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Metaverse and Psychiatry: A Review

Metaverse ve Psikiyatri: Bir Gözden Geçirme

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ABSTRACT

Today, with the development of technology, the concept of the virtual world is gaining more and more importance. "Metaverse", which has become popular in recent years, aims to provide an environment where people can interact, do business, have fun and even live in the digital world. Metaverse, which has become increasingly popular in recent years, offers many different uses in the field of mental health. However, we do not yet have enough information about the effects of this technology on mental health. The effect of Metaverse on mental health has been the subject of many researches that it can be used in areas such as the treatment of psychological disorders, stress reduction, self-confidence, and development of social interaction skills. The biggest advantage of using Metaverse for psychiatric treatment is that the virtual world is separated from the real world. Therefore, the stress, anxiety and other emotional reactions experienced during treatment have no real-life consequences. In addition, the therapist is easier to access in the virtual world and can help patients adapt to treatment more easily. However, the use of Metaverse for psychiatric treatment also has some disadvantages. For example, this method of treatment may be an unrealistic experience for some patients and not effective enough for others. Also, this treatment modality has limited accessibility as it requires high cost equipment and technology. In particular, there has not been enough research on the relationship between the use of Metaverse in the diagnosis and treatment of psychiatric diseases. More research is needed on the effect of Metaverse on mental health. In particular, more studies are needed on its long-term effects and effects on different people. In this review, studies investigating the potential relationship between Metaverse technology and psychiatry and how this technology can be used in the psychiatric field are reviewed.

Keywords: Metaverse, psychiatric disorders, mental health, artificial intelligence

ÖZ

Günümüzde teknolojinin gelişimiyle birlikte sanal dünya kavramı giderek önem kazanmaktadır. Son yıllarda popüler hale gelen "Metaverse" ise, dijital dünyada insanların sanal olarak etkileşimde bulunabilecekleri, iş yaptığı, eğlendiği ve hatta yaşadığı bir ortam sunmayı hedeflemektedir. Son yıllarda giderek popülerleşen Metaverse, ruh sağlığı alanında da birçok farklı kullanım alanı sunmaktadır. Ancak, bu teknolojinin ruