic homework, facilitating generalization to the day-to-day life of its users (Ben-Zeev et al., 2015).

The use of mobile devices seems to be the logical path for self-management. More than self-management, mobile devices may help alerting patients, therapists, and caregivers in more faster way than traditional methods. They also allow to interact in different manners with patients and therapists.

Research Group on Intelligent Engineering and Computing for Advanced Innovation and Development (GECAD) has contributed to the implementation of innovative solutions in the field of AI and PA, Recommendation Systems, Medical Informatics and Mental Care on the scope of previous projects. Some of these projects that we consider relevant are presented below.

SmartHealth

The scientific vision of this project focus on augmenting the knowledge, information, and interaction at the disposal of agents, robots, and humans to improve their performance in the healthcare ecosystem. Namely is to blend Artificial Intelligence (AI) with Personal Assistant (PA) to build a recommendation system that, using specific algorithms and knowledge database, may help people with mental disorders, namely anxiety disorders by reducing the response time to episodes or even prevent those same episodes from happening.

A number of practice guidelines fairly consistent have been published on the treatment of anxiety disorders in the last years (American Psychiatry Association, 2017)(Katzman et al., 2014)(Baldwin et al., 2014)(Bandelow et al., 2012)(Borwin et al., 2012). They confirm that anxiety disorders can be treated mostly on an outpatient basis and are responsive to intervention, and that effective treatments include pharmacological approaches, psychological approaches and combinations of these treatments.

Smarthealth project allows and helps therapists and patients to interact with the purpose of minimizing response times to people anxiety episodes, it also allows patients to self-management and gives feedback to the therapist.

The Smarthealth mobile app, integrate AI algorithms, used by the PA and a recommendation component.

The Mobile App and web platform enable the user to Manage anxiety episodes beyond the medical context. Receive recommendations in order to adjust lifestyle habits, reduce anxiety disorders risk factors, promote independent living, and so on, supporting the person in their efforts to change and define a set of goals or tasks to accomplish.

The functionality of Anxiety Problem Solving describes a cognitive-behavioural therapy (CBT) tool. This tool can be considered a way of interaction and a place where the user can describe and manage a stressful situation in a safe space while working to find a possible solution for the problem.

CBT is a talking therapy that attempts cognitive and behavioural change based on an individualized formulation of a user's personal history, problems, and goals. In general, the evidence-based of CBT is very strong when applied to anxiety disorders. CBT models emphasize the importance of cognitive appraisals (reasoning biases) and emotional dysfunction on the appearance and maintenance of symptoms. Thus, it is necessary to work on reducing distress and stressful environments and managing negative schemas and reasoning biases.

Chill Out Tools feature offers the user not only stress management skills but also a relaxing environment with access to media files to view or listen. Mindfulness, the process by which one attends to present-moment sensations, thoughts, emotions, and experiences in a non-judgmental manner, has been reported to exert beneficial effects on health and well-being, both in non-clinical and clinical samples. Mindfulness has consistently been associated with lower rates of anxiety.

The mobile app has been designed to generate a low cognitive load and it have a simple and intuitive interface: the use of pictures rather than text; reduced sentence lengths; inclusive, non-clinical language.

FoodFriend

The quality and quantity of the food we eat affects our health and mental disorders. Population frequently suffers from diet-related diseases and their management and treatment brings additional concerns over the sustainability of healthcare systems. One evident factor that contributes to this issue is disease-related malnutrition. In fact, malnutrition has serious negative consequences for the health and mental illness of the patient and leads to a slower recovery, more serious complications, and increased mortality. As a result, we observe longer hospital admissions, weak response to medical treatment and increased use of medication, which demands for an increase in healthcare costs.

Malnutrition and poor diets can be observed in several different contexts. For example, in cases where the patient cannot eat any food because of a mental illness, has a decrease in appetite, difficulties in swallowing, or some type of surgery that interferes with eating.

Overall, it becomes clear that the patient him/herself should have an active role in the disease management process and this will contribute positively to improve a healthier ageing, allow the definition of more personalized and efficient ways to support the patient and as a result improve health and mental outcomes in an improved cost-effective manner (Wu et al., 2017).

In this context, the Food Friend project was established and is focus on the development of secure, innovative, and user-friendly technology for food intake related data acquisition, storage, analysis, and visualisation and for providing feedback and recommendations under the different malnutrition contexts that were presented.

Personal Health Empowerment

One of the most impactful global challenges we are currently witnessing is an increase of the world's population which is growing older. With the prevalence of chronic and mental diseases within this age group we observe an increase in the healthcare costs. Patients require regular medical consultations and constant monitoring of their health and mental health throughout their daily lives. Healthcare, namely mental care has traditionally been provided through either face-to-face intervention between the patient and the healthcare professional, separated by periods without structured support or using self-monitoring tools (such as flow meters, handheld spirometers, oximeters) and self-management tools (such as symptom diaries, manuals, pamphlets, and web resources) between consultations. The reality, however, is that the constant monitoring of patients' condition has become a burden on the healthcare providers (Gibson, 2013) and traditional healthcare delivered through health professionals' face-to-face interactions becomes more difficult to achieve. As such, the necessity to develop cost-effective solutions to monitor and treat patients with has increased significantly in recent years (Gobbi, 2015).

Healthcare providers have noticed the importance of the person or patient him/herself in the management of his/her health and mental condition, and the importance to include him/her into the process in an active role. As a result, new healthcare paradigms have emerged with the development of preventive solutions to help the person adopt a healthier lifestyle by providing him/her with tools to actively participate in the treatment of his/her diseases, and this way, decreasing the burden on healthcare personnel and costs. In this scope, concepts such as mobile health (mHealth) has emerged towards the self-management of the patient's disease, by developing mobile systems that are capable of monitoring patients' health and mental status and giving customized feedback about activities and behaviours that can be done to improve health and mental wellbeing (Steinhubl et al., 2013)(Luxton et al., 2011).

Personal Health Empowerment (PHE) project here presented, was established with the main goal to empower people to monitor and improve their health using personal data and technology assisted coaching. To achieve this goal, PHE has applied innovative and intelligent measuring and monitoring tools for preventive healthcare and allow cost-saving and self and home-care solutions with increased patient involvement.

The project innovations revealed a significant impact on healthcare and mental sanity to the patient, providing both evidence and means to realise people-centric and preventive healthcare, and allowed for cost-saving self- and home-care solutions with increased patient involvement.

CHALLENGES AND CONCLUSIONS IN THE APPLICATION OF AI TO MENTAL CARE

AI systems could help to offer more personalized and preventive mental care and approach mental illnesses in a more targeted way. The capacity of analyse of genetic data can unlock the key to understanding mental health. Neuroimaging can help to understand how the brain works.

The data quality can be particularly challenging when it comes to mental healthcare. The data used to train AI models is a crucial aspect of their clinical utility – and data quality can be particularly challenging when it comes to mental healthcare. The intelligent system will be only as good as the data it's trained on and the people that are using it. The data used to train these models must be diversified because if we only take one region, one clinic, or one population, these algorithms are going to have very limited utility. These tools must be built from the ground up with a very diverse approach – we must work with the patients, as well as consider input from clinicians, data scientists, and regulators.

The role of data and information has always been crucial for decision making and the provision of Mental healthcare. With the increased digitization in healthcare, an immense amount of data is also generated from other segments of the healthcare industry than hospitals and healthcare providers, for example, medical insurance, medical equipment, life sciences and medical research. There are several different channels to collect this data. A new source is social networks. For instance, Twitter feeds can be used to try and predict the onset of depression. Currently, access to large volumes of data allows to support the development of a wide variety of medical and health care services. The emergence of advanced analytics, machine learning and AI techniques alongside, provides various possibilities for transforming this data into meaningful and actionable insights to support decision making, provide high-quality patient care, respond to real-time situations, and save more lives on the clinical front. With the use of analytical techniques, healthcare stakeholders can harness the power of data not only for analysis of historical data (descriptive analytics) but also for predicting future outcomes (predictive analytics) and for determining the best action for the current situation (prescriptive analytics). From the dissemination of communication and information technologies in mental health, AI and machine learning, in particular, appear on the basis of the development of applications for solving problems of prediction, monitoring and treatment for mental health care.

The role of AI in mental healthcare that has the most potential to make an impact now, is supporting human therapists and the use of Personal Assistant to help them. In the application area of PA, numerous researches and developed systems already seem to promise good results, but yet some experimentation and implementation are still necessary to conclude about the utility of the PA in Mental healthcare context.

The analysis, application, implementation, integration, and evaluation of Artificial Intelligence techniques to be used in the contextual PA will allow management and monitoring by health beyond the medical context, as well as the assertive adjustment of some lifestyle strategies, and reduce anxieties risk factors. It will contribute to improve lifestyle habits of the user by suggesting changes in user behaviours (individual and collective) and support the prevention of mental disorders.

Healthcare apps can be used to deliver medication alerts, patient education material and human-like interactions to gauge a patient's current mental state. The application of AI in the form of a contextual personal assistant can have an incredible impact on monitoring and assisting patients with some of their needs when clinical personnel are not available. Making the services available 24/7, in real time at no cost, and they can reduce stigma in terms of accessing treatment.

Intelligent Mental health apps can target a broad range of functions: self-management, cognition improvement, skills-training, social support, symptom tracking, and passive data collection. Also, intelligent mental health apps span all stages of clinical care provision, including immediate crisis intervention, prevention, diagnosis, primary treatment, a supplement to in-person therapy, and post-treatment condition management. Intelligent mobile apps are a good choice for psychological treatment delivery compared to other platforms due to ease of habit, low effort expectancy, and high motivation, especially in young people (Marshall et al., 2013).

Accompanying patients with mental diseases in the exam room is not enough. "Care providers who treat patients with chronic diseases recognize the importance of maintaining contact with their patients outside of the exam room." (Chouffani et al., 2018) With today's AI capabilities and mobile apps, patients can receive feedback on several data elements captured on their phone or wearable devices. Whether it relates to medication adherence or is simply a motivational voice that encourages fitness activities and healthy habits, AI as a personal life coach creates a customised experience for each individual patient and offers proactive alerts that can be sent back to physicians.

Several practice guidelines have been published on the treatment of anxiety disorders. They confirm that anxiety disorders can be treated mostly on an outpatient basis and are responsive to intervention and that effective treatments include pharmacological approaches, psychological approaches (particularly cognitive and behavioural treatments), and combinations of these treatments. Indications for hospitalization include suicidality, unresponsiveness to standard treatments, or relevant comorbidities, such as major depression, personality disorders, or substance abuse.

A new approach to solve this issue will combine the best evidence in the integrated treatment of these specific mental health problems, with strategies for empowerment and promotion of self-care.

Also, AI technology holds great promise to transform mental healthcare and can identify mental health problems at an earlier stage when interventions may be more effective, and personalize treatments based on an individual's unique characteristics. Thus, there is a scope of opportunities to use intelligent mobile apps to deliver interventions as a supplement to in-person therapy or/ and as a mechanism to treat sub-clinical anxiety conditions that may lie below the threshold for anxiety disorder treatment.

Information technology and PA can promote illness self-management, which has been shown to be effective (Bricker, 2014), and applied for example to e.g., smoking cessation (Ly, 2014) and stress management (Keyworth, 2018).

In addition to the benefits provided, there are a number of significant barriers to using the technology in mental healthcare.

The big challenge for mobile health applications is making that the user come back and interact with it on a regular basis. In other words, with smartphone apps and chatbots, patient engagement is a key factor in determining the success of the technology. With smartphone apps and chatbots, patient engagement is a key factor in determining the success of the mental care treatment. Typically, the more the individual uses the mental health application, the greater the benefit he'll get from it. Anything that can be done to boost engagement should help with outcomes in terms of accuracy and effectiveness.

To prevent risk situations, it is important that these tools were equipped with appropriate protections for high-risk patients. These systems must have safety features built into it, like language detection and rules for risk management. In case of a risk situation is detected, the system must generate an alert directed to the health professional (Xtelligent Healthcare Media, 2021).

NLP can for example enhance speech analysis to predict psychotic disorders in young people from high-risk populations. NLP can allow the study of the individual's psychological degeneration and the presence of symptoms in the patient's speech. Lack of thought organization is a typical symptom of schizophrenia and is usually diagnosed based on behavioural analysis and clinical observation. The NLP used as a basis for the semantic and coherence analysis in an interview using, for example, specific scripts to verify several parameters, can allow the application of a syntactic analysis model to analyse the coherence and phrasal construction of the discourse.

The definition of models that allow analysing the coherence and phrasing of speech, that is, if semantically similar words co-occur in texts with consistent topics more often than unrelated words, then the semantic similarity of two words can be quantitatively indexed to frequency of its co-occurrence in a sufficiently large set of texts. The use of these techniques can show a relationship between the structure of the discourse and the probability of developing a schizophrenic condition.

Robots that are marketed for example by Paro (http://www.parorobots.com/) try to simulate a pet so that elderly patients maintain some cognitive and social skills. Robots are equipped with various sensors of different nature to be able to produce feedback on the patient's behaviour. Using machine learning techniques with enhanced learning, robots can recognize positive behaviours such as petting. On the other hand, they are also able to change their personality to avoid negative actions suffered by the patient.

So far and to our knowledge there are no official standards to guide the use of AI and other emerging technologies in mental healthcare. Clearly, there is a need to integrate ethics into the development of AI. In this context, Privacy and Data security issues are a key role in the success of any AI project in Mental Care. It will be necessary to establish and develop ethical and privacy management plan for the user and application requirements analysis and the user studies involvement. The plan can ensure the safeguard of ethical and privacy rights of all involved end-users. The new European Union Regulation RGPD 2016/679 must be respected in relation to the user's saved data.

In Mental Care, there will always be a need for human-to-human connection and interaction. AI's role in this space shouldn't be to replace humans, it should be to support them.

Mental health is a huge challenge in our society, and the COVID 19 pandemic is only increasing the scope of that challenge. AI has the potential to alter dramatically mental healthcare, ultimately making mental care more accessible, responsive and reasonably priced.

The use of mobile devices seems to be the logical path for self-management. More than self-management, intelligent mobile devices may help alerting patients, therapists and caregivers in more faster way than traditional methods. They also allow to interact in different manners with patients and therapists.

The goal is to blend AI with PA in order to build recommendation that, using specific AI algorithms and knowledge database, may help people with mental disorders by reducing the response time to episodes or even prevent those same episodes from happening. The challenge will be to allows and helps therapists and patients to interact with the purpose of minimizing response times to people with mental disorders and Improve Independent Living.

However, it will be necessary to validate and see the impact of using artificial intelligence on mental health recommendation systems.

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Chapter 11
AI Chatbots in Mental Health:
Are We There Yet?

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ABSTRACT

People with mental health problems often struggle in getting the suitable treatment regarding not only the type of interventions available but also the conditions required for a proper treatment, mainly cost, locality, and frequency. The use of AI chatbots for this population is a new trend and can reduce the gap between the need for mental health care making them accessible in a cost-effective way. Although chatbots are not a substitute for formal treatments, they are sometimes used in tandem with other treatments with positive results. This chapter provides a review on the subject, presenting several chatbots for mental health problems and also addressing some concerns such as privacy, data security, AI limitations, and ethical implications. Future research directions are also discussed.

INTRODUCTION

In 2017, the tech giant IBM stated that Artificial Intelligence (AI) will transform the delivery of mental health care over the next five years by helping clinicians better predict, monitor and track conditions, and that "what we say and write will be used as indicators of our mental health and physical wellbeing" (IBM, 2017). In 2021, we are already seeing some of those promised transformations and positive impacts.

Chatbots, as part of AI devices, are natural language processing systems acting as a virtual conversational agent, mimicking human interactions. While this technology is still in its developmental phase, health chatbots could potentially increase access to healthcare, improve doctor–patient and services–patient communication, or help to manage the increasing demand for health services such as remote testing, medication adherence monitoring or teleconsultations. The chatbot technology allows for activities as specific as health surveys, setting up personal health-related reminders, communication with clinical

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teams, booking appointments, retrieving and analysing health data or the translation of diagnostic patterns considering behavioural indicators like physical activity, sleep or nutrition. Such technology could potentially alter the delivery of healthcare systems, increasing uptake, equity and cost-effectiveness of health services while narrowing the health and well-being gap, but these assumptions require further research.

The development of Cognitive Behavioural Therapy (CBT) chatbots, which mimic normal conversational style to deliver CBT interventions (Kirkpatrick et al., 2017; Inkster et al., 2018) are being developed, however the outcomes are still unclear given the initial stage of research. These advanced chatbots rely on AI techniques to implement the conversational style that mimics a normal conversation as if it were a human being on the other side interacting with the user.

The use of AI chatbots may also increase accessibility by overcoming some barriers associated with stigma in the demand for services. Due to stigma, individuals with psychopathology tend to have reduced social support, being mostly supported by family members. However, users are more prone to perceive chatbots as non-judgmental (Lovejoy et al., 2019). AI chatbots are increasingly being seen by psychiatrists, psychologists, therapists, politicians and tech companies as having a significant role in future mental health treatment and care, with developments in the field being driven by their particular agendas and goals. Nonetheless, it appears that key stakeholders are currently excluded from the discussions about AI in mental health – service users, carers, and families. If rights-based guidelines for ethical AI (AI HLEG, 2019) are to be implemented in mental health, then the implications of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) needs to be considered. The UNCRPD have said that it is essential to involve disabled people (including those with psychosocial disabilities (Szmukler, Daw, & Callard, 2014) and their representative organisations in developments and decision-making that will affect their lives. It is therefore time to assess the situation, to question those who are driving this transformative agenda forward and to listen to excluded experts – those whose lives will be ultimately impacted by these technologies (Carr, 2020).

On the other hand, the current limitations of AI and chatbot technology and lack of knowledge about the real capabilities of the available tools may lead to an inappropriate usage of these technologies as a serious approach to solve mental health issues. Most of the tools and applications available focus on specific subjects or problems e.g. applications to cope with stress, anxiety, addictions are publicly available in the market, but consolidated applications that aim for mental health on its broader spectrum do not exist. This problem is directly related to the maturity level of conversational AI and chatbots, a metric that is described by different authors using different methods and perspectives. Bosek (2018) describes it as a 4-level pyramid based on the features the system delivers, Gadiyar (2020) describes it as a 3-level schema based on the automation and communication skills of the system, Garga (2020) uses a multi-layered ellipse to describe the technology in three major vectors: interaction, intelligence and integration. These three analyses help to demystify a broader romanticized understanding of AI and chatbots that only exist in science fiction and that were popularized by Hollywood movies like “Her” (2013) and “I, Robot” (2004), describing the real limitations and scope of conversational AI.

Data privacy is also a main concern when it comes to healthcare applications. Most of these tools collect, process and store data, in most cases sensitive data such as mental health status that raises all kinds of ethical, legal and moral questions. What software companies do with this data should be a subject of analysis. Even if the main goal is to provide a service with the aim of helping the user, more and more frequently the collected data is used for different purposes, sometimes with little or no knowledge and lack of explicit consent of the user. Moreover, news of data leaks that expose sensitive data of the same users that put trust in an application to collect and store their own personal data, are becoming increasingly common. From 2005 to 2019, roughly 250 million individuals were affected by healthcare data breaches, being 157 million in the last five years alone (Seh et al., 2020). This is clearly an issue and a risk when using chatbots designed to help users to overcome or cope with mental disorders - what happens to user data right after being collected by the chatbot should be a major subject of concern. What are the major threats and opportunities, what is the right balance between the data that is asked from the user and the benefit produced by these companies and organizations, how can this process of asking, storing and treating personal and health data can be as transparent as possible for all stakeholders, and what mechanisms exist to protect data, these are all questions worth to explore.

Although there are plenty of studies that describe the benefits of using technology in mental health, there is an aspect that can be a potential issue while using chatbots and technology in general: the well-studied effects of addiction and social isolation (Pontes, 2017), which can be especially dangerous in this population - some of these individuals go potentially undiagnosed, others embraced self-diagnose and self-treatment (Bauer et al., 2017). There is apparently contradictory evidence that points in different directions when it comes to usage of technological devices and applications by users with some form of mental illness.

Throughout this chapter, the authors intend to address all these themes with depth and reflection beginning with a comprehensive and comparative presentation of the state of art of AI chatbots relevant for mental health, including a critical analysis of weak and strong points of each application. Next, the authors provide an analysis of how these applications and tools can profit from the inclusion of key stakeholders and potential users right from the design phase and overcome some of the most common obstacles and flaws faced by the most used chatbots. Then, the authors explore the technical boundaries and the current technical limitations of AI and chatbots, how those limitations are an obstacle to better applications and what the immediate landscape in terms of new developments in conversational AI looks like. The authors also explore the benefits and the dangers of data handling by applications of this sort, where data can be provided by the user without the same kind of awareness as if the user is wilfully filling a form. To conclude, the authors make some observations about the pros and cons of the use of AI chatbots by mental health patients, exploring why some studies point to social isolation and proneness to anxiety while others present positive results and progress while using technological applications by this population, especially chatbots.

BACKGROUND

Mental health problems are a growing concern worldwide because they impair quality of life, cause disability and represent an issue to the economy (GBD Disease and Injury Incidence and Prevalence Collaborators, 2018).

The demand for better mental health services has increased, and meeting these demands has become increasingly difficult and costly due to a lack of resources. Therefore, new solutions are needed to compensate for the deficiency of resources and promote patient self-care. Distance can delay the reach of traditional mental health services to populations in remote areas in both high-income and low-income countries. Technology-based treatment, such as mobile apps, can overcome most of these barriers and engage hard-to-reach populations.

One technology that offers a partial solution to the lack of capacity within the global mental health workforce is mobile apps. Due to factors like cost, portability, ubiquity and ease of use, mobile apps are becoming powerful tools that contribute to making mental health more accessible and affordable. One of the main mobile apps used for mental health are conversational chatbots or simply chatbots, computer programs able to maintain a conversation and interact with human users. These systems use spoken, written and visual languages to interact with human users. The number of available chatbots and the number of users of these systems is growing year after year with special focus on the last decade. This is also true for chatbots aimed for mental health. More recently, the Covid-19 pandemic has exposed even more the need for these kinds of services, because of the limitations in the access of healthcare services and also because of the psychological consequences of the lockdowns (Miner, Laranjo, & Kocaballi, 2020). Some authors argue that chatbots will address the lack of mental health care services available and also, they can facilitate interactions with people that do not search for mental health care services due to stigmatization and allow more conversational flexibility (Abd-Alrazaq, Rababeh, Alajlani, Bewick, & Househ, 2020).

ARTIFICIAL INTELLIGENCE AND THE EMERGENCE OF CHATBOTS

Chatbots are becoming more prevalent in our daily lives, as we can now use them to book flights, manage savings, and check the weather. Chatbots are also increasingly being used in mental health care, with the emergence of "virtual therapists". Chatbots are programs "that use machine learning and artificial intelligence methods to mimic human-like behaviours and provide a task-oriented framework with evolving dialogue able to participate in conversation" (Vaidyam et al., 2019); some include psychotherapeutic interventions (like cognitive behavioural therapy techniques) offered in real-time and may have a role to play in patient care — in a sense, therapy without the (human) therapist. Chatbots may offer certain advantages: unlike a human therapist, a chatbot is always available when the patient chooses to make contact, never distracted by thinking about what to cook for dinner (or anything else), and "remembers" everything a patient told it through its data repository, using that information to develop a more data-informed understanding of the patient.

A clear and recent example of the development of a chatbot with positive and direct impact in a population that experience mental health and wellbeing challenges has been made by Christine Grove. In this case, a chatbot using AI technology to respond to anxiety, stress and depression in youth was developed by different stakeholders that included healthcare experts, technological experts and the target population. The result of this collaborative work was the design and development of a chatbot that answers to the needs and habits of this specific population having the input and support of healthcare professionals (Grove, 2021).

AI is being widely used by different applications and services in order to deliver a better and more personalised user experience, offering to each user a different experience based on the user needs and preferences. AI is also used to create models that can predict or detect mental health conditions. A good example is the detection or prediction of "digital exhaust" of a given individual based on data gathered from the different systems that the user interacts with. The data collected can be analysed to produce conclusions and insights. And this data can be something from simple metrics like the number of hours spent interacting with digital systems to more advanced techniques like natural language processing. AI algorithms are able to read and interpret natural language and extract insights as powerful as inferences of the current mental health status of an individual but also able to provide complex answers, which is a great feature to be used by chatbots for therapeutic intervention (D'Alfonso, 2020).

Natural Language Processing (NLP) is a field of Artificial Intelligence that interprets what the user says or writes using its own words as one would usually do in an ordinary situation. NLP then converts the sound or the text into machine language, which is binary. It is not a simple word recognition technique that translates word by word, it is more than that as NLP tries to get context or the intention of what the user is trying to say, explain or ask using AI techniques like pattern recognition. This is a powerful approach to human-machine interaction as it removes all the complexity of sending commands to the system to execute tasks or set the environment, NLP tries to do exactly that just by analysing the natural language of the user.

Machine Learning is also a field of Artificial Intelligence that uses data analysis to train and produce models that are able to categorize, segment and predict values based on past observations. With a model or multiple models running in parallel and connected between them imitating neuronal connections (Deep Learning), it is possible to provide different but correct answers to different requests from different users with a degree of probability based on past data. Thus, NLP and Machine Learning used in tandem are the basis for an AI powered chatbot that is able to understand common language used by its users and provide responses that are based on past learnings of the current user or of other users.

As AI techniques continue to be refined and improved, it will be possible to help mental health practitioners re-define mental illnesses more objectively than currently done in the DSM-5. Identify these illnesses at an earlier or prodromal stage when interventions may be more effective, and personalize treatments based on an individual's unique characteristics. However, caution is necessary in order to avoid over-interpreting preliminary results, and more work is required to bridge the gap between AI in mental health research and clinical care (Graham et al., 2019).

The rapid integration of AI into the healthcare field has occurred with little communication between computer scientists and doctors. The impact of AI on health outcomes and inequalities calls for health professionals and data scientists to make a collaborative effort to ensure historic health disparities are not encoded into the future. There are studies that evaluate bias in existing Natural Language Processing (NLP) models used in Psychiatry and discuss how these biases may widen health inequalities (Straw & Callison-Burch, 2020).

Abd-Alrazaq and colleagues have done a scoping review (2019) and a systematic review with meta-analysis (2020) to compare the different levels of safety and effectiveness across mental health chatbots using results of previous studies and research. The aim was to assess the effectiveness and safety of using chatbots for improving mental health. In the scoping review, the authors checked 53 chatbot studies - 17 of them aimed for therapy, 12 for training and 10 for screening. Forty-nine of the analysed chatbots were rule-based and implemented in stand-alone software. In forty-six studies, chatbots controlled and led the conversations. The most common form of input is written language (seen in 26 studies) and the most common output form is a combination of written, spoken and visual languages, 28 in total. In the majority of studies chatbots have some form of virtual representation. The most common scope of these chatbots are depression or autism. This review reveals a great offer of chatbots with different focus and approaches, which means that healthcare providers have a variety of tools they can use or promote to help their patients and their mental health needs. However, in the systematic review they conclude that there was not sufficient evidence to draw solid conclusions about chatbots safety and effectiveness at this moment.

According to a scoping review on perceptions and opinions of patients about mental health chatbots, the results showed positive feedback, although it is necessary to invest more in the good quality and variability of responses to unexpected questions from users (Abd-Alrazaq, Alajlani, Ali, Denecke, Bewick, & Househ, 2021).

EXAMPLES OF CHATBOTS IN THE MENTAL HEALTH FIELD

There are several chatbots in the mental health field currently available and some of them enjoy a high degree of popularity and success. This often happens because of a multiplicity of reasons.

The first one is the scalability aspect of these systems. Unlike human professionals, chatbots can be replicated fast, easily and at a low cost and be available at any time anywhere via the internet. They are not also affected by fatigue or cognitive errors and they do not have any personal bias. Because chatbots are depleted of these human factors, some users may see in chatbots a way of being more transparent when discussing private matters, concerns or acts such as diseases or risk behaviours. Users can also feel less anxiety exposing their private lives to a chatbot than to a human being. Some chatbots allow the configuration of parameters to be closer to the user and offer a more personalised experience, these parameters can include the physical appearance of the avatar, language, accent, mannerisms, race, ethnicity or socioeconomic status. This is an important feature that aims to establish a stronger relationship with the user hoping to contribute to a higher impact and engagement of the treatments and ultimately a better health outcome.

- WYSA

Wysa is a chatbot with focus on the management of anxiety, loss, worries, energy, sleep and other issues. According to the authors "Wysa is an AI-based emotionally intelligent mobile chatbot app aimed at building mental resilience and promoting mental well-being using a text-based conversational interface". The Wysa app assists users to develop positive self-expression by using AI to create an external and responsive self-reflection environment." The app is free however if the user wants to interact with a human coach that is a paid service. Using Facebook Messenger as its own interface and chatbot capabilities, "the app responds to emotions that a user expresses over written conversations and, in its conversation, uses evidence-based self-help practices such as CBT, dialectical behaviour therapy, motivational interviewing, positive behaviour support, behavioural reinforcement, mindfulness, and guided micro actions and tools to encourage users to build emotional resilience skills" (Inkster, Sarda, & Subramanian, 2018).

- TESS

Tess is a psychological artificial intelligence chatbot, which delivers emotional wellness coping strategies. This mental health chatbot coaches patients and also caregivers to create resilience by having text message conversations using a mix of machine learning techniques and supervised intervention by psychologists, Tess provides a variety of interventions that responds to the users' needs. The users can access this app through Facebook Messenger, SMS texting, web browsers, and also as smartphone apps (Joerin, Rauws, & Ackerman, 2019).

- WOEBOT

Woebot is a fully automated conversational agent developed by Woebot Labs in San Francisco. It treats depression and anxiety using a digital version of time-tested cognitive behaviour therapy. NLP techniques are used by Woebot to build a human-like conversation interface. According to a 2019 comparative study, it was found that Woebot was able to have a positive effect in people that suffer from depression (Singh, 2019).

- ELLIE

Ellie almost serves as a virtual therapist as it can detect subtleties in facial expressions, rates of speech, or length of pauses and responds accordingly. It also provides an option to meet an actual therapist (Fitzpatrick, Darcy, & Vierhile, 2017). Ellie is part of a larger project developed by the University of Southern California that identifies and tracks multimodal signals like body posture, language patterns or facial expressions to detect signs of stress or anxiety in patients.

- YOUPER

Youper is a mental health app with a chatbot it calls an "emotional health assistant". For users who have never consulted with a clinical professional, Youper introduces the types of questions and exercises they might experience in therapy. The questions and exercises given by Youper's chatbot are meant to help users achieve a better understanding of their emotions, thoughts and behaviour (using CTP techniques and strategies). Youper's chatbot asks users to focus on their thoughts and identify how they are feeling from a list of descriptive words. Then a scale lets them rate the strength of that emotion from "slightly" to "extremely." More questions help them narrow down what is causing those feelings and track their mood. As it learns more about the user, it fine-tunes the experience to better fit users' needs. Users are also given options for mindfulness exercises and journaling prompts (Shu, 2019).

- REPLIKA

A companion chatbot that is "an AI companion who cares" and was created to provide a place for people to express themselves in a "safe, judgement-free space" and engage in meaningful conversations. Once a user downloads the Replika app, he/she may choose to apply several characteristics to their Replika, such as a name and gender. Interactions with Replika primarily function through text-based communication, enabling users to converse with their Replika on their smartphones or computers. Like other chatbots, increased interactions with Replika allow it to learn more about the user, and it is built to resemble natural human communication as much as possible (Ta et al. 2020). Replika makes use of Open AI's GPT-3 language model that runs deep learning techniques to generate text and conversations indistinguishable from humans.

The ability of chatbots to provide companionship, support, and therapy can lessen the load on therapists. It emerges as an option for people who have problems with accessibility and affordability both in terms of time, distance, and finances. However, several concerns are being raised in this matter. Confidentiality is the foremost concern. Other concerns are universality of application, lack of standardization and monitoring, overdependence on the bots, and lack of severe mental disorders. We need to develop chatbots more "suited" to our culture and have a regulatory and evaluating process in place to enjoy the benefit of this technological advancement (Singh, 2019).

NEW TRENDS

The impact of the various presentation modalities currently used by chatbots (text, verbal, or embodied as a 3D avatar) and the preference therein remain largely unknown. While some groups have claimed that voice, and not animation of a 3D avatar, is the primary determinant of a positive experience with a chatbot, it remains difficult to conclude today as no studies compared adherence or engagement measures between chatbots of identical functionality but different modalities.

Vaidyam and colleagues (2019) highlight the need of establishing appropriate rapport or therapeutic alliance on patient interactions, because an early alliance establishment predicts more favourable outcomes. However, more research is needed to know exactly how patients feel supported by chatbots.

Creating chatbots with empathic behaviours is an important research area. Exhibiting humanlike filler language such as "humm"s and "ah"s may allow patients to feel more socially connected, and studies focusing on adding these behaviours into chatbots suggest that such simple and subtle changes may more effectively build rapport. With today's technology, patients must be explicit about their emotions while communicating with a chatbot since they cannot reliably understand the subtleties or context-dependent nature of language. However, since such explicit dialogue would be unnatural between humans, it may break an established illusion with the chatbot. In addition, chatbots that ask scaffolding-based questions with open-ended "why" or "how" prompts, subsequently leading to irrelevant and non-contextual conversation, risk losing the interest and alliance of the patient. Another challenge regarding empathy is that patients know chatbots cannot empathize with "lived experiences" so phrases such as "I've also struggled with depression" will likely fracture the patient-chatbot relationship (Vaidyam et al., 2019).

OLD CONCERNS

It is obvious the potential of chatbots and other AI powered services to help address some health care services, however it is always difficult to provide an e-health service that safeguards aspects that are crucial in a relationship between professionals and patients that include dignity, respect and ethics. This is a two-way challenge. On one hand it is desirable that developers include healthcare professionals during the software development life cycle in order to ensure that from a technical standpoint the product delivers the most accurate response to the user needs. On the other hand, ethics codes and practice guidelines of healthcare professionals should include the use of technologies as part of common practice.

There is the need and the space for global organizations like the World Health Organization to lead and promote a cooperative environment to address these questions, create guidelines and promote the safe and effective use of technology in the healthcare space. Moreover, the cooperation between software developers and healthcare professionals should also include the input of patients and potential users of these technologies, especially the ones that are underserved and most affected by health-care disparities as valid and important stakeholders. This approach would also potentially accelerate the adoption of new technologies with evident benefits for all stakeholders (Luxton, 2020).

Ethical Implications

Much of the impact of the usage of chatbots by patients is still unclear. Some aspects that are taken for granted in in-person relationships between healthcare professionals and patients like privacy and confidentiality are yet a discussion topic when analysing chatbots and other services that deal with personal and healthcare data. Although there is specific legislation for data handling aimed for technological services (more of that in a topic below) in the United States, most chatbots are not currently covered under the Health Insurance and Portability and Accountability Act (HIPAA), meaning that there is the potential of users' personal data to be handled freely and possibly traded by companies the owners of these services bypassing the usual confidentiality rules followed by classic in-person consultation.

It is also important to consider the relationships that may be formed between users and chatbots. Due to the constant availability of these chatbots (24 hours per day, every day of the year), there is the risk of addiction and isolation by these users that seek responses for their mental issues making the case worse. In these cases, there is not a clear responsibility that can be pointed to chatbot developers as laws and regulations are practically non-existent.

Currently we are experiencing a boom of chatbots and other conversational services aimed for mental health, however most of the research seems to be happening in the engineering and technological side, leaving behind aspects that should be a concern for research in the mental health scope. For instance, there is a lack of tools and frameworks that can evaluate the outcomes and impacts of these services as well as transparency of how these systems work as many of these companies work in a market logic and that see intellectual property as part of their business. Until such evaluation tools are created, it will be difficult to compare and understand in depth what chatbots do under the hood, how they react to different scenarios, what are their outcomes and what are the real impact they have to their users.

Although we are living in a world where there are virtual assistants that are able to perform tasks such as booking restaurant tables and interact with humans sounding indistinguishable from a human, we are still to see these assistants do the same kind of interaction to create diagnoses and implement treatments and therapies (Vaidyam et al., 2019). Nevertheless, we can already speculate that different ethical issues will surge when conversational chatbots reach to a fairly advanced state that makes them indistinguishable from human beings and proactively integrate with other services or data sources in order to provide an answer to the user (Gratzer and Goldbloom, 2020).

Risk of Harm

Due to the level of autonomy of chatbots, there is a real risk of harm for their users. This can be especially problematic if the technology does not address or identify scenarios of risk. For example, a person conversing with a chatbot could reveal that they are experiencing suicidal thoughts, this should be a cause for alert and immediately addressed. Also, patients that may suffer from some kind of psychotic symptoms or cognitive deficits, may not be suitable candidates for the use of chatbots. To help address these concerns, the stakeholders of these technologies should put in place processes or rules to identify who are the suitable users for each application and what are the potential risks. It is also desirable that these systems are able to monitor and alert risk scenarios. Ideally, these chatbots should provide immediate help or the resources to search for help, such as a phone number or a contact with the responses for each scenario. It is also desirable to have human intervention and validation; a review of the information is key to monitor the functioning of the system and the prevention of risk.

Currently, most companies that develop mental health chatbots, describe them to the public as information providers or training tools, and not as replacements for health professionals. This is a simple way of avoiding the same level of responsibility that is demanded for healthcare professionals. Making clear what are the scopes, limitations and potential risks of each chatbot, platform, application or system is essential to set expectations, both for users and healthcare professionals. Moreover, these chatbots developers, owners and other stakeholders should have a clear picture of what are the services and resources available in each region or country and helping users to contact them in case of need is also a key requirement to mitigate risk.

Artificial Intelligence Limitations

The romanticized narrative of AI and chatbots that only exist in science fiction and that were popularized by Hollywood movies like "Her" (2013) and "I, Robot" (2004) may lead to inappropriate usage of mental health applications and set unrealistic expectations of these technologies as a serious approach to solve mental health issues. Many of these misleading ideas are in part caused by unrealistic marketing campaigns around the topic of AI and popular beliefs influenced by science-fiction. In reality, most of the tools and applications available that claim to have AI technology make a limited use of AI resources and most of them focus on very specific subjects or problems. There are in the market applications to cope with stress, anxiety and addictions among other specific topics, but consolidated applications that aim for mental health on its broader spectrum and that are able to handle a vast set of mental conditions do not exist.

This problem can be linked to the current overall maturity level of conversational AI and chatbots, a scale that is described by different authors using different methods and perspectives. Bosek (2019) describes it as a 4-level pyramid based on the features the system delivers, Gadiyar (2020) describes it as a 3-level schema based on the automation and communication skills of the system and Garga (2020) uses a multi-layered ellipse to describe the technology in three major vectors: interaction, intelligence and integration. Each perspective makes clear that AI technology is yet being perfected and matured and that the current capabilities are just a fraction of what could be achieved in theory in the near future - maybe closer to the science fiction movies cited above.

The last level of Bosek's pyramid is what the author defines as Turing Bot, an AI application indistinguishable from a human-being capable of understanding the user and providing responses considering the situational conditions. An application with this kind of capability would be as good as a trained human, however we are far from this reality and the author forecasts that we are years away from this level of AI (if possible).

Gadiyar's perspective of the near future of bots is what the author defines as a master bot or a bot of bots. In his point of view, bots are becoming more and more specialized, opening the need for the orchestration of multiple bots in one single point, the master bot, that would work as a meta bot that calls the adequate bot to solve a specific user question or request.

In Garga's ellipse, the outermost layer (the most advanced form of chatbot) defines a system able to start a conversation based on a context, recognize the user's mood and build or have access to a personalized knowledge base, all requirements for an advanced chatbot. Like in the former two researches, Garga also did not find an example of a bot in any context that fulfils the most advanced requirements that define an advanced chatbot capable of replacing a trained human.

Until technology reaches an evolutionary stage of AI, human-machine interactions have limitations that should be considered when using and developing conversational applications and services in healthcare, especially in mental health. Users should be aware of these limitations as well as other stakeholders that encourage the use of chatbots and AI-powered applications as a substitute or complement for a healthcare professional.

Privacy and Data Issues

In Information Technology, and in chatbots in particular, user privacy is a concern that needs to be taken seriously. If poorly addressed the potential for user harm is enormous. Chatbots have the capability of collecting and storing large sets of private and sensitive information of their users. Laws and regulations about data collection vary from country to country and from region to region. The developers of these technologies should be aware of the legislations that apply, cope with them and inform users about privacy, data protection and terms of service.

There are many regulations that protect users against the misuse of personal data and enforce developers and administrators of these systems to comply with policies and standards. Although most of the time users are willing to give some details of their own personal information to companies in exchange for products or services, there is always the risk of this data being used within a different scope or with different purposes than the initially agreed by the user. Aggressive legislation exists to fight this kind of conduct, the European Data Protection Regulation (General Data Protection Regulation (GDPR) – Official Legal Text, 2019) and California Consumer Privacy Act (California Consumer Privacy Act (CCPA), 2021) are two of the most advanced regulations that cover these and other misuses of personal information with heavy penalties for companies that do not comply with the rules.

A common practice of personal data misuse is seen in applications that offer a service in exchange of the user's personal information. The user is lead to believe that the personal information that he/she is about to provide is fundamental for the good execution of the service and that the shared information will be used only for that purpose, however the information now on the hands of a third party is used for other scopes that can include direct advertising of unrelated products or services, data trading with other companies or data inference. Famous examples of data misuse by tech companies include for instance the 2014 Uber's God View incident where both drivers' and riders' GPS position were used for other purposes than Uber's goal of moving people from point A to point B (Hill, 2014), or the Cambridge Analytica scandal during the US elections in 2016 (Confessore, 2018). Big tech companies like Google and Facebook are often in the news because of the suspect of data misuse and they were even called to public hearings in Europe and in the United States to explain their methods and goals around the collection and handling of personal information, but smaller companies are also referenced in the news from time to time due the abusive use of their users' personal data. This reveals that data misuse is a transversal issue across all kinds of companies and that the general public is more and more aware of the importance of data management.

Electronic health records are one type of personal information that has a great value for tech companies working in the healthcare area. An individual's healthcare data can have many useful and positive usages, for instance, it can be used on all sorts of algorithms or compared against databases of healthcare data in order to find patterns that can alert for possible diseases or health issues that can be treated in an early stage. On a negative note, knowing healthcare details of an individual may have an undesirable impact in scenarios like the enrolment for a health insurance plan or in the hiring process for a new job. Today, these kinds of data points are collected seamlessly by mobile devices and wearables that continuously track users' heartbeat, physical activity, sleeping patterns and other healthcare related metrics. Often the user gives an initial consent for data collection but not knowing exactly what will happen with it once collected. Chatbots are also a clever way of collecting data, they use a conversational style that leads the user to slowly giving details of its personal information in opposition to the more traditional way of data collection using forms. In the healthcare chatbot's scope, these personal details are often information about the current health status that may include for instance an overall mood, physical wellbeing details or mental issues.

Even when coping with all standards and best practices of data handling, a serious issue that tech companies face is the chance of data breaches or data leaks. An event like this expose publicly or to unauthorized third parties personal data that is intended to be secured by the companies who collected and stored the data. Most of these events happen because of an attack intended to steal data or because of deficient implementation of data security, in any of these scenarios the security of any personal data, including healthcare data, is compromised and exposed to people or organizations that should not have access to this information. Current regulations include penalties for organizations that expose their own users' personal information in data breaches and data leaks or that do not comply with the security measures to protect data. For instance, in 2013, Adobe suffered one of the biggest attacks ever which exposed personal data, including credit card information, of 150 million users. In August 2015 Adobe had to pay $1 million USD in legal fees and an undisclosed amount to users to settle claims of violating the Customer Records Act and unfair business practices (Hern, 2017).

There is a long road to be done in order to educate common users how to effectively handle and provide their personal and healthcare data to third parties, organizations and services. Cybersecurity awareness is a topic that is not top of mind and a priority for common users of IT products and services (Koyuncu, 2019). Having informed and educated users of these applications and services help to have a correct handling of data and prevent catastrophic events like data leaks. On the other hand, there is also a long road in order to force tech companies to implement best practices and proven standards around data privacy and protection. Although security is a main aspect of software development, sometimes shortcuts are taken when building an application or a service that jeopardises the security of applications and postponing or deprioritizing security implementation is something that often happens when deadlines to deliver a product are approaching (Hala, 2019). Both parties - users and tech companies - are responsible for their ends of data management, a poor handling of data security can lead to disastrous consequences for both users and organizations undermining the confidence on technological solutions to solve healthcare issues.

DESIGNING AI CHATBOTS IN MENTAL HEALTH

To increase usability, engagement and security, the focus should be on developing short, simple, and consistent modules and testing them with small iterative studies. Then, developers can move toward expanding the content (or modules) of the chatbot. As with most digital interventions, the attrition rates are significantly high; therefore, developing an extensive set of modules that users do not end up engaging with is not a good use of resources. Research on frameworks for developing engaging and effective chatbots offers the opportunity to create and test scalable interventions. Data from large studies on chatbots could lead to effective personalized interventions that could eventually answer the question of which intervention works for which individual (Dosovitsky et al., 2020).

Safety and trust are factors to be considered when developing new AI-based technologies. This is the opinion of different experts in AI, healthcare professionals, software developers, system owners and administrators and other stakeholders. That need was clearly stated in a recent Lancet commission on global mental health - "technology-based approaches might improve the reach of mental health services but could lose key human ingredients and, possibly, lower effectiveness of mental health care" (Patel et al., 2018). Human supervision will always be needed at some point.

AI powered chatbots may augment the work of psychotherapy, therefore product designers, health-care professionals and researchers must evaluate the impact of these new approaches and practices on mental health patients and professionals. The changes of processes and workflows must be considered when AI-powered treatments are made available and used. The deployment of these technologies must be followed up by training and awareness campaigns to inform clinicals of the possible impacts, limitations and scopes of these technologies. And because this requires the expertise of two different areas, healthcare and IT, the discussions about the needs of each end should be constant. Having a healthcare professional understanding the capabilities and limitations of a technology is as important as an IT professional to understand the needs of a healthcare professional.

Therefore, these are Kretzschmar and colleagues (2019) recommendations for chatbot development around three major vectors: efficacy, privacy and safety.

Efficacy:

- The technology provided should be evidence-based;
- Platforms should be tested empirically;
- Users should be informed about the extent to which the service is backed up by evidence;
- Users should be informed about what the chatbot targets and what effects to expect.

Privacy and Confidentiality:

- Personal information, if collected, should be kept confidential;
- Content of conversations, if shared, should be de-identified;
- Privacy arrangements and limitations should be made transparent to users;
- Users should have the option of being reminded of privacy arrangements and limitations at any stage.

Safety:

- Users should be informed that they are talking to a robot;
- Automated chatbots should encourage people to seek human support;
- Automated chatbots should have systems in place to prevent over-reliance;
- Automated chatbots should have systems in place to deal with emergency situations.

FUTURE RESEARCH DIRECTIONS

There are risks when using conversational assistants for mental health provision purposes (Bickmore et al., 2018), so more research is required into the design of conversational assistants for safety-critical dialogue that allows the flexibility and expressivity of natural language while ensuring the validity of any recommendations provided. Given the state-of-the-art in Natural Language Understanding (NLU), conversational assistants for health counselling should not be designed to use unconstrained natural language input, even if it is in response to a seemingly narrow prompt. Also, users should be advised that medical recommendations from any non-authoritative source should be confirmed with health care professionals before they are acted on. More reviews are needed to summarise the evidence regarding the effectiveness and acceptability of chatbots in mental health as well as the impacts in the mid and long term of the usage of these technologies.

Chatbots, especially the ones that are text based, open new forms of communication through the use of emojis, avatars and other visual elements. What is the impact of the use of non-textual elements on chatbot users and how does that relate with patients that do not use chatbots as part of their therapy is as of now an open question and worthwhile of exploration.

Regarding usability best practices and evaluation, a lot has been done lately regarding mobile applications and web applications in the scope of e-health, however little to none was published under the scope of e-health chatbots. What kind of interaction works better, what approaches have the greatest impact for the users and how to optimize the communication between humans and chatbots are questions yet to be answered.

Ultimately, the great goal of any mental e-health tool, application or service is to promote the patient's recovery. Despite of the variety of tools that are emerging in this area, and all the new players involved, there is the lack of solid evidence that this goal is effectively achieved by any of the available services, especially chatbots, either used as a stand-alone alternative by the users or in tandem with the supervision of a healthcare professional. Even if these tools are capable of offering diagnoses and therapies, the capability of delivering a satisfactory personalized recovery plan for each user is yet to be assessed (Meadows 2020).

CONCLUSION

AI chatbots are programmed with therapeutic techniques to help people with mental health problems, but the promise of this technology is softened by concerns about the apps' efficacy, privacy, safety and security.

As AI techniques continue to be refined and improved, it will be possible to help mental health practitioners re-define mental illnesses more objectively than currently done in the DSM-5, identify these illnesses at an earlier or prodromal stage when interventions may be more effective, and personalize treatments based on an individual's unique characteristics. However, caution is necessary in order to avoid over-interpreting preliminary results, and more work is required to bridge the gap between AI in mental health research and clinical care. Conversational chatbots are seen across the literature as a low-cost and highly customizable, a technology capable of addressing an ever-growing need of mental healthcare services. However, at one and the same time, it is made clear that conversational agents should complement rather than replace traditional therapeutic options.

The Covid-19 pandemic produced a major impact on mental health services and chatbots could be useful in this matter (Miner, Laranjo, & Kocaballi, 2020).

Nevertheless, the field of AI has shown improvement in leaps and bounds in the last few decades. And one can only hope that mental health treatment protocols using AI in a growing digital world would be effectively bridging the gap between the patient and the treatment.

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Section 5

Virtual Reality in Psychosocial Interventions

Chapter 12
Virtual Reality and Forensic Mental Health

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ABSTRACT

This chapter provides an overview of virtual reality (VR) treatment and rehabilitation for mentally ill patients who have committed a crime or are at risk of relapse. The authors focus on the forensic mental health field since this area relates to any individual dealing with a psychiatric condition that is in trouble with the law, whether they be inpatient offenders, outpatient offenders, or inmates at a regular prison. Virtual reality (VR) and its current uses, as well as its benefits and barriers, are presented as a successful and individualized eHealth treatment. In addition, some examples of VR studies that were recently done with these individuals will be presented to show the results of their current approaches, demonstrate their limitations, and figure out possible ways of improvement.

INTRODUCTION

Technology is an area in constant growth and development. With the creation of this chapter, the authors present a synopsis of Virtual Reality technology employed in the treatment, rehabilitation, and reintegration of Forensic Mental Health in and outpatients.

Although the first application of VR in this field takes us back to 1960, only a short time ago there has been observed a significant evolution and blooming in virtual reality, both in general and in this

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target population. The studies carried out in this area are reduced, but enough to show its importance and how much this technology can raise the effectiveness of mental health treatment for those who have shown deviant behavior or are at risk of it.

The main goal of this paper is to assemble a brief context of Virtual Reality technology and Forensic Mental Health and, after some research, provide an overview of the studies already made in this area. Furthermore, with the purpose of reinforcing the utility of VR in forensic psychiatry, the authors present the advantages and the barriers of this application, in addition to future recommendations to overcome them.

BACKGROUND

Even though there are some assessment tools we can use with VR, which can help measure different needs and responsivity issues for offenders, no tool is able to predict violence or reoffending at 100 percent. VR offers new possibilities to improve current evaluations and inform on upcoming correctional rehabilitation strategies (Ticknor, 2018).

Virtual reality allows us to generate an immense variety of safe, cost-efficient, and simple-to-control environments (Ticknor & Tillinghast, 2011). These environments are computer-generated simulations that incorporate the world in a three-dimensional (3D) visualization, allowing user interaction through transmission devices (Ticknor, 2011) with various sensory modalities. Some authors consider that VR began based on fictional and fantasy thoughts of scientists. However, presently, this type of technology can be more representative of real environments than the traditional technics that usually rely on people's memory and imagination. (Marques et al., 2008; Ticknor & Tillinghast, 2011; Smeijers & Koole, 2019). Additionally, it presents us an opportunity to manipulate the circumstances according to each patients' specificities (Marques et al., 2008; Ticknor & Tillinghast, 2011; Smeijers & Koole, 2019).

Researchers imply the need to understand two essential aspects to ensure the quality of this technological approach: immersion and presence (Cisneros et al., 2019; Dores et al., 2012; Ticknor & Tillinghast, 2011). The first concept contemplates the perception of reality while in VR. Ticknor (2011) suggests three types of perception: fully immersive, semi-immersive, and non-immersive. The term presence describes the notion of being physically present in a virtual environment while in a different location (Dores et al., 2012; Ticknor, 2018).

This technology can be supplemented with other devices and, while doing so, more valuable information might be provided (Benbouriche et al., 2014). For example, with physiological response measurement, the investigators can assess the participants' heart rate, perspiration, muscular tension, and blood pressure (Benbouriche et al., 2014; Ticknor, 2018). Despite this, it is important to keep in mind that not every participant reacts well to VR technology. Some people might experience certain physiological responses, for instance, cybersickness. Its symptoms can include eye strain, headache, paleness, sweating, mouth dryness, disorientation, and vertigo (Ticknor, 2018). Some individuals might also experience nausea and mild pain from the head-mounted device's weight or shape (Greg & Tarrier, 2007).

Besides that, the quality of the graphics, frames per second, and response time can also impact the participants' engagement in the VR simulation (Greg & Tarrier, 2007). To confirm VR's effectiveness, the scenario must guarantee enough information so that the participant can understand the background of the simulation. It should be manageable enough to ensure a response in the simulation so that participants' involvement is reinforced and their decision-making is conscious and educated.

Many researchers demonstrate the success and effectiveness of this application in reducing aggressive behavior, impulsivity, anxiety, posttraumatic stress symptoms, as well as in improving self-regulation and pro-social behavior (Benbouriche et al., 2014; Smeijers & Koole, 2019). So, virtual reality environments have potential, not only in assessment and treatment but also in training and rehabilitation of a diversity of domains, including mental health (Benbouriche et al., 2014). The safety and control associated with VR are understood as an advantageous and useful tool in many fields for several purposes, for example, entertainment, arts, military, medicine, education, robotics, business applications, etc. (Cho et al., 2002), and with various populations such as soldiers (Taupiac et al., 2019) or astronauts (Wu et al., 2015). Such is possible, given the fact that this technic can provide safe learning environments, which would otherwise involve risk, as well as develop situations that are impossible to create in real life (Benbouriche et al., 2014; Cornet & Gelder, 2020). Nevertheless, this chapter will focus on the role of VR in the criminal system, particularly forensic mental health (FMH).

Forensic mental health is a specific area in the criminal sphere that revolves around assessing and treating individuals who are mentally unbalanced or disordered and whose behavior is or could be associated with criminal offenses (Mullen, 2000). FMH treatment regards the relation between psychiatry and the law. In other words, it deals with the relationship among the assessment and treatment of mental illness of people whose behavior has led or could lead to criminal offenses (Cornet & Van Gelder, 2020; Kip et al., 2018). The authors choose to focus on FMH instead of criminal justice, in general, because FMH involves a much broader population that is experiencing or has experienced mental health issues and is or could be in trouble with the law. Whereas the criminal justice system includes only the incarcerated individuals, whether they be in regular prisons or psychiatric wards.

Forensic psychiatric patients have specific characteristics, such as low motivation for mandated treatment. These patients are often poor, unemployed, and have low literacy, which also affects their engagement and adherence to interventions (Arboleda-Flórez, 2006; Benbouriche et al., 2014; Kip et al., 2018). There are multiple causes and reasons for delinquent behavior, and they should all be addressed in treatments (Kip et al., 2018). The gradual increase of forensic psychiatry may be due to changes in the law and to a more liberal acceptance of psychiatric justifications of behavior (Arboleda-Flórez, 2006; Kip et al., 2018). However, Arboleda-Flórez (2006) considers a more immediate reason for the upsurge of mental patients in forensic facilities, jails, prisons, and penitentiaries. Furthermore, this author believes that the failures of the general mental health system may be the cause of the growing relevance of forensic psychiatry (Arboleda-Flórez, 2006).

Modern forensic psychiatry has benefited from four essential development moments that consist of: the evolution regarding the understanding and appreciation of the affair between mental illness and criminality; growth of the legal exams to define legal insanity; new methodologies for the treatment of mental health conditions that offer an alternative to conservative (custodial) care; and the changes in public attitudes and perceptions about mental disorders over-all (Arboleda-Flórez, 2006). These four moments are the basis of the expansion recently seen in forensic psychiatry, from matters entirely related to criminal prosecutions to the treatment of mentally ill offenders or several other fields of law and mental health policy (Arboleda-Flórez, 2006).

One of the reasons that have been mostly considered to justify the large number of mental patients appearing in the justice system is the policy of deinstitutionalization. This policy has been implemented by governments worldwide over the past fifty years. Moreover, according to Arboleda-Flórez (2006), deinstitutionalization is at fault for the criminalization and the transmigration of mental patients from the mental health system to the correctional system. Ticknor (2018) proposes the application of VR in offender assessment in order to identify a risk probability for future behavior – low, moderate, or high risk. When the designation is concluded, the treatment and its supervision become adequate and efficient, whether the intervention occurs when the person is still institutionalized or after he is released.

Besides the treatment of psychiatric disorders, the main goal of this field is to prevent criminal recidivism by addressing risk factors of offense, such as antisocial behavior, aggressive behavior, or flawed coping skills (Cornet & Van Gelder, 2020; Kip et al., 2018). Listwan et al. (2004) pointed that without treatment, these offenders are more likely to escalate their behaviors in a negative way, increasing their recidivism rates after they are reinserted into the community. These risk factors should be addressed through evidence-based interventions and therapies, for example, cognitive behavior therapy (CBT) (Benbouriche et al., 2014; Kip et al., 2018). Therapeutic techniques, such as exposure and CBT can be improved with the use of VR. This has been proven with individuals that experience anxiety, PTSD, and substance abuse (Andrews & Bonta, 2010; Optale et al., 2004). VR programs that combine the intervention with CBT have demonstrated greater success in treating, preventing, and correcting criminal and delinquent behavior (Andrews & Bonta, 2010; Optale et al., 2004). When compared to alternative approaches, it has been shown that virtual reality cognitive behavior therapy (VRCBT) is unique and engages the unconscious mind by helping the participants overcome various cognitive barriers (Andrews & Bonta, 2010; Optale et al., 2004).

VIRTUAL REALITY AND FORENSIC MENTAL HEALTH

The Benefits and Barriers of VR in Forensic Mental Health

eHealth is an emerging field that can be described as potential web-based interventions used to promote the health and well-being of individuals, such as apps, wearables, augmented reality, or virtual reality (Kip et al., 2018). Health technologies have been growing exponentially and attracting many investments to develop their expansion and applicability (Kip et al., 2018). According to Ticknor (2018), VR is already a frequent resource of the criminal justice system, for it is frequently used in policemen training and crime scene recreations for forensic investigations. Benbouriche et al. (2014) demonstrated that VR became the first available real-time methodology to analyze violent offenders' underlying mechanisms while promoting highly controlled experimental designs. However, there has been little treatment exploration using this technology in forensic mental health patients after the individuals have been arrested, charged, convicted of a crime, or at risk of reoffending. Many studies describe entirely new possibilities of using VR, but only a few indicate the real effectiveness and expose the applicability and the advantages/barriers of VR as an instrument for forensic mental health specifically (Bierbooms et al., 2015; Eysenbach, 2001).

VR has a high potential for providing entirely new possibilities for diagnosis, risk assessment, and addressing multiple senses, such as sound and vision, instead of thinking and talking, which is often the case in more traditional therapeutic technics (Cornet et al., 2019; Eysenbach, 2001; Fromberger, Jordan, & Müller, 2018; Klein Tuente et al., 2018; Smeijers & Koole, 2019). Besides that, it can also bring new insight for patients, help support their self-management, and provide therapists with a rather unusual insight into their patients' minds (Kip et al., 2018). VR's interactive nature gives feedback which by itself reinforces the user's presence. This application permits the customization of different parts of the scenario when or if needed. By administrating a virtual environment, users can have a more realistic, customizable, adaptable, and responsive rehabilitation scenario (Ticknor, 2018).

In the Criminal System, professionals that opt to work with criminal offenders suggest that these environments can combine modeling, role-playing, and instant feedback as a means of social reeducating (Ticknor & Tillinghast, 2011). Therefore, VR could help offenders by teaching them appropriate social norms and cues, as well as reducing their fear and anxiety in reintegrating society/community. In other words, VR could be used as a tool to promote the process of learning and practicing new social and coping skills, in a realistic environment. These virtual scenarios have the possibility of adapting to the patient's needs while also providing a unique way of exposing offenders, besides just training their coping skills in virtual simulations (Kip et al., 2021; Fromberger, Meyer, Jordan et al., 2018).

Kip, Bouman, Kelders et al. (2019), in "eHealth in Treatment of Offenders in Forensic Mental Health: A Review of the Current State", refer that many publications point to the same type of advantages regarding these types of interventions. Patients and therapists' opinions were positive, all in all, the authors concluded the following: patients' access to care grew; technology was individualized or fitted to the individual; the technology used in all the studies reviewed mentioned the increase of fidelity in treatment; the interventions offered new possibilities, resources, and information (Kip, Bouman, Kelders et al., 2019).

Fromberger, Jordan, and Müller (2018) mentioned the existence of barriers and disadvantages in VR research applied to forensic psychiatry, for instance, ethical and legal aspects that have not yet been discussed in-depth and can cause some serious and long-lasting harm. The disadvantages also include the fact that some people might not be able to use this technology, or not be enthusiastic about it; privacy concerns; contact to other people could decrease depending on the technology; the intervention could have negative consequences; not all studies found enough strong proof of effectiveness and efficiency; the possibility of errors in the technology; many settings did not have eHealth regulations or protocols (Kip, Bouman, Kelders et al., 2019; Fromberger, Jordan, & Müller, 2018).

Many patients pointed out that VR could cause some unnecessary negative feelings, for example, an abundance of anxiety because of a specific stimulus (Kip et al., 2018). Participants worried that all the skills learned from VR application would not be relevant for real life and indicated that behaviors and conversations with virtual avatars should resemble the real world as closely as possible (Kip et al., 2018). Other possible barriers can include: high initial costs, lack of standardization of treatment protocols, not adequate for every forensic-relevant disorder, the potential negative impact of technology on treatment, among others (Kip, Bouman, Kelders et al., 2019; Fromberger, Jordan, & Müller, 2018). Setting up a VR system implies an investment in specific hardware and software setups. The hardware systems are related to the subject's immersion and include a head-mounted display (HMDs), controllers, monitors, keyboards, speakers, and other devices (Ticknor, 2018). The more immersive, the more expensive the system is.

It is important and necessary to do more research, discuss, and implement guidelines that can standardize the use of this technology. This is valid for VR applications in general but much more pertinent in the forensic psychiatric field since this population appears to be more complex and challenging. "Technology can take the low literacy and education level of forensic psychiatric patients into account by not relying primarily on language and cognitive reflection; it can create real-life, interactive situations in which skills can be trained, or information on reactions can be gathered via physiological measures which can be integrated in treatment." (Kip, Bouman, Kelders et al., 2019, p.14).

WHAT HAS CURRENTLY BEEN DONE IN THIS FIELD?

It is predictable that VR is more entertaining than current psychosocial therapies, which may be directly related to better engagement in treatment, and fewer participant drop-outs (Klein Tuente, 2020). The development and implementation of interventions in this field have shown to be challenging. This indicates the urgency to continue developing and improving the FMH interventions and therapies in hopes that it will become more common and acknowledged. From now on, some examples of studies done in this field will be presented.

In their study, Cho et al. (2004) aimed to evaluate the effectiveness of neurofeedback combined with virtual reality (VR) in reducing the level of inattention and impulsiveness. The twenty-eight juvenile offenders who took part in this study were male, their ages ranged from 14 to 18, and they were considered to have social problems (Cho et al., 2004). The individuals were separated into three groups, a VR group, a non-VR group, and a control group. The first two groups received eight neurofeedback training sessions over two weeks, with each session lasting around 20 minutes (Cho et al., 2004). The VR group used a head tracker and a head-mounted display (HMD) which allowed them to experience the virtual scenario (Cho et al., 2004). Contrariwise, the group that did not undergo a virtual reality simulation experienced only a computer monitor simulation with a fixed viewpoint (Cho et al., 2004). All participants performed a continuous performance task (CPT) before and after the complete training session. A CPT provides the investigators' measurements related to the participant's ability to respond and pay attention (Cho et al., 2004).

The results demonstrated that compared to the control group, both non-VR and VR groups reached better scores in the CPT after the training session (Cho et al., 2004). In comparison to the other two groups, the VR group showed a tendency to have better results, which suggests that immersive VR, when applicable to neurofeedback, can be beneficial for the rehabilitation of inattention and impulsiveness, more specifically for attention enhancement (Cho et al., 2004). However, the results presented were not significant; the authors believe that it might be because they only conducted eight experimental sessions. Therefore the long-term effect of the neurofeedback training the participants underwent could not be measured (Cho et al., 2004). With these results, it is possible to confirm that there is still a large gap for improvement in the individualization of the treatment as well as the amount and duration of sessions.

Virtual reality combined with cognitive behavior therapy is believed to be a potential technique that can be used with a high-risk criminal population (Ticknor & Tillinghast, 2011). In this sense, Hubal et al. (2008) led an investigation where the main purpose was to assess the role of executive cognitive functioning (ECF) and emotional deficits in aggressive prisoners, as well as to investigate the effectiveness of neuropsychological and emotional to predict treatment response and institutional misconduct.

For this study, the sample involved 226 male prisoners between the ages of twenty-one and forty-nine. At a baseline phase, the participants were tested on several complementary dimensions of ECF and conditions that affect it (Hubal et al., 2008). In add-on, interactive embodied conversational agent (ECA) vignettes were used to assess actual baseline and post-treatment changes in risk-taking decision making (Hubal et al., 2008). The ECA vignettes involved short, focused interactions. Their purpose was to examine dialog, behaviors, and decisions made in a real-world context. Each vignette mentioned a specific cognitive function consistent with the ECF dimensions measured, such as risky decision making, impulsivity, and sensitivity to penalties (Hubal et al., 2008). In the baseline ECA interaction, only 194 prisoners took part, and for several reasons, of those, only 97 participated both in the baseline and post-treatment (Hubal et al., 2008).

The prisoners underwent a cognitive behavioral therapy program, which was used to detect underlying differences between responders and non-responders (Hubal et al., 2008), CBT is designed to assist prisoners' development of impulse control, manage rage and learn new behavioral responses to real-life situations. (Hubal et al., 2008). Directly after the particip re found between baseline and post-treatment, appearing to be no added knowledge. Howe ants completed the CBT program, as well as three and six months later, their performance was evaluated by the professionals and by the prisoner himself.

After the outcome procedures were analyzed, no differences wever, the participants did tend to improve the speed of rejection in all vignettes (Hubal et al., 2008). Regarding the behavior analyses, participants revealed slightly better engagement, verbalization, and comprehension during post-treatment testing contrasted with baseline testing (Hubal et al., 2008). Still, as the outcome results showed, the participants' social skills exhibited no differences between baseline and post-treatment (Hubal et al., 2008). The investigators justified these results with the prisoners' unfamiliarity with the technology and their unwillingness to communicate their responses (Hubal et al., 2008).

Renaud et al. (2014) bring a study with a sample of twenty-two males who admitted to engaging in inappropriate sexual activity with minors and forty-two non-deviant males randomly recruited. It evaluated the participants' erectile response when confronted with computer-generated VR characters or auditory scenarios, using a head-mounted display to present dynamic 3D stimuli, and included an infrared ocular tracking system (Renaud et al., 2014). Both stimulus modalities elicited different arousal profiles among sex offenders compared to the control group, but the VR method showed significantly higher classification accuracy. The results suggested that the presentation in virtual immersion provoked significant sexual responses and generated significantly different genital arousal profiles for sexual offenders in comparison to the non-deviant group (Renaud et al., 2014). In general, the authors concluded that VR and related simulation technologies might indeed change the way we do forensic research, clinical practice, and preventative screening with sex offenders (Renaud et al., 2014).

Fromberger, Meyer, Jordan & Muller (2018) conducted a study with six sexual offenders and seven non-offenders, involving four scenarios, one neutral and three others with virtual risk. Each participant would walk around in a virtual supermarket where they would find a child avatar asking for their help, having to choose between predefined behavioral responses of approach or avoidance (Fromberger, Meyer, Jordan & Muller, 2018). When asked to predict offenders' behavior, in 25% of the virtual risk scenarios, therapists were incorrect because they predicted avoidance behavior, and the offenders exhibited an approach attitude towards the child (Fromberger, Meyer, Jordan & Muller, 2018). The results of this study revealed that virtual risk scenarios offer the opportunity for participants to test their decisions on unsupervised privileges without putting at real risk children (Fromberger, Meyer, Jordan & Muller, 2018). The authors also mention that behavioral monitoring of sexual offenders against children (SOCs), in virtual risk situations, demonstrate that in 50% of all cases SOCs were not able to transfer the coping skills therapists focused on in therapy, or the coping skills they have learned during therapy. This may be a result of the low self-regulation abilities of the SOCs. (Fromberger, Meyer, Jordan & Muller, 2018).

Seinfeld et al. (2018) guided a study using immersive VR to instigate empathy among perpetrators of domestic violence. With this purpose, the authors created a full-body ownership illusion that permitted offenders to be in the body of a female victim of domestic abuse (Seinfeld et al., 2018). The sample included a group of male domestic violence offenders (n = 20) and a control group without any history of violence (n = 19), both groups of participants faced a virtual scene of abuse from the first-person point of view (Seinfeld et al., 2018). During the virtual meeting, the participants' real bodies were replaced with a life-sized virtual female body that moved synchronously with their real movements (Seinfeld et al., 2018). Both groups completed the Face-Body Compound emotion recognition test before and after the VR experience. In this test, faces showing fear, anger, or happiness were shown for 100ms on a computer display (Seinfeld et al., 2018). Signal detection analysis was used to assess the sensitivity index and the level of recognition of angry and fearful facial expressions in male and female stimuli (Seinfeld et al., 2018).

The results of this study suggest that when it comes to sensitivity, in the baseline (pre-VR), the control group recognized fearful female expressions more precisely than the offenders' group (Seinfeld et al., 2018). This group also identified fearful and angry male facial expressions more accurately than angry female facial expressions. After the VR session, the offenders' group considerably improved their recognition of fearful female facial expressions compared to the control group (Seinfeld et al., 2018). Nevertheless, the offender's capacity to acknowledge angry female faces remained lower than the control participants (Seinfeld et al., 2018). There were no obvious differences in the perception of angry and fearful male expressions after the VR exposure in either group (Seinfeld et al., 2018). The authors found that the domestic violence offenders had a larger bias towards classifying both male and female faces as happy instead of fearful than the non-offenders' group (Seinfeld et al., 2018).

A pilot study was conducted with ten male juveniles, at the residential facility in Wyoming, Ohio, in June 2013. The participants trained various skills using a group format within a virtual environment, the Virtual Environment for the Treatment of Offenders (VETO) (Ticknor, 2018). The purpose of this study consisted of exploring how group facilitation could be done in a virtual scenario (Ticknor, 2018). Participants logged in to the virtual environment via laptops for one-hour sessions three times a week for ten weeks. All the participants had been in other CBT sessions. When asked to compare the traditional CBT sessions with the new virtual group, they confirmed that learning skills and role-playing in the virtual environment were much more likable (Ticknor, 2018). Among other positive points, the participants also said that they enjoyed being able to transport to various locations and that role-playing with their avatar was more comfortable than doing it in front of other people (Ticknor, 2018).

There is a large and growing number of prison inmates with substance abuse problems. After their release, they are usually confronted with several challenging situations that can trigger that craving. VR-based exposure therapy (CET) can be a way of exposing substance and alcohol abuse patients to these triggers in a way so that they can control their cravings for drugs and alcohol in a controlled environment. In this sense, Cornet and Van Gelder (2020) consider that virtual reality can help future incarcerated or institutionalized offenders deal with the cravings/relapses they might face after entering said environment (Cornet & Van Gelder, 2020).

Leaving prison and reintegrating society can also be a challenging process, especially for those who have served long sentences. With VR, incarcerated people can be virtually transported to the outside world and practice with relevant situations that they are probable to face after their release (Cornet & Van Gelder, 2020). In addition to this, it can also help learn/develop skills that are needed for a successful return to society while avoiding incidence (Cornet & Van Gelder, 2020). An interesting effort in this area is VITA (Virtual Interactive Training Agent) which was developed by the Institute for Creative Technologies at the University of Southern California (USC) (Burke et al., 2018). VITA is a VR job interview practice system developed in the beginning for aptitude building and anxiety reduction with the autism spectrum disorder population (Burke et al., 2018). Preliminary results suggest that VITA is a positive factor when preparing young adults with autism or other developmental disabilities for job interviews. In association with the Dan Marino Foundation, the USC Institute for Creative Technologies is presently investigating the value of VITA with incarcerated juveniles.

The intervention Klein Tuente et al. (2018; 2020) created focuses on practicing behavior rather than developing cognitive abilities. The authors established a virtual reality aggression prevention therapy (VRAPT) that targets aggression in a sample of forensic psychiatric inpatients, of a highly secured facility, in the Netherlands. This randomized control trial done with four forensic mental health centers compares VRAPT with a waiting list control group.

The participants were observed for aggression and hostility, direct aggression, non-planning, anger control-out, and anger expression index. Each of these variables is related to a specific subscale of a certain questionnaire (Klein Tuente et al., 2018; 2020). As stated by Klein Tuente et al. (2018; 2020), the literature indicates that aggressive behavior in forensic patients is not easily altered because this population has some problems in accurately recognizing emotions, such as fear and/or anger. However, the authors also indicate that individualized VR skills training for real-life situations and role-playing are key components in reducing (violent) reoffending (Klein Tuente et al., 2018; 2020).

According to Klein Tuente et al. (2020), the experimental group improved more than the control group in all the variables mentioned before. Nonetheless, these improvements weren't maintained at the three-month follow-up. This indicates that the treatment temporarily influences anger control skills, impulsivity, and hostility. Still, altogether, based on staff rating and the participants' self-report questionnaires, it was ineffective in reducing aggressive behavior long term (Klein Tuente et al., 2020).

Nevertheless, there are several explanations for these results, one of which could be that, although the motivation of the individuals to participate in the VR treatment was high – as shown by the high inclusion rate – the number of sessions (16) might not have been enough to achieve the intended goals. As stated by the authors, for therapy to be effective in forensic patients with chronic and severe psychiatric behavioral issues, it requires thorough and recurring training of new behavior. As well as integration of several factors, such as social environment, individual aspects and participants' emotions (Klein Tuente et al., 2020). The fact that the participants were inpatients of a psychiatric unit might also be one of the reasons the treatment wasn't effective because the patients didn't have an option to bring what they had learned in VRAPT into real-life experiences. It would be interesting to experiment with this virtual reality aggression prevention training with participants who are already working or residing outside a forensic psychiatry center (FPC). It may be important to consider observed-rated measures, including perceptions of relatives and friends, and not only staff observations since this could give a more significant unbiased reflection of change (Klein Tuente et al., 2020).

Besides the limitations mentioned already, Klein Tuente et al. (2020) mention many other possible limitations to the results, which in turn are aspects that should be taken into consideration for further studies. To the best of the authors' knowledge, this was the first study to conduct a large, rigorous randomized clinical trial of aggression treatment with a VR-oriented treatment on forensic psychiatric patients (Klein Tuente et al., 2020).

Cornet and Van Gelder (2020) expose their opinion that VR technology could significantly contribute to the existing toolbox of correctional programs and that VR is experienced as more involving and motivating than traditional intervention programs, mainly among young people who are growing and developing in the digital era and are used to interacting with technology in their day-to-day life. Nonetheless, it is important to keep in mind that this field is in constant development and evolution. Therefore, there are still many limitations to this practice. To achieve a more concise and significant VR rehabilitation, by evaluating the existent studies and keeping in mind their limitations, some of which we have presented, future investigators could benefit by taking such aspects into consideration since it could potentially help them upgrade and improve future interventions.

WHAT CAN BE IMPROVED IN THIS FIELD?

According to Kip, Bouman, Kelders et al. (2019), there is still a large gap between potential and current practice, and many interventions fail to have actual clinical benefit in real-world settings. To bridge this gap and reach eHealth's potential it's crucial to create an appropriate relation between the technology, the people involved, and the existing context, with the treatment/interventions approach. This field seems to be very promising, even though not all interventions are successful. Most point out certain limitations and barriers, as well as how to rectify these aspects, with the aim of improving this practice. Many authors mention the same types of limitations along with ways to revise them, for example, creating specific guidelines for this area on topics such as privacy, data security, and ownership of data (Cho et al., 2002; Kip, Bouman, Kelders et al., 2019).

In the study Kip et al. (2021) conducted, the authors focus on identifying recommendations to overcome limitations and increase the benefits of eHealth technology. The results derived from the answers of 118 participants belong to multiple populations within forensic mental healthcare practice, such as professionals, patients, and eHealth experts (Kip et al.,2021). These participants showed a positive attitude towards technology in forensic mental healthcare – on a scale from 1 to 5, their average score was 4 – mainly, they indicated that the professionals should have more training and that the patients' skill level and preferences should be taken into consideration (Kip et al.,2021).

Kip, Kelders, Weerink, et al. (2019) identify aspects of current forensic mental health VR treatments that need improvement to increase their efficiency. In the VR treatments, one of the authors' pointed out the importance of presence and emotional engagement. Not all professionals and patients have positive attitudes toward technology because they might not have much knowledge about the potential positive or negative impacts of technology on treatment, among other reasons (Kip et al., 2021). For this reason, by provoking interest and sensitizing about this type of technology within the sample of participants, the administrators of such treatments might have better results post-intervention.

Most interventions done with this population have a one size fits all approach, which means they do not take into consideration the individual differences and needs of each patient (Kip et al., 2018; Kip, Bouman, Kelders et al., 2019). The personalization of eHealth interventions is meant to suit each user, according to their characteristics, needs or context, in this way, the content and design of technology should accommodate the complexity and diversity of the forensic populations (Kip et al., 2018; Kip, Bouman, Kelders et al., 2019). The technology should not be used as a separate, standalone tool for the intervention to go as efficiently as possible. Instead, it must be integrated within the situation, personalized and with an evidence-based approach (Kip, Bouman, Kelders et al., 2019). Practice in the real world is still an indispensable factor for significant effects (Ticknor, 2018).

The participants indicated, and the authors reinforce, that there should be more protocols to support therapists with integrating eHealth technology into their treatments (Kip et al., 2021). Ticknor (2018) points out that it is essential to create an evidence-based curriculum centered on incorporating the benefits of a virtual environment into traditional therapeutic technics, for example, CBT, and train all administrators based on that curriculum and each feature in the VR technology. The administrators of said interventions should be capable of handling this type of VR technology perfectly (Ticknor, 2018). Therefore, it is important to educate the professionals and participants about this and establish partnerships with other organizations to share knowledge and costs (Kip, Bouman, Kelders et al.,2019; Ticknor, 2018).

A participatory development process is essential to ensure that the technological intervention impeccably fits the needs of patients and therapists (Kip et al.,2021). Certain studies might benefit by having a first contact one-on-one with the participants, a debriefing about the scenario and its characteristics, if it is necessary to make changes/alterations (Ticknor, 2018). Ticknor (2018) says that the debriefing sessions should be given before the start of the group (at least three initial information sessions). The trained facilitator should have the opportunity to meet with each participant in the first session to build the therapeutic relationship. They should allow the participants to adapt to the virtual environment if needed and explore its software features. Other areas in need of improvement are the length of the interventions in general, the number of sessions, the amount of time for each session, as well as replication of the same study with different populations and realities to evaluate and compare its effectiveness (Klein Tuente et al., 2020).

eHealth interventions with forensic mental health patients would benefit by focusing on virtual reality intervention since the population seems to be receptive to this type of technology. The intervention should be personalized to each individual, with a vast number of sessions, and combined with other forms of therapy for better results while taking into consideration the perception of friends, family, and professionals, as well as the participants.

CONCLUSION

This chapter reveals important aspects of VR technology and forensic mental health interventions. It also underlines the urgency for more research since continuing to create more literacy in this area can affect how we implement future interventions. Gaining insight into the reasons behind forensic patients' intervention motivation can help professionals implement a more suitable design, and therefore increase participants' engagement and adherence. Besides this, the authors of this chapter believe that creating valuable universal guidelines/technics, for specific populations could make this type of intervention more recognizable worldwide. To achieve the complete applicability of this approach, the guidelines should be adaptable to each culture and social context.

Along with this chapter, the authors bring about some aspects of which virtual reality intervention with forensic patients should consider, for example, individualization, interest, immersion, interaction, and imagination. To create a unique and effective approach, these techniques should be individualized to each participant's needs, interests, and skills. Moreover, they should promote complete immersion of the individual in the virtual scenario. By doing so, the participant is able to imagine and interact more intensely with this experience. VR technology makes possible the exposure of offenders to virtual situations that can produce disorder-relevant behavior, as well as monitor it without endangering other people. Although, readers should keep in mind that even if the five aspects previously mentioned are taken into account during the development of a VR intervention, it does not mean that the participants will significantly change their behaviors. Given the fact that this population has them so intrinsically incorporated into their way of functioning and coping, it is necessary to implement a long-term intervention strategy.

Concrete applications of virtual reality in mental health with forensic populations are becoming more common. Nevertheless, with the studies presented in this chapter, the authors conclude that most of these interventions focus on a short-term intervention plan, with a short span and number of sessions. In long-term interventions, individuals have the possibility to change or adapt their behavior and skills with the course of the plan since it allows them to practice them outside of the session for a vast period of time. Changing perspectives and mentalities demands time, however, it is never impossible, even in the most difficult and challenging of populations.

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KEY TERMS AND DEFINITIONS

Deviant Behavior: A person's behavior that deviates from the rules of a social group.

eHealth: The use of technology for knowledge, care, and health support.

Forensic Psychiatry: A psychiatric subspecialty that intersects the law with mentally ill individuals.

Inpatients: A person who goes to the hospital to stay for more than one night, to be monitored more closely, and receive medical care.

Mental Health: A person's well-being concerning, not only psychologically but also emotionally and socially.

Offenders: A person who committed a crime and whose actions caused problems.

Outpatients: A patient who goes to a health institution for treatment but does not stay overnight.

Virtual Reality: A computer-generated environment with a three-dimensional image that allows the person to interact with this environment through electronic devices.

Chapter 13
Usability and Applications of Virtual and Augmented Reality in Older Adults

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ABSTRACT

Virtual reality (VR) and augmented reality (AR) have been explored to be an effective alternative to integrating mental health intervention proposals, particularly in eldercare. The objective is to map the usability and applications of VR and AR technologies in interventions for the elderly population. The main areas of interventions in AR and VR applied to the elderly are stimulation and cognitive rehabilitation, physical rehabilitation, treatment of mental diseases, and promotion of quality of life. Despite the need for further studies, VR and AR have strong adherence among the elderly and demonstrate promising potential in interventions that seek to promote mental health and improve the quality of life.

INTRODUCTION

The growth of the elderly population has been increasingly noticeable due to the increase in life expectancy. The World Health Organization points out in its World Report on Aging and Health (WHO, 2015) that there was a significant increase in population aging, where one out of five people is aged 60 and over. It is necessary, then, to think about new forms of social functioning through actions and

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interventions that promote the health and autonomy of the elderly. Technological resources appear as an effective alternative in optimizing care for the elderly since they can overcome barriers such as cost, durability, and reach. These advantages have been enhanced due to the current global health conjecture, where contact between health professionals and patients has been restricted or drastically reduced (Ferreira-Brito et al., 2020).

Aging is a natural human course characterized by a decline in physical, sensory, and mental capacities (Tuena et al., 2020). In addition to the deficits arising from the normal aging process, some dysfunctions are commonly present among the elderly population, such as Alzheimer's disease, mild cognitive impairment (MCI) and Parkinson's disease. Thus, it is a priority to take care of this population's health and promote actions that keep them healthy and active (WHO, 2015). In this sense, although the idea of the elderly interacting voluntarily and masterfully with technological devices is unthinkable for some (Wiederhold, 2020), many studies have been conducted, and new technologies are being developed to address problems associated with the physical and mental abilities of the elderly, aiming to improve their quality of life (Lee et al., 2019).

New technologies are consolidated as an effective alternative in integrating intervention proposals with the elderly, especially in mental health. Virtual reality (VR) and augmented reality (AR) are technologies characterized by having components of visual, tactile, and kinesthetic perception, very similar to the real world (Malik et al., 2013; Optale et al., 2010). Prata et. al. (2018, p. 203) define VR as "a computer-generated self-contained digital world, consequently, virtual reality in a game is another powerful resource for the game designer to provides a richer and deeper player experience for the player because the entire "world" that the game is taken place is under his/her control. According to Grabowski (2020, p.01), VR technology is a form of illusion, a tool capable of replacing the real world with a virtual world fabricated using an electronic device such as a computer. The author explains that VR is commonly characterized by "Head-Mounted Display goggles equipped with one or two screens that display a computer-generated image. The image is generally stereoscopic, which means that it depicts slightly different images for each eye to simulate the impression of spatial vision". Augmented Reality is defined by Azuma (1997) as a variation of a virtual environment where there is no total immersion. While using an AR resource, the user is able to see the real world in an integrated manner with the virtual environment and virtual objects (or images) are just superimposed or composited with the real world. To be considered an AR system, this technology must combine the real and virtual environments, it must be interactive in real time and provide a 3D registration of virtual and real objects.

Both VR and AR have been widely explored for promoting, through their power of immersion and stimulation, several positive experiences for different audiences, in other contexts, such as the improvement of physical, psychological, and social factors; treatment of symptoms associated with stress and trauma (Dibbets, 2019; Zimmer et al., 2019); cognitive assessment and rehabilitation (Tuena et al., 2020); contribution to the treatment of schizophrenia (Dyck et al., 2010; Macedo et al., 2015); and disaster training with students (Caroca et al., 2016).

Current research indicates that the use of VR and AR to treat disorders such as depression and anxiety among the elderly emerges among the new evidence-based practices, with promising results and strong adherence among this population, going against the stereotype that the elderly are not adapt or are not attracted to technologies (Bhar et al., 2020).

In recent years, a multiplicity of studies on AR and VR interventions and experience have been produced (Mascret et al., 2020; Merriman et al., 2018); focused on increasing confidence and balance to prevent falls (Bakker et al., 2020; Chen et al., 2020); dementia (Sari et al., 2020); well-being and quality of life applied to the elderly (Barsasella et al., 2021). Therefore, the use of technologies shows promising potential in interventions that seek to promote mental health, rehabilitation, and this population's quality of life improvement.

The main objective of this review is to map and present, in a descriptive way, the available evidence about the usability and applicability of VR and AR technologies in interventions aimed at mental health and psychosocial rehabilitation of the elderly population.

VIRTUAL AND AUGMENTED REALITY AMONG OLDER ADULTS

In the last few years, there has been an increase in virtual reality and augmented reality investigation as an intervention for the elderly population to develop physical and mental health. The results found in this review confirm that technologies have been consolidated as an effective alternative, overcoming the most evident barriers over time, such as the current world situation of physical distance and other contact restrictions. Another contribution to its expansion concerns the constant evolution of technological devices that always prevent the improvement and resolution of everyday problems.

In this sense, the present study reinforces the advantages resulting from the use of technologies, namely for the domain of cognitive and psychosocial rehabilitation, quality of life, and mental health of the elderly in studies divided into five categories that are classified as the areas of greatest expansion in the articles found.

The main themes of the articles included in this review were categorized according to nature and objectives proposed by interventions that used VR and or AR for the elderly population. In this way, the studies were divided into five main categories:

1. Feasibility studies and acceptance of the experience in AR and VR
2. Prevention and contribution in the treatment of dementia, Alzheimer's disease, dementia, Parkinson's disease, depression, and anxiety
3. Evaluation and rehabilitation of cognitive functions such as memory, attention, language, and executive functions.
4. Training in spatial navigation skills, confidence, and balance improvement in the prevention of falls, and performance of daily activities
5. Promoting social engagement, well-being, quality of life, and mental health

Feasibility Studies and Acceptance of the Experience in AR and VR

The feasibility of applying VR arouses great interest from researchers since it presents itself as a strategy that can overcome barriers such as cost and sustainability and cognitive issues treatment (Abichou et al., 2017). Acceptance is a fundamental criterion in technology usability and involves understanding aspects such as effort, expectation and performance, social influence, and facilitating conditions as primary factors for predisposition to use (Tuena et al., 2020). In general, the authors found positive results about the use and acceptance of VR by the elderly (Lin et al., 2018; Syed-Abdul et al., 2019; Tuena et al., 2020; Yeh et al., 2020). Although technical and usage problems use suitable usability design methods, it is possible to obtain viable virtual systems for clinical purposes aimed at the elderly (Tuena et al., 2020).

However, some studies point to important characteristics that influence the acceptance of VR use by the elderly. Data from the study by Roberts et al. (2019) indicate that VR acceptance varies according to the perception of usability and usefulness. Marivan et al. (2016), in turn, found that the acceptance of the elderly also varies according to the motivation and willingness they have to carry out the activities. Syed-Abdul et al. (2019) highlight how the perception of utility, ease, and satisfaction has significant effects on VR acceptance and use. Yeh et al. (2019) reinforce that as a leisure activity, the continuous use of VR is associated with ease of use, utility, safety and flexibility, and fun. Therefore, the elderly can have both positive and negative perceptions about the use of VR. Thus, the approaches must consider the particularities of the users, prioritizing the interest of the elderly with the technologies to maximize their use and the consequent improvement in the quality of life (Marivan et al., 2016). They should also consider that some health problems, such as labyrinthitis and other vision related diseases, can interfere with satisfaction when using VR, so it is essential to consider the barriers in this type of intervention (Syed-Abdul et al., 2019).

The studies brought information that there is a positive response regarding the acceptance of VR use for leisure purposes, with virtual activities being a new entertainment option for the elderly (Yeh et al., 2019). In the research by Lin et al. (2018), the data revealed good acceptance by the elderly for leisure activities of virtual reality that are fun, safe, and easy. They seek an innovative experience that makes them feel physically and mentally healthy, which improves the quality of life, interpersonal relationships, and the feeling of belonging. The articles also point to positive results regarding the feasibility of using VR (Coelho et al., 2020; Park et al., 2020; Ferreira-Brito et al., 2020, Marivan et al., 2016). These data were extracted from studies that aimed to analyze the improvement in cognitive aspects in patients with mild cognitive impairment (Park et al., 2020; Ferreira-Brito et al., 2020) and patients with dementia (Coelho et al., 2020).

Ferreira-Brito et al. (2020) also highlighted, in addition to feasibility, the instrument's ecological advantages, as well as its accessibility and low cost. Marivan et al. (2016), in turn, showed the viability of VR for psychomotor rehabilitation by highlighting a positive response regarding the use of virtual reality training by patients with post-fall syndrome. Thus, we can see that the assessments on the feasibility and acceptance of VR among the elderly show that this technology has brought positive effects on cognitive and motor improvement, and consequently, on the quality of life of the elderly.

Prevention and Contribution in the Treatment of Dementia, Alzheimer's Disease, Parkinson's Disease, Depression, and Anxiety

Among the significant psychological disorders people face in their aging process are dementia, Alzheimer's disease, Parkinson's disease, depression, and anxiety. Studies point out the potential of using VR and AR tools to assess and treat these disorders (Ahmed et al., 2018). Dementia is considered a growing problem in current societies. Although science has not yet indicated an immediate cure for its treatment, it can still be delayed and even stopped under certain conditions. Alzheimer's disease accounts for about 60% to 70% of all dementia cases (WHO, 2015) and is often preceded by mild cognitive impairment (Manera et al., 2016), characterized by a multifaceted impairment of cognitive and executive functions, in addition to difficulty interacting with the physical and social environment (Tarnanas et al., 2013).

García-Betances et al. (2015) presented an overview, criteria, and strategy for developing VR tools in cognitive rehabilitation training to assist medical teams, health professionals, and other caregivers improve daily life activities to people with Alzheimer's disease and MCI. Results showed that cognitive rehabilitation systems based on VR could achieve the training goals and support procedures to mitigate behavioral and psychological symptoms of patients with Alzheimer's Disease and MCI. Another research, a case study, the potential of training with VR-based learning techniques to increase autonomy in culinary activities for patients with Alzheimer's Disease was evaluated. The results indicated that the patient relearned some culinary activities using virtual reality techniques, transferred to real life, and the improvement in task performance has remained stable over time (Foloppe et al., 2015).

One of the most advanced therapies in this field is cognitive rehabilitation using VR and AR. Studies reported that after rehabilitation with this type of tool, patients with dementia were more attentive and focused, not only on training skills but also on tasks of daily living. In a rehabilitation intervention using a serious game with VRs for 4 to 5 weeks, the performance of patients with mild dementia was assessed before, during, and after the intervention based on neuropsychological tests. The results showed a statistically significant improvement in four cognitive functions: functional memory, memory retention, executive functions, rigid thinking, and marginal changes in two other functions: attention and problem-solving. Although the results seem promising, the researchers pointed out the need for further studies with larger samples to corroborate the findings (Fasilis et al., 2018).

An alternative treatment for people with dementia, admittedly more fragile in terms of physical constitution, as they remain sedentary, would be the use of exergaming. This tool combines physical exercises with cognitive stimulation in a virtual environment. A study with the application of exergaming for two weeks in older adults with dementia showed positive results in their health status, with a higher adherence level than traditional aerobic exercises and reduced frailty in the physical, psychological and social domains. However, this item has no statistically significant difference compared to conventional aerobic training (Karssemeijer et al., 2018).

In a study with 30 participants with dementia undergoing attention activity and other cognitive tasks, comparing the use of VR and paper, it was demonstrated that 70% of the participants were more satisfied with the activities in VR. This number is still curiously higher among apathetic patients than the non-apathetic participants, demonstrating the potential to use VR in cognitive training with these patients (Manera et al., 2016). Another study compared the performance of older adults with mild dementia, impaired memory, and healthy older people through neuropsychological tests in a fire evacuation simulation VR tool, compared to neuropsychological tests in standard questionnaires. Results demonstrated success in diagnosing pre-dementia with the VR tool, overcoming the predictive clinical validity of traditional assessments (Tarnanas et al., 2013).

Depression and anxiety are mental disorders that affect people of all ages but have become increasingly common among the elderly due to changes in the body, mind, and social life. An experimental study evaluated the effect of an immersive sensorimotor rehabilitation program based on virtual reality - including scenarios of urban and natural environments, of free fall, among others - on mental health in the elderly, with pre and post-intervention assessment on the scales of depression, anxiety, and well-being. The tool demonstrated a multidimensional approach, responding appropriately to reducing symptoms associated with mental disorders and reducing all scales used (Brito et al., 2021). A systematic review using exergames to reduce depressive symptoms in the elderly found positive results. Studies that required depressive symptoms as an inclusion criterion for participation reported a significant decrease in depressive symptoms within the group after the exergame intervention. The main criticisms of the studies pointed out in this review were: small samples, exclusion of older adults with disabilities, and poorly standardized definition of exergame (Drazich et al., 2020).

A study using the VR tool with an elderly Thai population was developed to simulate a garden environment to treat depression, including walking in the virtual forest, arm movement, and brain function stimulation. Most older adults presented a high degree of satisfaction concerning the experience. However, adjustments were suggested, such as improved image quality and higher interaction environments (Suwanjatuporn & Chintakovid, 2019).

For Parkinson's Disease, the second most frequent neurodegenerative disease, related to age and resulting in loss of neurons with negative effects on dopamine production and movement regulation, some studies have revealed the successful use of VR-based treatments. However, in a systematic review, it has not been demonstrated that the effectiveness of VR-based systems therapy has been superior to conventional physiotherapy programs in patients with Parkinson's disease on motor balance and psychosocial variables, mainly cognition and quality of life (Morales-Gómez et al., 2018). Scope review found promising results in cognitive and motor rehabilitation, pointing out that VR-assisted cognitive-behavioral therapy can be adapted to suit the subtypes of anxiety disorders with the potential to improve the effectiveness of psychotherapy for patients with illness Parkinson's. However, it was pointed out that none of the researched articles explicitly focused on the treatment of anxiety in Parkinson's Disease, and further studies are needed (Thangavelu et al., 2020).

Evaluation and Rehabilitation of Cognitive Functions such as Memory, Attention, Language, and Executive Functions

The use of VR tools with the elderly has been widely used for four main purposes: assessing and diagnosing cognitive impairment, cognitive training or testing, training of caregivers, and approaches to treat cognitive deficits (Skurla et al., 2019).

Schneider et al. (2020) point out that it has become possible to promote improvements and more effective treatments related to cognitive functions with advancing technology and medicine. Among the various options available, technologies such as virtual reality and augmented reality have stood out for offering good cost-benefit, effectiveness, and a good level of adherence. The authors presented in their review a description and comparison of possible alternatives directed to the improvement and rehabilitation of cognitive processes. They clarified that, as memory depends on the environment, VR becomes a handy tool in the evaluation and even cognitive deficits rehabilitation and recovery.

It is known that cognitive training has positive effects on the cognitive level and can be developed especially through virtual reality, given its characteristic of imitating a real situation (Park et al., 2020). Furthermore, stimulation using virtual reality devices has characteristics similar to the primary mechanism of the human brain, which facilitates cognitive modeling through designs designed to simulate the internal and external environment (Gaggioli et al., 2017).

Chan et al. (2020) reveal that cognitive stimulation through virtual reality has great potential to be used as an alternative to traditional models of cognitive stimulation and show good adherence by the elderly. One of the advantages pointed out by this study concerns the possibility of intervention with VR being self-managed. On the other hand, it is questioned about the engagement of the elderly in virtual activities since they have reduced interpersonal contact compared to traditional interventions. Liao et al. (2019) also compared the effects of physical and cognitive training using VR with traditional physical and cognitive training techniques in older adults with mild cognitive impairment. Their results show an advantage concerning VR training. Although both training sessions develop executive function and verbal memory (immediate recall), only VR training improved performance in global cognition, verbal memory (delayed recall), and daily instrumental activities. In yet another comparison between interventions with VR and traditional interventions, Park et al. (2019) bring in their studies significantly positive results on an intervention in the elderly with mild cognitive impairment aimed at improving the visuospatial work of memory. When applying the training using mixed reality for six weeks and comparing it with a control group, it was observed that the group that received the mixed reality intervention obtained significantly better performance than the group that received the conventional intervention. Finally, the systematic review carried out by Skurla et al. (2019) shows that interventions with VR as a training tool for cognitive impairment for the elderly provide greater ecological validity than traditional interventions.

Thapa et al. (2020) investigated the effects of an intervention using fully immersive virtual reality on physical, brain, and cognitive functions in older adults with mild cognitive impairment. The 68 participants were randomly divided between the control group and the VR intervention group. The intervention program consisted of 4 sets of games using an Oculus VR headset and two manual controls for the assessment of physical and cognitive aspects, and participants performed 24 cognitive training sessions using VR, lasting 100 minutes each, three times per week for eight weeks, in addition to receiving guidance on the practice of eye stretching exercises and educational training. Participants performed only educational training for general health care in the control group, which consisted of a weekly session lasting 30-50 minutes for eight weeks. This study showed that interventions using VR technology are highly effective, and cognitive training based on this technology has positive effects in improving some physical, executive, and cognition aspects of patients with MCI.

In a literature review, Cherniack (2011) analyzed the published evidence in the medical field on the VR applicability in identifying and rehabilitating cognitive disorders in older adults. The results showed possibilities for using technologies, including neuropsychological assessment, diagnostic tests for deficits in executive functions, Parkinson's treatment and rehabilitation. In conclusion, comparative and more in-depth studies are still needed with a more significant number of participants. However, VR applied to the assessment and rehabilitation of the elderly is seen as an effective and versatile tool capable of meeting the health needs of this population.

Anderson-Hanley et al. (2018) proposed to evaluate the effects of an intervention involving aerobic and cognitive exercises in elderly residents in the community with or without risk of mild cognitive impairment. The study lasted six months, with 111 older adults who were randomly divided into three groups, and consisted of guiding an ergonomic bicycle connected to a screen that displayed the simulation. In group 1 (Exer-tour), the participants took a virtual panoramic bike tour and physical exercises interactively but with a low level of effort and cognitive load. Group 2 (Exer-score) consisted of performing interactive physical exercise, with goals and scores and with a relatively difficult cognitive effort from a video game; and in group 3 (game-only), the participants played the same type of video game, but the virtual bicycle needed to be guided through a joystick. This study showed that in the exer-tour and exer-score groups, there was a significant improvement in one of the three measures of executive function, in verbal memory. After three months of intervention, it was noticed that the exer-tour group had a significant effect on aspects of memory and everyday cognitive function. The authors concluded that the association between interactive physical and cognitive exercises brought significant cognitive benefits to the participants over six months.

Gaggioli et al. (2017) presented a fully immersive virtual reality system for training and rehabilitation with the elderly. The "positive bike" was designed to promote a real bike experience for dual-task intervention training in older adults. The system of this training program consists of an exercise bike arranged in an Automatic Virtual Cave Environment equipped with stereoscopic projectors. In the simulation, the user rides on the exercise bike through a park with animals and plants on the way and has the task of performing dual-task activities (motor and attentional). The authors clarified that the "positive bicycle" program is still in the testing process (pilot study) to determine clinical viability and usability. In the next phase of the research, the program was carried out with a sample of frail older people to evaluate the effectiveness of this population's functional state and well-being.

Studies to evaluate the use of VR-based tools in the characterization of memory profiles are also being developed. In the review by Plancher and Piolino (2017), it was possible to identify that the use of VR to assess episodic memory in normal and pathological aging has grown in recent years. The data also demonstrated that there is an improvement in episodic memory with active exploration of virtual environments. Widmann et al. (2012) used a photorealistic virtual reality model of a city to assess episodic verbal and spatial memory in healthy elderly and with mild Alzheimer's, comparing it with standardized neuropsychological tests of verbal and spatial ability. The results showed that, while healthy participants had an equivalent performance in VR and traditional interventions, participants with Alzheimer's had their capacities impaired in both interventions, especially about free memory, becoming more evident in the context of virtual reality than in standardized neuropsychological tests.

Monteiro-Junior et al. (2017) and Serino et al. (2017) also positively evaluated the VR intervention for memory improvement purposes, indicating the potential feasibility of this VR-based training for the spatial orientation of the elderly population. The study by Plechatá et al. (2019) evaluated and compared the user experience of immersive VR and non-immersive VR between two different age groups. The authors also evaluated immersion level effect on episodic memory performance for diagnostic purposes and tested the memory task validity performed in a virtual environment in both groups. Participants in this study were divided into two groups. The activity consisted of performing The Virtual Supermarket Shopping Task Performance, an exercise in a virtual environment that simulated a grocery store. As a result, the authors cite the significant differences in the participants' age-related performance when performing the task on a desktop vs. performing the same task in VR. Older adults had more errors when using VR, indicating that performing tasks with VR can be more difficult for this population than using a personal computer. However, this study also identified motivation and a good acceptance in using this technology by older adults.

Some state-of-the-art diagnostic methods are being developed to characterize cognitive impairment (Valladares-Rodriguez et al., 2019). Skurla et al. (2019) presented, through a systematic review, that virtual reality tools are helpful not only to detect the presence of MCI and Alzheimer's but also to perform the differential diagnosis between the two. Park et al. (2020) investigated the effectiveness of applying VR training programs based on the culture in patients with mild and amnestic cognitive impairment. The results showed that a 12-week program has no significant effect on patients' cognitive appearance. Still, for diagnostic purposes, Zygouris et al. (2017) evaluated the accuracy of a cognitive VR training application as a screening tool for the diagnosis and remote detection of MCI, indicating that the application is helpful in the detection of MCI.

In a systematic review, Cibeira et al. (2020) explored VR applicability as a therapeutic tool for diagnosing and preventing cognitive impairment in older adults. Most of the studies selected were related to cognitive impairment treatment, five articles aimed at diagnosing cognitive deficits, and only two articles were directed to study the use of VR as a preventive tool to the decline in cognitive functions. The results suggest that the use of technologies effectively improves the cognitive functions of older adults with some level of impairment and can be used in tasks of daily living. However, just a few studies focused on preventing cognitive decline, and more research is needed in this field.

Training in Spatial Navigation Skills, Confidence and Balance Improvement in the Prevention of Falls, and Performance of Daily Activities

With the aging process, it is natural to experience a decline in motor and balance functions in the central and peripheral nervous systems, consequently causing impairments in cognitive functions and a reduction in both sensitivity and the capacity for discrimination and interpretation by sensory receptors (Arlati et al., 2019; Laurence & Michel, 2017). According to Mirelman et al. (2013), recent studies have shown a strong correlation between motor and cognitive deficits with falls among the elderly population. The use of technologies such as VR can be an attractive and more effective alternative in the context of intervention because it can promote a more stimulating and prosperous environment than more traditional rehabilitation options.

Dermody et al. (2020) proposed evaluating the effectiveness of virtual reality applications using VR headsets available in the market to improve mental, physical, or psychosocial health among elderly residents in the community or institutionalized. Seven studies were analyzed, and the results indicate that the use of VR resources promoted significant improvements in the participants' health related to reduced risk of falls, and cognitive functioning in Alzheimer's disease, for instance. Those results indicate that technologies associated with health interventions have great potential.

Laurence and Michel (2017) carried out a literature review to analyze the causes for the occurrence of dizziness and imbalance and about the possible factors related to the high rates of falls among the elderly population, in addition to reviewing the methods for prevention, rehabilitation, and recovering the quality of life of these individuals. Among the possible forms of intervention, the authors clarify that both classical activities such as the use of cognitive stimulation or physical exercise and aerobic training, as well as the use of recent technologies such as virtual reality, video games, or computer training, can reduce the cognitive decline and improve balance and levels of attention and memory, in addition to helping to prevent falls and age-related deficits.

Mirelman et al. (2013) evaluated the effects of treadmill training combined with the use of VR simulating an obstacle course on the risk of falls, and improved mobility and cognitive function in a group of older adults without cognitive impairment, with mild cognitive impairment and diagnosed with Parkinson's disease without cognitive impairment. The intervention group task consisted of walking on a treadmill while a camera captured movements with sensors, and a simulation of paths with obstacles was projected onto a screen. The results and considerations are partial, and the authors conclude that the proposed intervention can maximize motor learning and induce the subject to perform a behavior change. Because it has a standardized protocol, it is a therapy that can be reproduced. This intervention project is favorable to developing and improving new care models that combine mobility training, cognitive stimulation, and technology to prevent and control falls and improve the quality of life of the elderly population with or without chronic diseases.

Monteiro-Júnior et al. (2017) investigated the effect of physical exercises using VR with exergames (PhysEx) on depressive symptoms, physical performance, fear of suffering falls, and the cognitive functions of institutionalized elderly. Participants were allocated between the VR experimental group and the active control group. The results demonstrated significant improvements in mobility and short-term memory among subjects in the VR experimental group, suggesting that the inclusion of physical exercises may contribute to the prevention and reduction of cognitive decline and functional loss in institutionalized elderly.

Davis and Ohman (2016) sought to compare the participants' performance in two wayfinding tasks in a virtual reality environment called Virtual Senior Living. In the tasks, the participants needed to find their way to a location through a VR simulation of a residence for elderly. For the first task, the subjects needed to find their way to a dining room (without signs), and in the second task, the path with multiple signs was directed to a specific door that led to the external environment. The control group included older people without cognitive impairment, and the intervention group included older adults with mild cognitive impairment or an early-stage Alzheimer's diagnosis. This intervention demonstrated that the use of signs in the environment makes it more favorable to orientation and has great potential in helping older adults with Alzheimer's find their way more effectively.

Ijaz et al. (2019) conducted a study to develop and analyze the viability of an immersive VR program to assess memory and spatial navigation capacity in the elderly. Participants were divided into an intervention group using the VR-CogAssesse platform and a control group using a standard screening platform on a personal computer to perform a recall test. The results demonstrated a higher score of recall of reference points, a lower index of navigation errors, and a significantly more significant increase in engagement and levels of presence in the intervention group. The authors concluded that immersive VR is effective, feasible, and compatible for spatial navigation memory assessment.

Lin et al. (2020) evaluated the effects of a combination of 3D virtual reality and horticultural therapy on the mental and physical health of institutionalized elderly. Participants were divided into experimental and control groups, and the intervention lasted for nine consecutive weeks. The results demonstrated that implementing the intervention with institutionalized older adults using 3D virtual reality resources was successful. Therefore, a 9-week program may be sufficient to promote significant improvements in health status, perception of importance, the meaning of life, socialization, improved mood, life quality, and depression levels.

Promoting Social Engagement, Well-Being, Quality of Life, and Mental Health

Emotional experience and its regulation have been associated with protective factors for physical and mental well-being throughout life, even affecting human immune functioning (Diamond & Fagundes, 2012). The use of virtual environments to increase positive experiences through mood inducers, such as exercises to generate positive autobiographical memories, mindfulness, and breathing rhythms, showed significant results in joy and relaxation and a decrease in sadness and anxiety of the elderly (Baños et al., 2012).

Ronquillo et al. (2020) evaluated an AR application to create an intelligent recommendation system for user's emotional state detection. The system shows multimedia content that connects emotionally with the user, selecting videos, images and sounds to improve the well-being of the elderly in their daily activities. The image sequence had a good impact on users, and the results showed good acceptability. The participants also provided important feedback for the development of future apps such as the need for clear instructions on app's use and the importance of having a facilitator to make the experience more pleasant and provide greater service so the users can adapt to the AR lens.

The emotional impacts of watching a 360º video in immersive conditions using VR headsets versus a non-immersive video using smartphones were also evaluated in a comparative study between elderly and young people. The results suggest that the smartphone intervention had a significant impact on the emotional well-being of elderly participants, while the immersive VR intervention generated some divergences regarding acceptability. In both studies, participants contributed important information for improving these tools, indicating that it is essential to involve and consider the needs of the elderly in the development of VR technologies (Liu et al., 2020).

The importance of involving the elderly and caregivers in the co-design process of new technologies was the focus of the study by Guerrero et al. (2019), which, through a co-participatory design, involved the elderly and caregivers in the development of an intelligent assistive system, which uses augmented reality based on projection with user interface technology to assess the functionality of the technology for daily medication management activity. The study presented a formal structure to understand the level of independence in daily activities and how assistive technology can adapt the support to an individual and be an essential support for carrying out daily activities.

Another determining factor for promoting and maintaining the well-being and mental health of the elderly population is social interaction. Studies indicate that virtual worlds can be an essential resource to provide social engagement, entertainment, and valuable information for the elderly population. Virtual worlds are known as computer-simulated environments in which multiple users can enter simultaneously to interact with the environment and other users. The research carried out by Siriaraya et al. (2014) was based on semi-structured interviews and previous research on healthy aging to explore the role of virtual worlds in personal engagement and characteristics of older adults who participated in virtual worlds simulations. This study had the participation of 15 older people who were already regular users of two virtual environments through the use of computers. The results showed that virtual worlds provide mental stimulation and engagement in productive activities, facilitate social involvement, and empower the elderly to manage their disabilities.

Shaunfield et al. (2014) carried out the project with long-term care residents. They evaluated the impact of face-to-face visits and trips to virtual fields concerning depression, social support, and physical and mental health. The results showed a significant mental health increase of the residents after the intervention, with a decrease in the indicators of depression and an improvement in physical health and social support. These results coincide with the systematic review carried out by Van Houwelingen-Snippe et al. (2021). They sought to understand how implementing interventions using virtual representations of nature to provide greater well-being in older people occurs, concluding that there is preliminary evidence on the effectiveness of virtual (natural) environments to improve well-being among the elderly.

Social support was investigated through a study that used an interactive VR environment to conduct an online support group for elderly widows, compared to a grief education website. The results showed that both interventions showed good acceptability and viability and resulted in significant improvements in grief, anxiety, loneliness, perceived stress, and overall quality of sleep at all times of the study. However, only widows in the VR support group showed a significant improvement in depression level over time (Knowles et al., 2017).

Comorbidities that arise throughout the aging process, such as mild cognitive impairment or dementia, are also associated with depression and negative emotional states that affect the mental health and well-being of the elderly. The literature review carried out by D'Cunha et al. (2019) indicated that virtual, mixed, and augmented reality interventions are becoming more accessible and are an exciting and emerging method to promote life quality, social interaction, and psychological well-being.

Advances in technology, particularly virtual reality, are also being studied in the elderly population suffering from chronic pain or pain to provide analgesia for involvement, distraction and improving these people's quality of life and depressive symptoms. The immersive VR intervention performed by Benham et al. (2019) did not indicate differences in the quality of life or depressive symptoms among the elderly. However, the results showed a significant decrease in pain perception and good acceptability for the use of this intervention. The authors suggest that the immersive VR intervention showed good applicability and effectiveness in reducing pain intensity for elderly residents in the community. These findings corroborate the systematic review carried out by Mathias et al. (2019), who identified the use of VR in the clinical environment for the elderly population in several domains of mental health, such as cognition, conditions along the spectrum of mood, anxiety, and anxiety disorder, for example. The authors point out that the use of this technology is promising but is necessary for future studies to address the key issues surrounding the use of VR in clinical settings, such as usability, data privacy, and confidentiality.

CONCLUSION

This review mapped the studies found in the literature regarding the usability and applicability of VR and AR technologies in interventions aimed at mental health and psychosocial rehabilitation of the elderly population. It was found that in the last ten years, there has been a growing increase in the number of annual publications on this theme, primarily experimental studies, showing the emerging and innovative character of new technologies. A significant majority of research on the use of VR and AR by the elderly focus on their cognitive and motor improvement, and are aimed at individuals diagnosed with Alzheimer's or Parkinson's. VR was considered an adequate tool for treating disabilities such as spatial memory and other cognitive functions and is characterized as an innovative, interesting, and economical approach to promote social engagement and mental health in elderly populations.

Despite the exponential interest, it is emphasized that it is still a field of study under construction. The studies show excellent acceptability of VR and AR technologies, in addition to positive effects in the most varied domains aimed at promotion, prevention, and intervention for the elderly population. However, they also make evident the importance of considering the specific needs of this population concerning familiarity and the impact of the immersive experience. One solution would be to include this audience in developing interventions through a co-participative design to improve usability, promoting greater accessibility and technological literacy.

It was also observed the lack of standardization of the studies regarding the terminologies used referring to the new technologies and little conceptual framework referring to the elderly population. One of these aspects is the fact that while virtual reality reaches more people and promotes a safe immersion experience, on the other hand, it does not require fundamental physical contact in relationships and may not be accessible to those whose physical, psychological, or social barriers hinder the use of technological devices.

While ethical issues are important when talking about the use of new tools and represent an area in ascending exploration such as RA and RV in mental health interventions with the elderly population, just a few studies address this subject. Davis and Ohman (2016) report that even though some studies with these technologies are conducted with a potentially vulnerable population, it is still a low-risk intervention. Skurla et al. (2019), on the other hand, explains that ethical issues related to the use of these technologies with older people in a severely vulnerable position still need to be addressed and warns of the need to ensure privacy and data confidentiality in the widespread VR use in clinical environments.

Although all studies show the importance of using VR and or AR technologies for the elderly population, many did not present clear information about the methodologies and interventions used and references regarding interventions follow-up. Thus, future studies should address the development, impact, and effects of interventions in a more integrative way and provide long-term follow-up and with larger samples to maximize the benefits and accessibility of new technologies for mental health and psychosocial rehabilitation for the elderly.

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Chapter 14
Virtual Reality Environments in Pain Management

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ABSTRACT

Pain is a distressing and subjective feeling that occurs in different intensities and may result from the stimulation of a nerve due to injury, illness, or emotional disturbance. This chapter aims to understand how VR can contribute to pain management. To this end, the authors will address topics such as: pain – types of pain and its consequences in everyday life, as well as ways to relieve it; virtual reality – what it consists of, its functionalities and components, as well as its application to health and well-being, its advantages and limitations; and virtual reality in pain management. It is intended to emphasize the importance of pain management for the daily lives of individuals and the consequent improvement in the quality of life of those who benefit from this type of intervention.

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INTRODUCTION

It is undeniable that, throughout life, we all experience some pain. Characterized as a sensory or emotional experience, pain is a distressing and subjective feeling that occurs in different intensities and may result from the stimulation of a nerve due to injury, illness, or emotional disturbance (Riva et al., 2011; Tait et al., 2009). More specifically, the International Association for the Study of Pain determines that this unpleasant experience is "associated with, or resembling that associated with, actual or potential tissue damage". It is a personal experience influenced by several unique and individual factors, which can translate into negative consequences, not only at the physical level, compromising the individual's functionality, but also the social and mental well-being (Merskey, 1994).

This reaction to harmful stimuli is regulated by non-nociceptive blocked mechanisms located in the spinal cord, as explained by the "gate control theory", allowing the increase or attenuation of perceived pain. It may also be due to distracting stimuli, which helps a harmful reduction of nociceptive neuronal signaling, attenuating perceived pain (Melzack & Wall, 1965; Triberti et al., 2014). In 2006, Luna considered that, as well as cardiorespiratory and thermal functions, pain should be considered a fifth vital sign, which informs the person about the danger to their physical integrity. That is why it is so important to know how to distinguish physiological from pathological pain. While the first assumes protective and adaptive functions, namely inflammatory and nociceptive pain, the second does not (Luna, 2006; Sneddon, 2017).

Nociception is the process that describes pain processing and responses that pose a threat to the normal state of nervous tissue. In general, pain is classified in two different kinds: acute pain, being transitive, manifests itself in a short period, usually resulting from easily identifiable causes; and chronic pain, a constant or intermittent painful feeling, that extends over time (Riva et al., 2011; Tait et al., 2009).

Even so, pain may differ according to its pathophysiology: nociceptive pain - caused by damage to the body, serving a purpose (protection, for example); neuropathic pain - presupposes a direct consequence of an injury or disease of the somatosensory system but which can be felt in areas far from the injured one; and nociplastic pain - emerges from a nociceptive change, even if there is no evidence or threat of tissue or somatosensory system damage (Jensen et al., 2011; Jensen & Gebhart, 2008; Kosek et al., 2016).

As a typical sign of acute pain, physiological pain responds to stop exposure to the harmful stimulus to preserve tissue homeostasis. For this to happen, it is necessary to intervene with the free nerve endings of first-order neurons, called nociceptors. The harmful external stimulus is transmitted to the Central Nervous System through processes of transduction, transmission, modulation, and perception of the neural signals generated as a response (Pace et al., 2018; Sneddon, 2017).

In a simplified way, this process consists of a chain where the first-order neuron originates from the periphery and protrudes into the spinal cord; the second-order neuron ascends through it, and the third-order neuron protrudes into the cerebral cortex. Projection neurons carry nociceptive information through five main ascending pathways that innervate the thalamus, midbrain, limbic system, and reticular formation, which in turn are responsible for the location of pain, its intensity, and its effective and cognitive aspects (Klaumann et al., 2008; Lamont et al., 2000). The periaqueductal gray of the midbrain is considered the most crucial anatomical region to the endogenous analgesia system, comprising the pathways that originate in the brain stem and spinal cord that end. The inhibition of the nociceptive neurons presents here is made by excitatory connections with serotonergic and noradrenergic neurons which lead to the dorsal horn of the spinal cord which results from the inhibitory neurons of the blades connections I, II, and V (Klaumann et al., 2008; Lamont et al., 2000).

As for nociceptive pain, the potential damage of the tissue is recognized by the sensory endings of the nerves mentioned above – nociceptors. It is called “potential damage” since damage to the nervous tissue may not occur if the exposure time to the harmful stimulus is short, resulting in temporary pain and indicative of danger, as an alert system – acute pain. When there is nociceptive signaling/excitation, the event is experienced as painful, depending on factors such as the context and the priority that the brain gives to the stimulus. Examples of this kind of pain are episodes when we place our hand on a hot surface or sprain an ankle (Moseley & Flor, 2012).

On the other hand, when nervous tissue damage occurs, the body triggers an inflammatory response – (nociceptive) inflammatory pain. This response, which involves chemicals from the blood, the immune system and released by specialized nerve fibers, will allow tissue regeneration. It is possible to verify that tissue healing occurs when edema, redness, and hypersensitivity to touch and movement appear. In these situations, acetaminophen or anti-inflammatory non-steroidal recurs to control the pain and thus allow the person to remain active, returning more quickly to their daily tasks.(Moseley & Flor, 2012; Schug & Goddard, 2014). This kind of pain is characteristic of the neck or nonspecific lower back injuries, bone fractures, or pulled muscles.

Concerning inflammatory pain, cases of hypersensitivity are recurring, resulting from severe changes in the function of the nervous system. In these cases, it is important to understand the adaptive mechanisms of the neuroplasticity nervous system, responsible for adaptations and neurochemicals in cells. These neuroplastic processes occur both in the nociceptive pathways, as in the spinal cord and the brain, and are related to memory storage and consolidation, resulting in cortical remapping (Pace et al., 2018).

When damage to the somatosensory nervous system occurs, we are faced with neuropathic pain, where can ocuur hyperalgesia - overreaction to painful stimuli; paraesthesia - pins and needles, tingling, pricking or a feeling as if ants are crawling over/under the skin; mechanical allodynia - extremely sensitive to touch; and spontaneous pain. The neurobiology of pain is extremely complex and the etiology and pathogenesis of this type of damage are very different, with several patterns of sensory symptomatology being verified (Baron et al., 2017; Finnerup et al., 2016; Maier et al., 2010).

Numerous parallel and interdependent pathophysiological processes in the periphery, spinal cord, and higher centers contribute to neuropathic pain. This is distinguished from chronic pain by pathophysiological changes, as it is marked by changes in normal sensory signaling, triggered over weeks or months, at the level of the periphery, spinal cord, as well as the thalamus and cortex. When inflammatory mediators are released, primary afferent neurons increase their excitability, which leads to the appearance of stimulus-independent ectopic activity (Alvarado et al., 2013; Costigan et al., 2009; Luo et al., 2014; Tajerian et al., 2013). It is also relevant to mention that an axonal injury of this nature can cause changes in the sensory mapping of the spinal cord, and these neuropathic pain disorders can be related to changes in the excitability of the injured neuron (Devor & Wall, 1978).

With these changes in synaptic transmission, excitatory processes are intensified, and, in contrast, inhibitory ones are attenuated. Even so, the intrinsic properties of dorsal horn neurons are little altered, which corroborates the hypothesis that central sensitization is conducted and maintained by continuous ectopic activity in peripheral nerves (Balasubramanyan et al., 2006; Daou et al., 2016; Sexton et al., 2018; West et al., 2015).

In this sense, the complexity of the physiological basis of neuropathic pain greatly complicates the search for effective therapeutic targets due to the various consequences of the use of gabapentinoids - drug class derived from inhibitory neurotransmitters - for synaptic transmission, the selective actions of neurons, and the excitability of the network, both at the spinal level and from the higher brain centers (Bannister et al., 2017; Biggs et al., 2014; Offord & Isom, 2016).

Beyond these, there are other ways to classify pain, knowing that uncontrolled pain can be translated into severe physical, mental, and social complications depending on the intensity, duration, and location. In addition to impairing functional capacity, studies have shown that pain can decrease satisfaction with basic needs, affect mood and promote aggressivity (Z. Chen et al., 2008; Riva et al., 2011; Tait et al., 2009). Believing that pain can totally change the way someone performs daily tasks and, in extreme cases, can even challenge the will to live, Cicely Saunders developed the concept of "Total Pain", which states that pain cannot be separated from personality or environment (Samoilova et al., 2010).

Although the pain has a protective function and promotes healing, causing sensitivity to movement or any stimulus that has the potential to delay recovery, it is not always linked to tissue damage or fulfills this protective function (Auret & Schug, 2005; Finnerup, 2019). Nowadays, there are some interventions to alleviate and/or manage pain, depending on its nature. Pharmacological options, as long as they are well managed, can be an effective and safe response, being generally economical and, in some cases, accessible without a prescription. These opioids interrupt the C-fiber pathway, which transmits nociceptive signals to the Central Nervous System (Auret & Schug, 2005; Finnerup, 2019).

However, drug treatment of pain has some limitations due to adverse effects and a high probability of toxicity and because it represents an increased risk to cases that present comorbidities, such as deficits in balance or cognitive function. It is also essential to consider additive effects, with half of the overdose numbers resulting from prescribed narcotics and the abuse of these substances already exceeds traffic-related injuries as a cause of death in the USA (Auret & Schug, 2005; McLean & Le Couteur, 2004).

Thus, to minimize the side effects caused by prescribed narcotics, the development of non-pharmacological interventions has been a target of significant investment (Chiamulera, 2019; Riva et al., 2011). There is cognitive-behavioral therapy, hypnosis, and Virtual Reality (VR), affecting pain perception via attention, concentration, and emotional alteration (Chiamulera, 2019).

Although there is no evidence to support these complementary therapies, meditation, yoga, acupuncture, music therapy, chiropractic, guided imagination, and biofeedback are also recommended (L. Chen & Michalsen, 2017; Taylor et al., 2019). Furthermore, Transcutaneous Electrical Nerve Stimulation (TENS) is recommended due to the involvement of endogenous systems for controlling pain and brain plasticity and cognitive-behavioral therapies, relaxation, and psychotherapy, commonly called mind-body techniques (Coutaux, 2017). When pain represents an obstacle to functionality and where the underlying cause can be treated safely, and with clinical benefit, surgical intervention is also indicated (Cruccu et al., 2016).

Knowing that, in addition to medical treatments, psychotherapy is an essential aspect in pain control, about the understanding and management of thoughts and emotions, five theory-based functionalities were outlined: pain-related education, self-monitoring, goal setting, peer-based social support, and pain coping skills training and rehearsal (Alexander & Joshi, 2016; J. Stinson et al., 2013; J. N. Stinson et al., 2014). Even so, the integration of multimodal approaches has had some barriers, such as poor accessibility for geographic reasons, high costs, and, mainly, lack of availability of qualified professionals, not allowing an adequate acquisition of knowledge and training of skills to deal with and, consequently, promote self-care (J. N. Stinson et al., 2013).

Studies and research on experiences in virtual environments begin to open unimaginable ways to understand brain processes, human behavior, the mind-body relationship, and how human beings interact in the environment surrounding them in a bidirectional relationship (Chiamulera, 2019).

BACKGROUND

1. Gamification

Star rating systems to classify products and progress bars to motivate users to complete profiles or actions are examples of motivation strategies using game features in non-game contexts. These strategies are called gamification, which has proven to be quite useful in repetitive and monotonous tasks, through playful and interactive experiences to promote motivation and involvement (Deterding et al., 2011).

In general, it is possible to transform any system, service, or activity in light of gamification, having already been widely used in the areas of fitness, education and learning, commerce, information retrieval, organizational involvement and health, and well-being, with evidence of that this game mechanics has a significant impact on the behavioral results of individuals when compared to the performance in mechanisms (Rapp et al., 2019).

Despite being a promising concept, few studies determine the effects of gamification on individuals, what their true scale is, and how they unfold. There is already a great effort to establish accurate, efficient, and based research questions based on current theorizing, namely regarding the psychological processes underlying the interaction with gamified systems and the impact of specific elements (Landers et al., 2019; van Roy & Zaman, 2019).

Depending on the authors, it is based on theories such as Social Interdependence Theory (Johnson, 2003), Goal-Setting Theory (Locke & Latham, 1990), and Systematic Multiple Level Observation of Groups (SYMLOG) (Berdun et al., 2019) that the use of gamification for different purposes has been studied. Some authors also suggest studies based on Determination Theory (Deci & Ryan, 1985) to deepen the theoretical and empirical explanation of the psychological processes that explain the results observed to date, as well as the effects of gamification and how it works at the level psychological and functional (van Roy et al., 2019).

The findings in the studies of gamification and, consequently, the improvement of techniques and methods that allow its use will enabling the development of applications that make use of this technique and that allow integrating more elements of the game besides points, emblems, and tables of classification (Rapp et al., 2019).

2. Virtual Reality

VR consists of a virtual and technological environment that promotes the interaction between people and the virtual environment, enabling the user to (re)live pleasant experiences, allowing it to be completely abstracted from the reality in which it finds itself (Freitas & Spadoni, 2019). Using advanced technological instruments, the person receives various sensory stimuli, which provoke the sensation of interaction with the virtual environment (Gonçalves et al., 2019). It is important to note that, while VR provides a virtual environment that is totally independent of the real one, Augmented Reality uses digital content to enrich the real world (Zhan et al., 2020).

To put it in context, in the early 1930s, Edward Link invented the *Link Trainer*, which consisted of a commercial flight simulator. It was a device that was controlled by engines and used a rudder to simulate turbulence. Later, in the 1960s, appeared the first multisensory machine, named Sensorama, with stereoscopic color display, odor emitters, stereo sound system, and a motional chair, and also the Telesphere Mask, the first monitor mounted on the head (Hoffman et al., 2004; Kohut & Kreminskiy, 2018).

In the 80's, VR became a popular term with the development of Data Glove - an interactive device that facilitates tactile sensing and finemotion control; the Eye Phone, and the Audio Sphere. It was also in this decade that NASA promised the development of remotely controlled space hardware by introducing two small LCD screens and a helmet-mounted sensor. In 1995, Nintendo released the first console capable of displaying stereoscopic 3D graphics, "Virtual Boy" (Kohut & Kreminskiy, 2018).

Nowadays, we have access to panoramic views of roads, interior buildings and rural areas, thanks to Google, which in 2007 came up with Street View. Only later, in 2011, appeared the iPhone VRViewer, which consists of a device that is incorporated into the iPhone to provide a three-dimensional and immersive experience for the user. A year later, were launched the VR glasses, which are currently known and used (Kohut & Kreminskiy, 2018).

Sinse "The Oculus Rift", a headset device that allows a 90 degree field of vision, companies such as Microsoft, Samsung, Sony, HTC, and Valve have invested in the development of this technology in different areas, such as entertainment, medicine, telepresence and telerobotic systems, education and digital marketing (Kohut & Kreminskiy, 2018).

Nowadays, VR has great applicability in human beings' daily lives and can have a significant impact on health. In these experiences, the individual visualizes a scenario created on the computer and feels totally immersed in that virtual environment. Depending on the type of VR, some materials are required, such as a computer, a projector, a screen, joysticks, consoles (PlayStation, Xbox, Nintendo), smartphone, and a screen used on the head at eye level – Head-Mounted Display (HMD), covering the whole field of view. The HMD completely covers the vision in order to enhance the feeling of immersion (Kohut & Kreminskiy, 2018). In VR, it is important to know how to distinguish three main features: immersion, interaction, and engagement. While immersion is the feeling of being involved in an environment (which can be subdivided into different types), interaction is what characterizes the individual's response to the stimulus exposed by VR and, finally, engagement is the degree of involvement of the stimulus (Pourmand et al., 2018; Silva et al., 2020).

On the other hand, in Augmented Reality (AR), something is added to the real scenario where the person is. Using a marker, a webcam or a smartphone (IOS or Android), it is possible to add and interact with characters and/or objects in an initially empty scenario. With a focus on the real world, it's easy to distinguish the real from the virtual. The goal is not to provide an immersive experience, but rather to enhance interaction with the real world. Some examples may be the world-famous game "Pokemon Go" and the "Beat Saber", the most played game in 2019, according to Steam's bestseller list (Stamm et al., 2020; van Roy et al., 2019).

It is unanimous that VR has numerous advantages for educational, therapeutic, social, and entertainment purposes. The fact that it is incredibly stimulating and insulating from the real world allows promoting motor, cognitive and social skills, which may be less developed in the user. The interaction of a game with a joystick can promote improvements in users with difficulties in the entire upper limb. At the cognitive level, we can talk about games in which it is possible to place the user in a painful reality and work to become something comfortable to overcome specific phobias or fears. As for the social level, video games are clear examples of promoting socialization among colleagues, and it is on these same platforms that new friendships are created. The fact that there is not always face-to-face contact in this type of technology, using other strategies such as video calls, makes the interaction between people more accessible (Kohut & Kreminskiy, 2018).

This is a technology that also has some less favorable aspects, highlighting that it is still expensive and the software is complex. The hardware and all the materials necessary for its correct use still have a high price, making it challenging to use on larger scales (Kohut & Kreminskiy, 2018).

3. Virtual Reality in Health and Well-Being

Virtual Reality, as an immersive environment, has offered new opportunities for serious games in therapeutic exercises, already having a great impact on the training of activities and/or tasks that require the development of specialized technical skills, being considered as a teaching resource, especially for the health field (Barilli et al., 2011).

The existing literature describes some limitations to the use of Virtual Reality in healthcare, including secondary effects (such as nausea, disorientation and balance disorders), as well as the person's own limitations and/or cognitive deficits, which can be an obstacle to the intervention . In addition, usability issues, the high cost and time for preparation and/or resolution of possible problems are also mentioned (Dores et al., 2013; Kiryu & So, 2007; Lewis & Griffin, 1997; Park et al., 2019).

Even so, the advantages of this technology are highlighted, since it can be used in several domains (cognitive functions, neurological diseases, physical disabilities and behavioral disorders). Its immersive, interactive and realistic features allow you to work in any context, with total control of the environment and minimal supervision, constituting a safe therapeutic environment. This way, the rehabilitation can be more personalized, resorting to goal-oriented tasks, adjusting the repetitions and intensities of the exercises as necessary (Dores et al., 2013; Lewis & Griffin, 1997).

a) VR Applied to Medicine and Education

The quick results in the biomedical field and the constant evolution of technologies associated with the clinical procedures have facilitated the continuous updating on health professionals, aggravating the need for investment in virtual forms of training to facilitate access. Nowadays, VR programs can simulate clinical cases in different specialties, reducing the need for real contacts between the doctor and patients in the early stages of medical learning (Tang et al., 2020). The study of anatomy in virtual modules makes it possible to provide color images and more realistic behaviors than the atlas in paper format and reduces the adverse psychological effects generated by contact with real cadavers, further reducing the need for their use. However, the risk of medical errors involved in this practice is quite significant, leading to health problems for patients, ethical and legal issues for health professionals (Tang et al., 2020).

VR applied to surgery has also been developed, covering various situations that range from planning, procedure, and training of techniques to perform these. These programs result from virtual simulations of specific operations so that surgeons can train specific techniques and enhance total success in future surgeries. The first surgical simulator was developed in Brazil to collect bone marrow. In the simulation area, prostate cancer diagnosis and post-cancer breast reconstruction were among the first programs to be developed (Tang et al., 2020; Vaughan et al., 2016).

b) VR Applied to Neurology

In brain disorders or damage, strategies have been explored to support the treatment of different motor and cognitive sequelae using this technology. In general, virtual environments enable various associations not possible with other human-machine interfaces due to the multisensory and spatial qualities of these environments, contributing to the enrichment of applications in the rehabilitation area (Mrakic-Sposta et al., 2018; Serino et al., 2017).

To recover the affected skills or optimize possible effects, it is necessary to create specific therapeutic strategies for each type of deficiency or pathology detected. An example of this is the case of individuals who suffered a stroke, who usually have motor complications that are easily visible and often accompanied by pain but can also impair cognitive functions (Mrakic-Sposta et al., 2018; Serino et al., 2017). To this end, telerehabilitation has been well developed, allowing the therapist to conduct interactive sessions for the treatment of people with motor sequels and attention and perception deficits, developing exercises in a 3D virtual environment to stimulate and enhance the performance of activities of daily living, without having to leave home. These patients have collaborated with enthusiasm in the intervention, ending up significantly optimizing the results and, consequently, promoting their rehabilitation (Goo et al., 2020; Nunes et al., 2007).

Also, it was revealed that VR is a method to follow in monitoring spinal cord injury. Studies report improvements at the physical level mobility (movement of the upper and lower limbs), balance, endurance, and development of muscle strength. However, once again, the most significant difference between the use of traditional therapies and virtual reality therapies is the motivation felt by the patients, which allows the therapy session to be accepted in a more positive way, which consequently affects the results favorably (Abou et al., 2020; Correia et al., 2018).

In the matter of Multiple Sclerosis (MS), numerous studies prove that this can be a form of therapy complementary to physical therapy. This is a chronic disease of the central nervous system of an inflammatory and demyelinating nature. Consequently, it is possible to observe multiple symptoms, including visual disturbances, emotional instability, balance deficits, moderate/severe fatigue, weakness, and, in advanced stages, all these symptoms accompanied by pain. Through games that approach the real world, VR provides these patients with proprioceptive stimuli and external visual feedbacks, which will simplify the relearning of motor strategies and guidance for low, medium, and high-intensity tasks. This contributes to increasing patients' motivation through experiencing different stimuli, increasing the likelihood that they will achieve improvements, essentially in terms of attention. Thus, a better ability to concentrate on the activity leads to the evolution of performance in the remaining motor and cognitive parameters due to the possible excitation of cerebral neurotransmission. Currently, three VR devices (PlayStation Move, Xbox 360 Kinect, and Nintendo Wii) allow adapting challenges to rehabilitation, although they were not developed for this purpose (Abou et al., 2020; Durão, 2019).

Studies in neurological pathologies, such as Parkinson's disease, attest, in the overwhelming majority, to the remarkable effectiveness of this approach in the face of deficits in balance and fatigue. Usually, these individuals stroll with small, dragged steps, with reduced arm balance and flexed posture. These behaviors and characteristics can cause a reduction in gait speed, a decrease in stride length, and an increase in cadence. In more advanced cases, they have a frozen gait, in which, despite the patient's attempt to walk, the progression of the feet forward is significantly reduced, increasing the risk of falls, which consequently leads to pain (da Cruz Souza et al., 2020; Gandolfi et al., 2017).

As previously mentioned, the Nintendo Wii and Playstation have been widely used to treat these pathologies. In addition to having a relatively low cost, technologies and rehabilitation programs through Virtual Reality are capable of facilitating the performance of high-volume exercises and improving postural control, mobility, gait performance, and balance in people with Parkinson's Disease. Commercial video games, although not explicitly developed for individuals with neurological disorders, are capable of stimulating multidirectional displacements, weight transfers, a high number of repetitions, planning, and decision making, in addition to the sustained concentration that is necessary, promoting motivation and commitment to the tasks performed. VR in these video games also has a very positive role in terms of motivation and adherence of the participants since many games replicate real-life scenarios and are appealing. It becomes a personalized and motivating way that brings fun and pleasure to the recovery process (da Cruz Souza et al., 2020; Gandolfi et al., 2017).

It is also possible to apply this technology in intervention with people with dementia, namely in reminiscence therapy, cognitive stimulation activities, ADL training and relaxation. It is also possible to apply this technology in intervention with people with dementia, namely in reminiscence therapy, cognitive stimulation activities, ADL training and relaxation. Although it was not possible to find evidence to support the use of VR in reminiscence therapy, non-pharmacological interventions represent a decrease in disorientation and depressive symptoms, an increase in the sense of well-being and improvements in executive functions (Caiana et al., 2016; O'Philbin et al., 2018).

c) VR Applied to Mental Health

This technology has also been widely used in the treatment of phobias, exposing the individual to stimuli related to the phobic object. This exhibition is characterized as an intermediate procedure between exposure by imagination and exposure *in vivo*, and must be graduated (Cunha & Leitão, 2003; Haydu et al., 2016). This approach has been well received as it is a safe environment where existing trigger stimuli are easier to control than in the real world. The therapist can regulate the intensity and frequency of the stimulus presented and also present it in different contexts (Netto, 2006). The individual interacts with the virtual environment through an interface that best suits their needs: glasses or helmet with visors; joypads, mouse or real control simulators. In this approach, without ever losing contact with the therapist, it is very important that the person feels immersed and involved in the created environment, so that they experience emotional responses as close as possible to in vivo exposure (Haydu et al., 2016; Netto, 2006).

Another very promising area is virtual exposure therapies for post traumatic stress disorders. Similar to the others already mentioned, using VR it is possible to verify that the person is more motivated to actively participate in the rehabilitation process. Furthermore, with this resource it is no longer necessary to use imagination to provoke emotional responses related to trauma, being in a safe environment (Rigoli & Kristensen, 2014).

d) VR Applied to Developmental Disorders

On the subject of Down Syndrome, these individuals have several perceptual-motor and sensory integration dysfunctions that are reflected in an atypical development in psychomotor and learning aspects. These neurological characteristics of the syndrome make it necessary for health professionals to work in ways that promote psychomotor skills since they are a prerequisite for developing higher cognitive skills. For this reason, many therapists turn to Virtual Reality (VR) to carry out activities aimed at the motor and cognitive skills, with possibilities for adjustments in the distribution of the steps of the actions relevant to the required performance times and functional capacities, constituting itself as an activity means and end of the intervention.

Sedentary behavior and low levels of physical activity are indicated as risk factors for health in the population with Down Syndrome. Researches also report that the sedentary lifestyle presented by most people with DS results from the motor limitations presented by many of them to perform numerous activities, especially when it comes to children. Therefore, VR enters this pathology as a motivating and playful intervention program, turning out to be attractive and promoting new active behavioral patterns.

MAIN FOCUS OF THE CHAPTER

Within the scope of health care, it is often necessary to resort to painful procedures, either for prevention, diagnosis, or treatment purposes. This threatening physical and psychological well-being situation affects all age groups, with a particular focus on children and adolescents (Wiederhold, 2006). With the growth of immersive and complex technologies, the aim is to obtain sensations or inhibit feelings through the modulation of afferent and efferent pathways to the human brain. In this sense, VR has been used as a mechanism capable of providing different sensations in adverse situations (Fernandes, 2019).

Similar to the rehabilitation of people with anxiety, psychosis, Parkinson's Disease, neurological syndromes, phobia, among others, VR has also been used to reduce pain in various age groups and different types of individualized pain, such as in burn and post-surgical patients (Pourmand et al., 2018; Silva et al., 2020). In the most recent years, the use of VR as a non-pharmacological therapy for pain management has been progressively gaining more adherence due to the decrease in analgesics and the possibility of being used at home with relatively reduced costs. There are several theories about the effects that VR has on pain relief. Some of them claim that this promotes distraction from the painful experience. Others suggest that VR affects how pain is processed in the Central Nervous System (Ahmadpour et al., 2019; Chiamulera, 2019).

The VR offers multisensory experiences in a virtual environment that can influence emotional processing in the brain and, consequently, pain. When presenting emotional stimuli, for example, through video images that transmit positive emotions to the patient, this approach can influence the perception of pain, involving downward modulating pathways, reducing it. Contrary to what was expected, the medical community has pleasantly accepted the use of VR as a therapeutic technology. Although there is still no consensus on the mechanisms through which VR has an impact on pain, it is known that, effectively, this new resource can alleviate different types of pain (Ahmadpour et al., 2019; Silva et al., 2020).

According to Hunter Hoffman, "using VR, we can teach chronic pain coping skills, techniques that patients can use on their own that will help decrease it. Learning changes the brain and gives patients something that keeps working when they take the device off. When they realize that their pain is not inevitable, they become more receptive to physical therapy exercises and more likely to move on their own" (Brody, 2019).

There are several theories about the action that VR has on pain relief; some claim that this feature promotes distraction from the painful experience. Others suggest that virtual reality affects the way pain is processed in the central nervous system. The literature argues that the method of distraction from the painful situation can alleviate the perception of pain. The device used allows the user to be immersed in a different environment, capable of distracting and stimulating them differently and filters out external information associated with pain or its source. In this way, its use allows inducing an analgesic sensation much superior to that felt during other types of distraction, such as games, films, or videos. Even so, it should be noted that the use of this technology does not annul or replace the analgesic treatment but serves as an adjunct to existing treatments (Chiamulera, 2019).

In recent years, several researchers have created techniques to control pain through technologies, such as VR. One of the pioneering projects with a VR approach to relieve the pain of burn patients is SnowWorld VR, developed at the University of Washington HITLab and Harborview Burn Center, Seattle, Washington. This system consists of an HMD through which patients visualize and interact with snow-themed characters and shoot virtual snowballs when approaching snowmen using a mouse or computer keyboard (Dascal, et al., 2017).

According to Scapin et al (2017), in the pediatric population, the use of VR allows shifting the focus of attention on pain during treatment, reducing the need to increase pharmacological analgesic doses. More importantly, it induces a significant drop in pain scores, where perceived pain decreased from 4 to 0 on the Visual Analog Scale (Scapin et al., 2017). Thus, the RV is known to be a high success rate technology for managing pain in burned patients, especially while performing the treatment, since it facilitates the abstraction of reality by allowing a total immersion in a virtual environment. Furthermore, it is a safe and fun technique, which can be adapted to people of different age groups, with no side effects or loss of effect from continuous use (Gonçalves et al., 2019).

VR benefits are also evident in the control of phantom pain, which is characterized as a problem that causes discomfort in amputee patients, who claim to feel pain in limbs they no longer have. In these cases, through digital applications, virtual reality helps the brain reconnect the stimulus areas, causing the patient a feeling of relaxation, making the pain lessened and even extinguished (Gromala et al., 2015).

As previously mentioned, chronic pain is considered an incurable disease due to its complexity. Perhaps, for this reason, the attentional distraction strategy allows for a decrease in pain. Still, there are no reports that it has successfully induced the hypoalgesic effect in patients with chronic pain. The lower effectiveness of this strategy is due to the selective attention to information related to the painful factor, especially when feelings of fear and pain catastrophization are (Indovina et al., 2018; Todd et al., 2018; Vlaeyen et al., 2016).

In any case, the evidence points to motivational factors as the focal point for the proper functioning of these strategies. In other words, to divert attention from pain, the distracting stimulus must be so motivating for the person that it is competitive with the painful stimulus and allows for almost complete involvement. It is in this sense that VR is promising, taking into account that, by itself, it is typically considered motivating due to its interactive characteristics (Indovina et al., 2018; Todd et al., 2018; Vlaeyen et al., 2016).

However, techniques, such as the *Virtual Meditative Walk*, are developed to help patients with this type of pain. This is an example of a VR system that incorporates biofeedback, virtual environment, and stereoscopic sound, addressing patients' specific conditions with chronic pain and low body awareness. Through stress reduction practice based on mindfulness (which has appeared as a primary approach to pain control), providing changes in the environment in real-time, patients have a mirrored view of themselves and learn to control their internal emotional states (Gromala et al., 2015).

To cope with pain, these researchers also invented *Mobius Floe*, which is characterized by being an immersed VR game developed for patients with chronic and/or acute pain, reducing their pain and anxiety. During the game, patients are immersed in a virtual winter setting and experience several moments of action. This game proves to be quite stimulating and captivating, making patients stay focused, inhibiting the focus on their physical pain (Gromala et al., 2015).

EaseVRx is a skills-based VR program that combines psychoeducation, pain education, breathing training, relaxation exercises, and executive functioning games. This is an evidence-based approach of Cognitive Behavior Therapy, mindfulness, and physiologic biofeedback therapy. It consists of a 56-

day standardized, prescriptive, and reproducible program, where each experience can last from 2 to 16 minutes. EaseVRx-Distraction is an identical program, with an identical user interface, and the same number of experiences, with the same approximate duration, but only including 360-degree videos. Both protocols were designed to be a safe, home-based, non-pharmacological intervention for chronic pain. (Birckhead et al., 2021).

Based on the assumption that pain is a subjective feeling and that it differs from individual to individual, the use of VR in medical procedures must be personalized. Anxieties, fears, thoughts, feelings, and other personal characteristics of the individual must be taken into account to select the most appropriate virtual experience to help reduce the processed and perceived pain (Ahmadpour et al., 2019; Freitas & Spadoni, 2019).

Evidence suggests that VR is not only effective in treating acute pain, but also has great potential in distraction therapy, allowing effective analgesia (Chan et al., 2018; Pourmand et al., 2018). Even thoug, the quality of the remaining studies is limited and statistically heterogeneous. There are numerous areas in which this innovative tool operates, and we will undoubtedly evolve further in this area. However, although the benefits of using VR as a therapeutic technique are notorious, it is necessary to continue to study this variable so that its results are more consistent and its benefits more concrete (Chan et al., 2018).

Some studies reveal a positive impact on the use of games, of downward movement, in immersive environments to treat chronic pain. In these studies, there is a 33% decrease in pain and a substantial difference between the use of 3D VR and 2D videos, demonstrating the patients' receptivity and the effectiveness and safety of using VR for pain control (Jones et al., 2016). However, although there are already applications designed to distract pain, specific applications for VR active exercise therapy and psychotherapeutic pain therapy cannot be found on the market, revealing a significant lack of studies in this area (Stamm et al., 2020). Existing applications have gaps in quality and quantity of content, being imperative the involvement of qualified health professionals in developing prototypes and a faithful following of the evidence (Hoffmann et al., 2020).

Another study, using functional magnetic resonance imaging, compared the use of opioids with the results obtained by using Virtual Reality, when exposed to a painful stimulus. There was a reduction of more than 50% in the activity of 5 brain areas, when the person exposed to a painful stimulus made use of Virtual Reality (Hoffman et al., 2004). Other studies carried out investigated the results of using Virtual Reality to control pain during other procedures, such as vaccination of children, physiotherapy sessions and dressings for burns. Although perceived pain was subjectively assessed through self-report questionnaires, the results of these studies were equally positive (Schmitt et al., 2011; Silverberg et al., 2017; van Twillert et al., 2007).

In 2020 a qualitative study was carried out on RV in pain therapy, and four dimensions were found to be essential to consider: the overall system, hardware, software, and gamification elements. The results of this study revealed that, with the overall system, the interviewed physiotherapists felt that it should contain an individual briefing, carried out by personal assistance, and a tutorial for correct operation. The system must also be easy to handle and incorporate exercises with a maximum duration of 30 minutes, with a break between them and 15 min of relaxation at the end, allowing the user to sit down (Stamm et al., 2020).

As for the software, it was defined that the system must perform an individual calibration to detect movement limitations and allow the therapist to intervene in patients, mainly when pain, anxiety, or incorrect execution of movements occurs. On the other hand, when it comes to hardware, it was defined that users should be able to put on the googles by themselves, and these should be easy to put on and take off (Stamm et al., 2020). Finally, regarding the gamification dimension, it was considered that the system should always give positive feedback, and never negative feedback, displaying verbal and/or visual praise and rewards, while also providing the user with behavioral recommendations, such as advice on how to relax (Stamm et al., 2020).

CONCLUSION

As already mentioned, these and other studies are insufficient. They often lack a quality theoretical basis, although it is increasingly evident that it is promising to invest in VR in pain management, as in other health-related issues. For this reason, it is urgent to invest in research and qualified health professionals to carry it out, to evolve in the area of pain therapies, and improve the quality of life of people who experience any pain (Chuan et al., 2020).

Also, it should be noted that the use of this technology does not annul the analgesic treatment but serves as an adjunct to the existing therapies. However, VR is beneficial when associated with traditional therapies, as it allows for significant reductions in pain perception, cognitive pain (time spent thinking about pain), affective pain (emotional discomfort), and sensory pain (Dascal, et al., 2017). To this end, the attentional distraction strategy is used, which, as the name implies, consists of diverting attention from the pain felt, hoping that it will lead to an effect of hypoalgesia - decreased sensitivity to painful stimuli (Van Ryckeghem et al., 2018).

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Section 6
Biosensors

Chapter 15
Biosensors, Biofeedback, and Neurofeedback

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ABSTRACT

In this chapter, the authors write about the processes of biofeedback, giving an insight about the sensors that might be used, the overall concept of biofeedback, as well as the evidence regarding the effectiveness of neurofeedback for the treatment of mental disorders.The main goal is to provide those introducing to the biofeedback as a self-regulation technique, used now for more than 50 years, with concise information about the sensors that might be used to detect the most common measured responses, the main types of physiological biofeedback, and the state-of-the-art evidence about neurofeedback as a form of brain training for individuals with the most prevalent mental disorders. Biofeedback and neurofeedback are guided therapies that include a vast and rowing variety of methodologies aimed to return information to the individual, regarding the physiological functions of the organism itself, in order to enable the modification of those otherwise considered unconscious physiological responses, designed to improve the individual's health and wellness.

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SUMMARY

In this chapter we will focus on the processes of biofeedback, giving an insight about the sensors that might be used, the overall concept of biofeedback, as well as the evidence regarding the effectiveness of neurofeedback for the treatment of some mental disorders.

The main goal is to provide an introduction to the biofeedback as a self-regulation technique, used now for more than fifty years, with concise information about the sensors that might be used to detect the most common measured responses, the main types of physiological biofeedback, and the state-of-the-art evidence about neurofeedback as a form of brain training for individuals with the most prevalent mental disorders.

Biofeedback (BF) and neurofeedback (NFB) are guided therapies that include a vast and rowing variety of methodologies aimed to return information to the individual, regarding the physiological functions of the organism itself, in order to enable the modification of those otherwise considered unconscious physiological responses, designed to improve the individual's health and wellness. This can be performed as a straight operant conditioning model relying on the reinforcement of the signals displayed for the individual to change the physiological responses.

In spite of emerging therapeutic and performance approaches and methodologies, in this chapter the authors focus upon the self-control ability to modulate physiological conditions like, for example, muscle tension evidenced by electromyography (EMG), electrodermal activity (EDA), heart rate (HR), heart rate variability (HRV) and bioelectrical brain activity based on electroencephalogram (EEG). These approaches constitute de physiological basis of biofeedback (EMG, EDA, HR and HRV) and neurofeedback (EEG), that can be applied in order to control a wide range of central, peripheral and autonomic nervous system symptomatology. Both BF and NFB modalities are designed in order to improve a healthy condition and reduce abnormal body activity. When that first condition is achieved, a positive visual (videogame or movie control) and/or auditory (on/off) feedback are given, not target if an unwanted second condition is recorded.

To address the effect of BF and NFB in neurodevelopment and mood disorders, throughout this chapter the main clinical EEG-based neurofeedback and biofeedback protocols applied in attention deficit hyperactivity disorder (ADHD), autism spectrum disturbances and in other adult disorders whose anxiety and/or depression symptoms are present (major depression, post-traumatic stress disorder, obsessive-compulsive disorder and insomnia) are covered.

BIOFEEDBACK

Biofeedback is a process whose basic operating principle is the monitorization of a normally automatic physiological function, providing information that may be used to train someone to self-control and improve such function. Traditionally, a biofeedback system is made upon and based in physiological information obtained noninvasively by a sensor attached directly to the body. It is a valuable supplementary treatment and complements rehabilitation protocols to recover healthy functions, mainly related to neuromuscular (Giggins *et al*., 2013; Spencer *et al*., 2021) and psychiatric disorders (Schoenberg and David, 2014; Markiewicz, 2017; Tolin *et al*., 2020).

The ability to modulate physiological conditions like, for example, muscle tension evidenced by electromyography (EMG), electrodermal activity (EDA), heart rate (HR), heart rate variability (HRV) and bioelectrical brain activity based on electroencephalogram (EEG) constitute de physiological basis of biofeedback (EMG, EDA, HR and HRV) and neurofeedback (EEG), that can be applied to control a wide range of central, peripheral, and autonomic nervous system symptomatology.

In EMG biofeedback myoelectrical signals (Figure 1) coming from surface electrodes over the individual's muscles that detect a change in skeletal muscle activity are converted into visual and auditory signals. In EDA biofeedback (Figure 2) the individuals are presented with visual or auditory signals related to the changes in skin conductance (usually referred as galvanic skin response), altered by the activity of sweat glands controlled by the autonomic nervous system, and detected by surface electrodes usually placed on the individual's fingertips.

Figure 1. EMG signal from surface electrodes during muscle contraction.

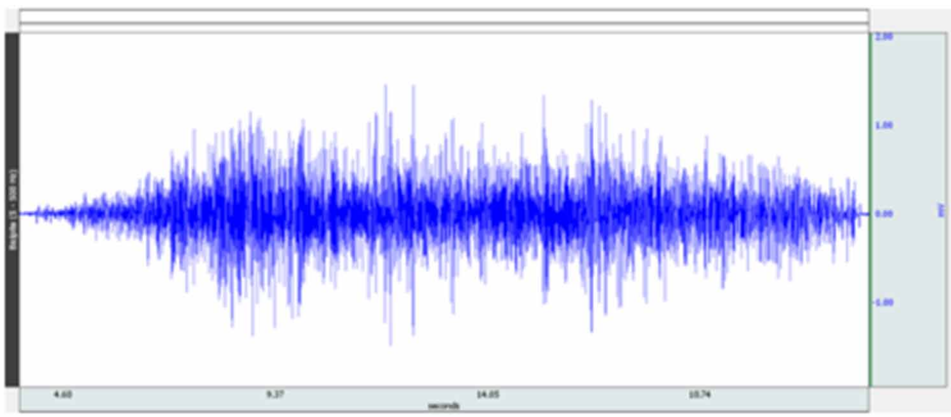
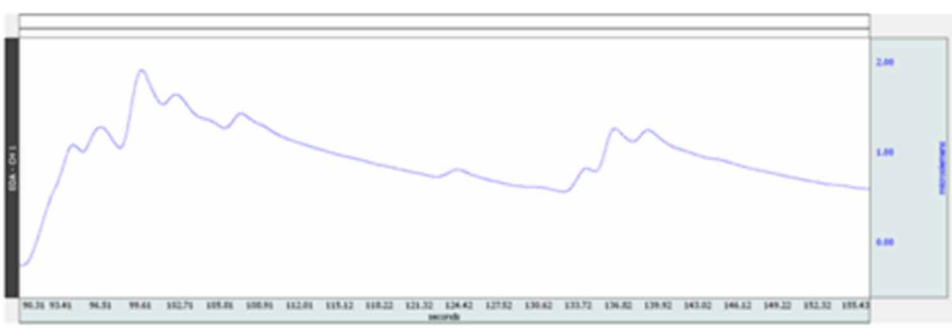


Figure 2. Electrodermal activity of the right fingertips during presentation of stimuli.



In cardiovascular biofeedback different types of responses can be detected as HR and HRV (Figure 3) that can be used to provide real time information about the level of activity of the sympathetic and the parasympathetic divisions of the autonomic nervous system, by using surface electrodes placed in the individual's chest or arms and legs. On the other hand, electrodes placed on the scalp can detect brain wave patterns (Figure 4) that may be used not only to diagnose disorders as well as in neurofeedback techniques.

Figure 3. ECG signal from lead II in supine position.

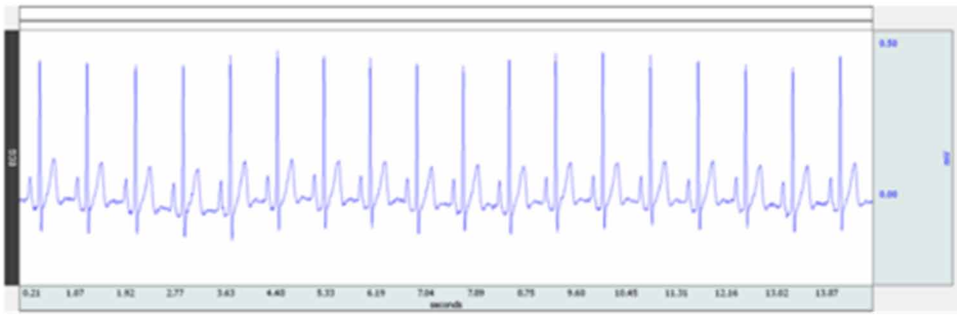
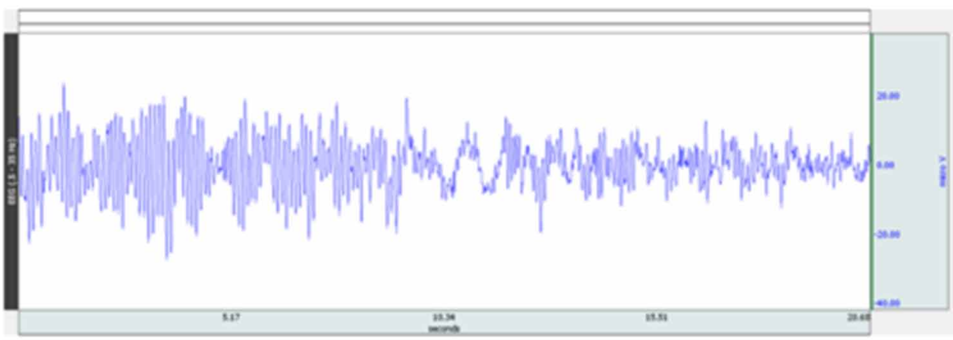


Figure 4. EEG signal from the parietal lobe with the eyes closed followed by open eyes.



The surface electromyographic signal resulting from the electrical activity generated by motor units, measured in millivolts (mV), provides information about the level of muscle activity and has been widely used in biofeedback with reports of its use in neuromuscular reeducation back into the 1960s (Schwartz *et al*., 2017). EMG biofeedback have also been used to treat the symptoms and disorders such as headaches and tension myalgias (Rausa *et al*., 2016; Alonazi *et al*., 2021), pelvic floor disorders that include incontinence, and other medical conditions (Kondo *et al*., 2019).

Sweat gland activity is a physiological response under the control of the sympathetic autonomous system that promote the production of sweat, containing electrically conductive salts, that turn the skin more conductive to electricity. Therefore, the application of a very small electric current to the skin, allows us to measure the skin conductance activity (SCA) that may provide information about the change in this electrodermal activity, that historically has been called galvanic skin response (GSR). The higher the activity of sweat glands the higher is the magnitude of the EDA, measured in units of electrical conductance named as microsiemens (microS). Any change in EDA from the baseline levels is called an electrodermal response (EDR) which normally have a magnitude of 0,1 to 1 microS, and that usually occurs 1 to 3 seconds after the presentation of a stimulus. The use of EDA in biofeedback is concerned with the observation that skin resistance changes with psychological events (Peek, 2017).

Heart rate variability refers to the variability in the duration of consecutive cardiac cycles and allows to evaluate the autonomous nervous system (ANS), by determining the balance between the activity of parasympathetic (PNS) and sympathetic (SNS) nervous systems. HRV is also dependent upon the respiratory cycle, as heart rate increases during inspiration and decreases during expiration, which is the HRV at the frequency of respiration, also known as respiratory sinus arrhythmia (RSA). As during rest the PNS exerts a dominant control over the cardiac pacemaker, HRV is higher than during exertion as the SNS exerts its cardiac chronotropic effects, increasing heart rate, but decreasing HRV. HRV biofeedback increases self-control over autonomic balance and can have a positive impact on various emotional and somatic symptomatology, namely on cardiopulmonary (Giardino *et al*., 2004; Leher et al., 2018) and psychiatric (Zwan *et al*., 2015; Goessl *et al*., 2017; Economides *et al*., 2020; Blase *et al*., 2020) conditions.

The electroencephalographic signal from the scalp can provide information about the background activity of the neurons from the cerebral cortex that is typically characterized by the power of the signal within different frequency bands: delta rhythm (δ), 0-4 Hz; theta rhythm (θ), 4-8 Hz; alpha rhythm (α), 8-12 Hz; beta rhythm (β), 12-30 Hz; and gamma rhythm (γ), usually 30-70 Hz. The modulation of this signal constitutes the basis of neurofeedback, but besides the neural activity, the activity of areas like the anterior cingulate cortex, the insula or the amygdala, key brain areas related with emotional activity and its regulation, have been shown to be successfully regulated through neurofeedback procedures (Johnston *et al*., 2011; Zotev and Bodurka, 2020; Zich *et al*., 2020).

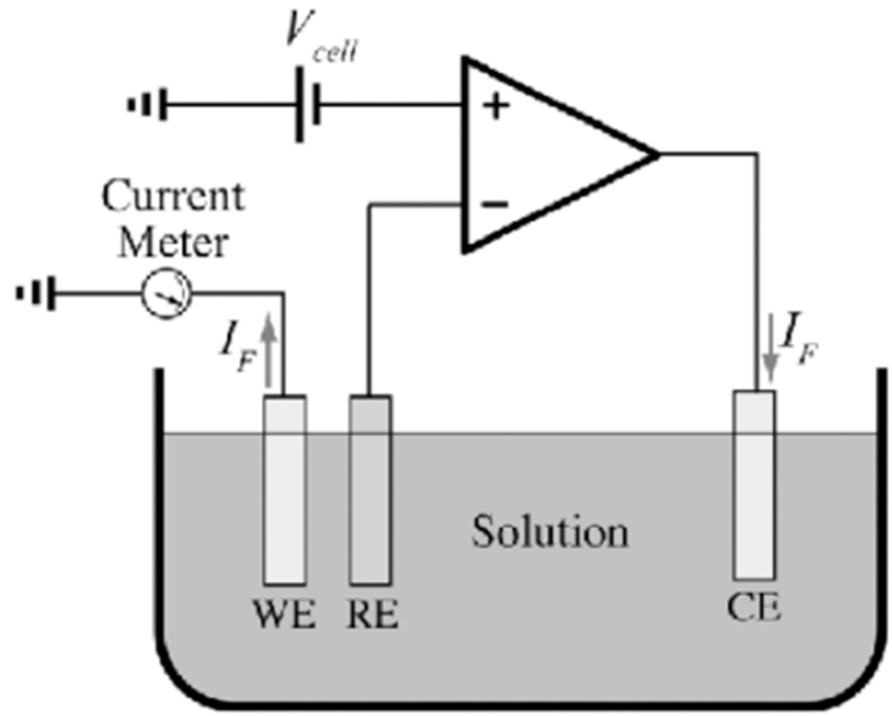
Even though traditional biofeedback is based on physiological information obtained by sensors attached directly to the body, as patients with psychiatric disorders may experience anxiety using sensors attached to their body, new technology has been under development to capture physiological signals with no contact (Oikawa *et al*., 2021) that may, in near future, revolutionize the instruments traditionally used in biofeedback.

Biosensors

Besides the technologies described above, alternative approaches based on the analysis of disease biomarkers could contribute to the diagnosis and monitoring of a wide variety of disorders. According to the Biomarkers Definitions Working Group (2001), a biomarker is “A characteristic that is objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes, or pharmacologic responses to a therapeutic intervention” (p. 91). This includes abnormalities in DNA (germline or somatic), RNA, proteins, metabolites, and abnormal cellular or tissue processes.

The use of a biochemical sensor, or biosensor, “a device that uses specific biochemical reactions mediated by isolated enzymes, immunosystems, tissues, organelles or whole cells to detect chemical compounds usually by electrical, thermal or optical signals” (Nagel *et al*., 1992, p. 148), for the determination of biomarkers can play an important role in the diagnosis and prognosis of a vast number of diseases/disorders. This is due to several factors, such as their high selectivity, which is a result of the use of a selective biorecognition element on the sensors’ transducer surfaces, the possibility of minimally invasive analysis strategies (i.e., analysis of blood, sweat, tears, breath, urine, etc.) using low sample volumes and the possibility of their use in point-of-care scenarios. Therefore, an ever-increasing number of studies regarding biosensor development have been reported over the years.

Figure 5. General concept of an amperometric device.



One of the most widely used type of biosensors are based on electrochemical transduction, employing methods such as voltammetry and amperometry, because they complete the advantages mentioned above with highly sensitive analysis. The electrochemical cell used in these methods is usually composed of 3 electrodes (working- (WE), reference- (RE) and auxiliary/counter electrodes (CE)) that are in contact with the analyte solution. The working electrode has a major importance because the redox reaction of interest, and the corresponding electron transfer, occurs on its surface. This WE is therefore modified with the biological recognition element through a variety of immobilisation procedures (e.g., adsorption, entrapment, cross-linking, covalent and/or affinity binding).

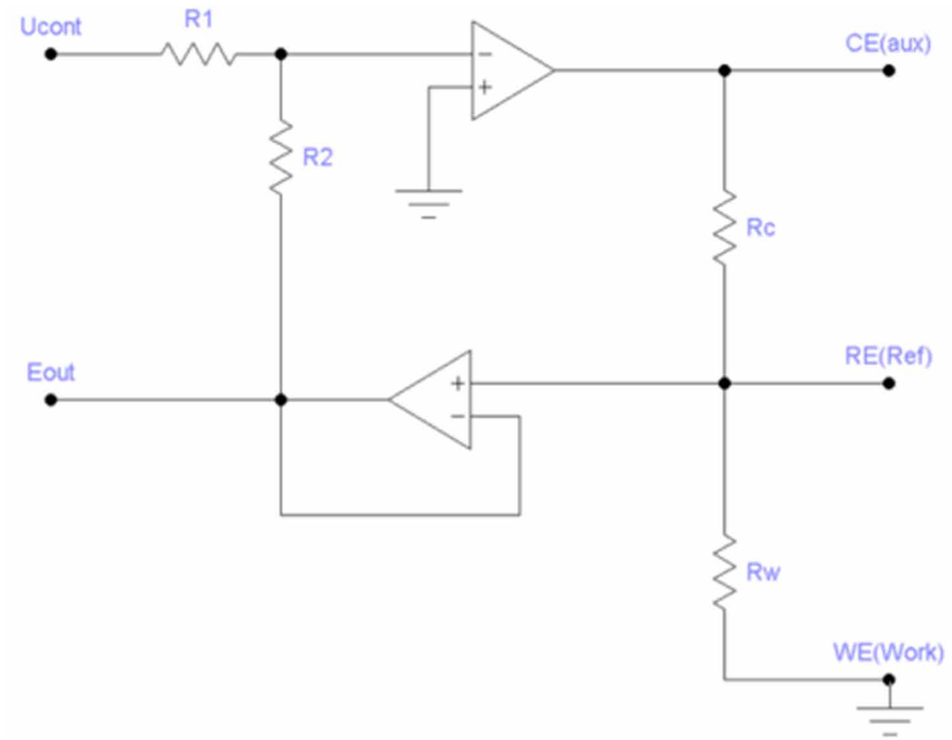
Amperometry

Amperometry is a generic term of a technique that refers to the quantity that is measured, i.e. electrical current. One method to measure current is potentiostatic, whose electrical topology is very similar to a potentiometer since it provides voltage division between three electrical nodes identified by the electrodes themselves: WE, RE and CE (being the *RE* electrode a high impedance input control voltage).

The device's general concept is schematically like the one depicted in Figure 5 (Ahmadi & Jullien, 2008).

A brief look at the circuit identifies a servo loop injecting current I_F at the CE and sampling reference voltage at the RE.

Figure 6. Example of a potentiostat circuit.



As the input impedance of the servo OpAmp is very high, at both inverting (-) and non-inverting (+) inputs, it is a reasonable rational to suppose I_F circulates to the WE.

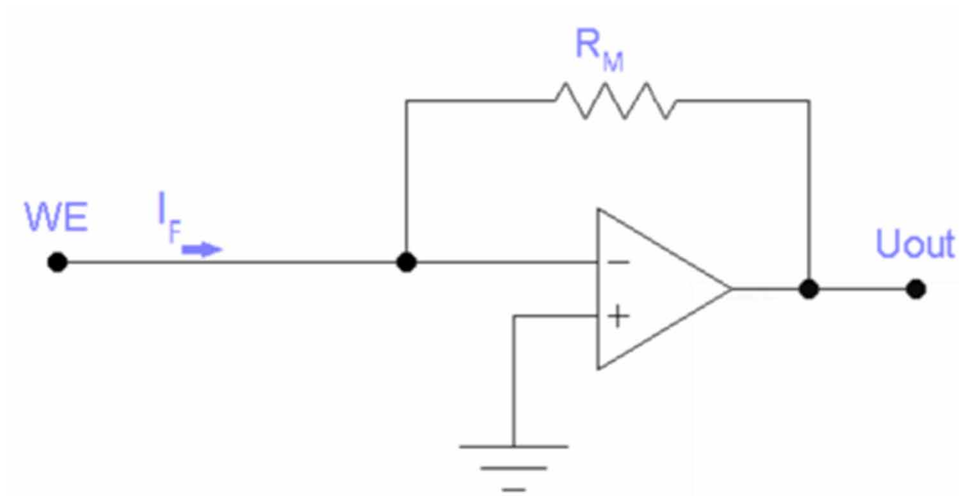
Although the behaviour of amperometric sensors is determined by the WE's specifications, (mainly where, typically, chemical redox reaction takes place), some more insight on how electrical measurements arise could be useful. Indeed, the other two electrodes (RE and CE) also intervene in the measurement.

Generally, amperometric devices use a constant voltage in some convenient neighbourhood of the WE, defining a geometry where electrical field (electrical potential gradient, which is a vectorial quantity) is constant in magnitude. This conception guarantees for WE area chemical reactions reproducibility purposes, as follows: such voltage is usually provided by a conveniently shaped good conductive sheet of material (typically metal like gold or platinum but also conducting carbon) whose conducting properties materialize an iso-potential or equipotential surface and it is connected to a very high input voltage-sampling-control-current loop (OpAmp in Figure 5), the **RE**. Such an electrode, although there is no significant current, either injected or absorbed, forces the shapes of the expected iso-potential surfaces to inherit the same shape parallelly to the WE. This desired spatial homogeneity voltage promotes, in principle, an equally desired reaction rate homogeneity at the WE, minimizing the WE's neighbourhood electrical field (or potential gradient) differences.

In this way, at the WE the current should be, in the neighbourhood of the ground voltage, proportional to the analyte concentration and be well distributed on the entire WE area.

Such voltage definition implies the design of power supplies with good feedback control loops and suitable instrumentation (i.e. voltmeters and ammeters equivalents) in order to assess current measurements.

Figure 7. Detail of the WE current measurement.



At WE electrode surface layer, ion adsorption can, however, impose supplementary caution in the applied voltage and subsequent current measurement.

Some of the exemplar circuits used in a potentiostat are like the one depicted in the Figure 6 (Hernández *et al*., 2003).

As can be seen, the circuit establishes the RE potential with the aid of the CE excitation while current is measured at the WE. Current measurements imply the use of resistances that are dimensioned to allow a very small to ground (reference *zero* potential) voltage difference. Also, the CE should remain chemically absent (while any oxidation-reduction process at the WE imply an opposite reduction-oxidation process at the CE). CE material choices could include platinum or gold for its relative inertness. In the schematics, Rc and Rw are the electrical equivalent solution resistances and so they are naturally implemented as soon as electrodes are introduced in the solution.

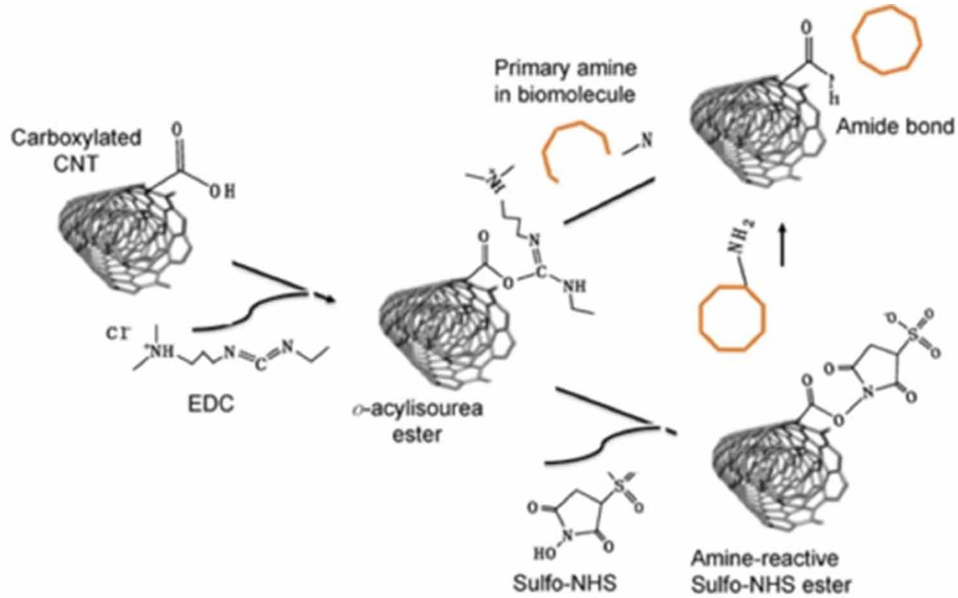
As a last step, WE currents can be enormously magnified by an equivalent transimpedance amplifier whose main task is the current to voltage transfer function $U_{out} = -I_F \cdot R_M$. It is this voltage, rather than the WE current, that is recorded and processed to assess WE biochemical redox phenomena (Figure 7) (Ahmadi & Jullien, 2008).

Biosensors for Neurological Disorders

Measurement of neurotransmitter concentrations can be used for the identification of several neurological disorders such as Parkinson's disease, Alzheimer's disease, post-traumatic stress disorder, epilepsy, schizophrenia, etc.

Glutamate is one of the biomarkers used for the diagnosis and evaluation of neurological disorders because its dysregulation is associated with several neuropathological conditions. A high level of glutamate in the blood and other biological fluids can indicate ischemic stroke, epilepsy, or other neurological disorders. Therefore, many biosensors for the analysis of glutamate have been developed, some of which are highlighted below.

Figure 8. Schematic representation of the reaction scheme for EDC and EDC-NHS based covalent immobilization of biomolecules on carbon nanotubes (Zhou et al., 2019).

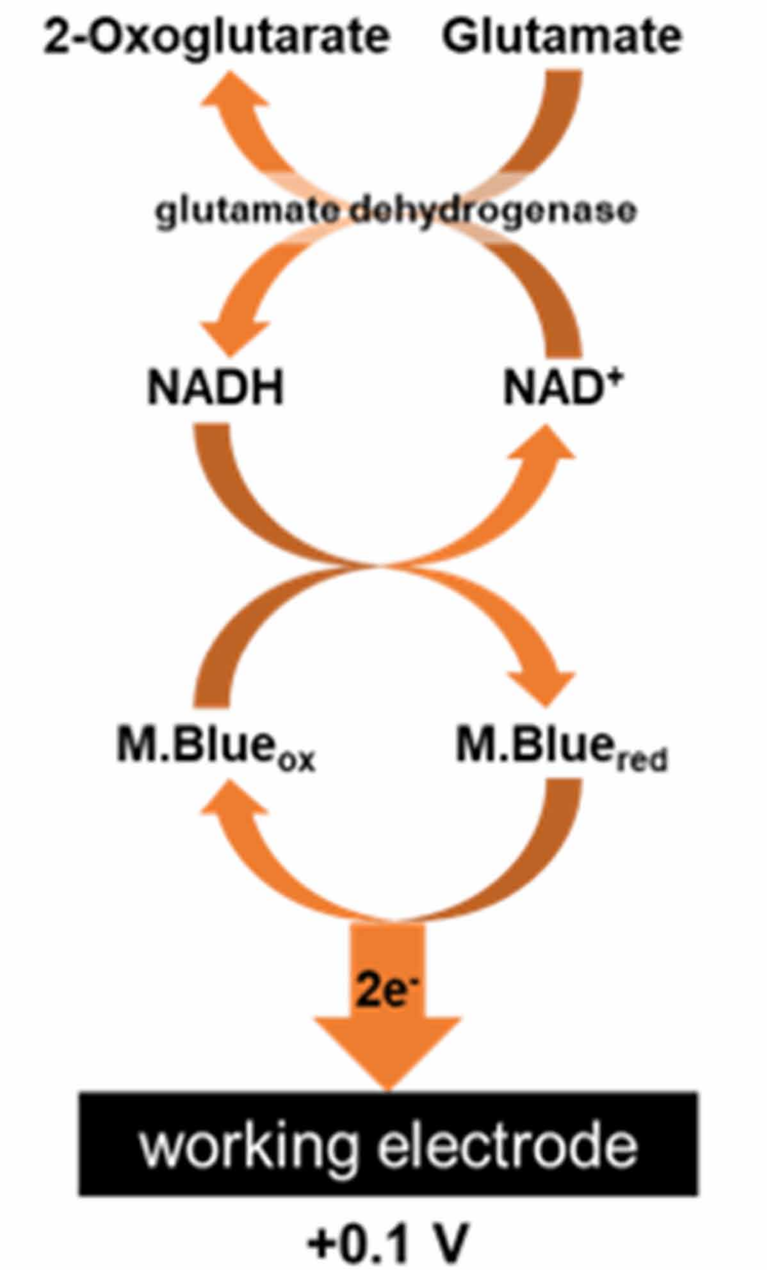


Batra and Pundir (2013) developed an amperometric biosensor for the determination of glutamate in human sera using the enzyme glutamate oxidase as the biological recognition element and a gold electrode transducer that was modified with multiwalled carbon nanotubes (MWCNTs), gold nanoparticles, and a chitosan composite film. The enzyme was covalently immobilized on the MWCNTs using N-ethyl-N′-(3-dimethylaminopropyl) carbodiimide (EDC) and N-hydroxysuccinimide (NHS) (Figure 8), providing a stable sensing platform. L-glutamate oxidase catalyzes the oxidative deamination of L-glutamate, in the presence of water and oxygen, to form 2-oxoglutarate, ammonia and hydrogen peroxide. In this work the quantification of glutamate was based on the fast (2 s) amperometric measurement (+0.135 V vs. Ag/AgCl) of the hydrogen peroxide formed in the enzymatic reaction. The authors reported a linear concentration range between 5 and 500 µM and a limit of detection of 1.6 µM.

In another approach, glutamate was also quantified in serum samples (Mruga *et al.*, 2021). The authors likewise used glutamate oxidase and measured hydrogen peroxide by amperometry (+0.6 V vs. Ag/AgCl, response time: 5-20s), but employed a platinum disk working electrode and immobilized the enzyme by using bovine serum albumin and gluteraldehyde. In this work the authors constructed the working electrode by soldering a platinum wire in a glass capillary. A fusible Wood's alloy was used to connect the platinum wire to an internal conductor, which was then linked to a contact pad to be able to connect the electrode to the potentiostat. In this case a linear concentration range between 5 and 600 µM and a limit of detection 3 µM were achieved.

Hughes et al. (2015) used another enzyme, glutamate dehydrogenase, for the construction of a reagentless amperometric biosensor for the analysis of glutamate in food and human serum samples. The transducer for the construction of this biosensor was a screen-printed carbon electrode modified with Meldola's Blue, which greatly reduces the over-potential for the oxidation of NADH (see below). Chitosan and multiwalled carbon nanotubes (MWCNTs) were used to encapsulate the enzyme and the

Figure 9. Schematic representation of the reactions that occurred at the amperometric glutamate biosensor's surface developed by Hughes et al. (2015).



co-factor nicotinamide adenine dinucleotide (NAD^+). The working principle of this biosensor was based on the oxidation of glutamate forming 2-oxoglutarate in the presence of the enzyme and NAD^+. NADH is also formed during the enzymatic reaction and subsequently reduces Meldola's Blue which was then electrochemically oxidized (+0.1 V vs. Ag/AgCl, response time: 20-30 s) at the electrode's surface to produce the analytical signal (Figure 9).

In this study a linear concentration range between 7.5 and 105 μM and a limit of detection 3 μM were achieved.

Non-Invasive Sensors

Non-invasive methods would be a sensational upgrade of the techniques for the evaluation of neurological disorders. One example is breath analysis for the detection of epilepsy crisis in early stage (van Dartel *et al*., 2020), which was based on the presence of volatile organic compounds in exhaled breath. Although the developed method was able to differentiate between epilepsy patients and control subjects, the number of false positives and false negatives was rather high, so additional research is still needed. Nevertheless, the proposed method is a promising concept because it is non-invasive and does not need the same amount of apparatus as amperometric-based devices.

NEUROFEEDBACK

The history of neurofeedback goes back to the beginning of the 20th century with the studies of Pavlov's conditioned reflexes in dogs. Later, between 1930 and 1940, feedback was transposed to living beings through self-regulation mechanisms, by Norbert Wiener and Petr Anokhin. But it is between 1960 and 1980, in the United States of America, that the true evolution of the technique and transposition for human beings takes place, with Joe Kamiya demonstrating, in 1962, that a person could control his alpha activity through feedback and with Roy John, during the 80's to develop different EEG-biofeedback protocols (Kropotov, 2009).

Neurofeedback (NFB) is thus part of neurotherapies, being a technique that, based on the subject's electroencephalographic activity, attempts to self-regulate using a modality of auditory and visual feedback, aiming at the alteration of a given parameter of brain activity in a conscious and voluntary way (Kropotov, 2009). In some cases, combined biofeedback skin conductance, electromyography and hear-rate variability are accessed to improve autonomic nervous system benefits.

In a global approach, clinical data, psychological tests assessment and qEEG analysis contribute to elaborate the patient protocol. Commonly, two brain frequencies are modulated. One example is SMR/Theta protocol applied in bipolar C3-C4 montage in scalp areas, in which first frequency (SMR) tends to be rewarded, and second frequency (Theta) tend to be blocked. NFB protocols allow us to train amplitude, coherence, Z-scores and power of certain brain rhythms.

It is estimated that 30% to 50% of people benefit from biofeedback and neurofeedback therapy. When good outcomes are reported, 20 to 50 sessions, twice a week are applied. Reduced number of sessions, lack of motivation or misunderstanding of the purpose of the intervention (commonly in very young children or in older population) are limiting factors to the success of the therapies (Kadosh and Staunton, 2019).

In Children population, both attention deficit hyperactivity disorder (ADHD) and autism spectrum disorders (ADSs), exhibit poor ability in behavioral control and in lower academic outcomes are achieved.

ASDs are characterized by early onset of impairments in social interaction and communication and the development of uncommon stereotyped behaviors, loss of face contact, poor attention, impulsivity, aggression, self-injury and, sometimes, hypersensitivities to sensory stimulation (Austin, 2008). Abnormal function in brain regions and networks associated with social cognition and action perception (Pelphrey and Carter, 2008) are linked with human mirror neurons (Hamilton 2013). Increased firing in inferior frontal gyrus and inferior parietal lobule during execution action's observation have been linked to potential mechanism of perceiver's sensorimotor (SMR) rhythm (Rizzolatti and Craighero, 2004; Pineda, 2005; Depretto *et al.*, 2006; Oberman *et al.*, 2008). Based on these mechanisms, NFB training protocols involving right and/or left sensorimotor cortex have been successfully applied. Positive behavior improvement was obtained after right (C4) SMR band reward and theta or beta band amplitude inhibition during a videogame or a DVD movie (Datko *et al.*, 2018). Imitation a simple finger-lifting action during NFB training was also applied (Iacoboni, 1999). Other neurophysiological changes in ASDs showed high delta and theta activity in frontal and central areas and a Betha/Theta protocol in Fz-Cz areas can be applied. Also, high beta activity was observed in 25% of cases. Because children with ASD show deficits in autonomic states, a model of neurovisceral integration, which proposes heart rate variability and skin conductance, BFB have been suggested in combination with NFB protocols (Friedrich *et al.*, 2014).

A complex ADHD etiology involving common and rare genetic variabilities, dopamine (Levy, 1991), norepinephrine (Del Campo *et al*., 2011), GABA (Edden *et al*., 2013) and serotonin (Quist and Kennedy, 2001) changes as well as several environmental risk factors including those associated to neuroinflammation (Reus *et al*., 2015; Hassan *et al*., 2016) has been linked to hyperactivity as well as impaired attention. These can induce electrophysiological changes in several cortical and subcortical areas, namely prefrontal cortex and its connection to striatal, cerebellar and parietal regions (Arnsten and Rubia, 2012), basal ganglia (Chen *et al*., 2018) and substantia nigra (Krauel *et al.*, 2010; Romanos *et al.*, 2010) explaining the lack in behavior control and disability in attention skills. Also, children with poor disability in motor planning and in concentration/attention seems to have an EEG market of slower fontal and central brain activity, reason why, in majority of cases, SMR, Betha/Tetha or even Betha/Delta protocols in frontal Fz-Cz (Schönenberg *et al.*, 2021) or monopolar F3, F4, Fz alpha power improvement (Hanslmayer *et al*., 2005) can be applied. Regarding with motor control, SMR 12-15 Hz activity reinforcement seems to be a very effective training applied in ADHD (Lubar and Shouse, 1976; Leins *et al.*, 2007; Arns *et al*., 2014; Cortese *et al*., 2016) and also in human epilepsy (Syerman and Friar, 1972), given SMR activity, performed by thalamocortical pathways, occurring if both attention and relaxation muscle are present. In order to improve the results, some therapists use EMG biofeedback in face, arms or legs muscles.

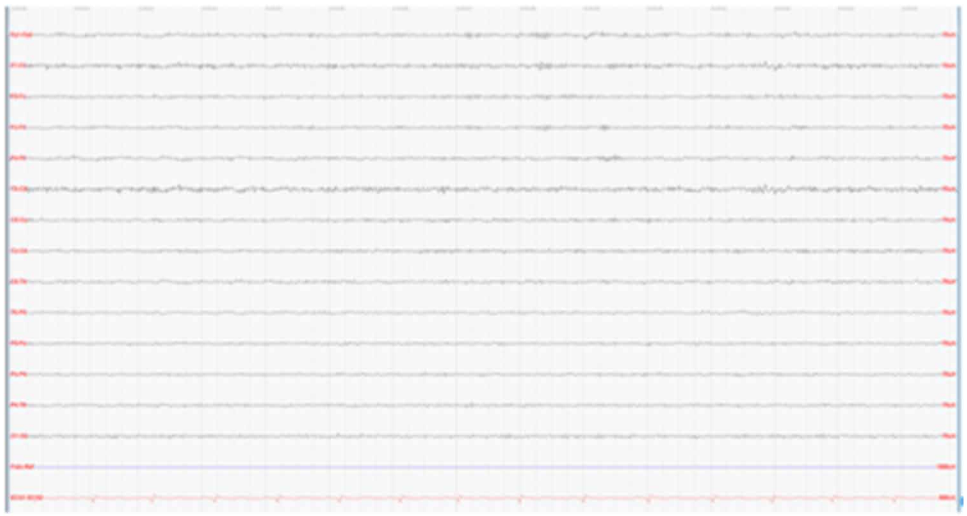
In adult population, mood disorders in which anxiety and depression take part of main symptomatology, NFB and BFB are considered one of non-pharmacologic therapeutical approaches. Major depression, post-traumatic stress disorder (PTSD), obsessive-compulsive disturbance (OCD), insomnia and others belong to neuropsychiatric disturbances whose changes in cellular dynamics of several brain areas induces a down-regulation of mood and emotions. For example, in case of PTSD, real-time MRI neurofeedback can help in self-regulation of hippocampal formation (Misaki *et al.*, 2021), dorsomedial prefrontal cortex, middle cingulate cortex, amygdala, parietal cortex and insula (Misaki *et al*., 2019, Misaki *et al*., 2021)

Despite the growing number of patients looking for alternative non-pharmacological therapies, majority of cases have been previously treated with pharmacological drugs whose target is the synaptic neurochemical modulation, what can be associated, in EEG patterns, at faster frequencies and lower amplitude brain signals (Figure 10).

In opposite, soft or mild symptoms in non-pharmacological-treated patients can show slower brain activity (Figure 11) in their EEG pattern.

There are a relatively accordance in psychiatric NFB application, in which Theta/Beta ratio and SMR reinforcement protocols should be explored (Batail *et al*., 2019). In each patient, this possibility should be previously confirmed by qEEG recordings. Additionally, alpha asymmetry protocol is identified as a promising EEG-biomarker (Choi *et a.l*, 2011; Wang *et al*., 2019), meaning and excessive beta or theta

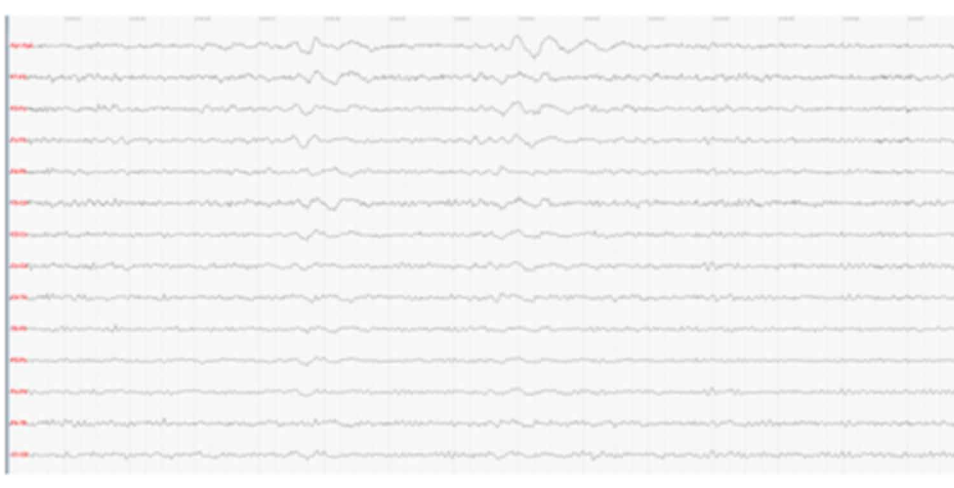
Figure 10. Electroencephalogram pattern recorded in an adult woman with depressive symptomatology after some years with antidepressant therapy. A fast and low-voltage pattern is recorded in all brain areas.



frequency in a given brain area, while contralateral homologous region remains in alfa domain. In these cases, and high beta downtraining (Wang *et al*., 2019) or Alpha/Theta training could be applied (Cheon *et al*., 2016) to control major depression and anxiety symptoms of OCD, sleep disturbances and PTSD. Because alpha rhythm of parietal and occipital brain areas is recorded in eyes-closed condition, an auditory feedback is given; in this case, positive feedback in linked to a completely clear and normal volume of sounds and, in opposite limit, negative feedback is associated with no sound.

Neurofeedback, despite not being a recent technique, still presents capacity and opportunity for expansion, as is the case of applying the technique to some sleep disorders (it is known that restorative

Figure 11. Electroencephalogram pattern recorded in an adult woman with depressive symptomatology. No previous antidepressant-drug therapy was administrated. Note, especially in frontal areas, slower brain activity.



sleep is essential for the physical and psychological well-being of any individual), or to addictive states such as alcoholism. Anyway, what stands out from the most recent literature is the combination of this neurotherapy with functional magnetic resonance, thus emphasizing, once again, that science will always be multidisciplinary (Tang *et al.*, 2016; Dousset *et al.*, 2020; Thibault *et al.*, 2018).

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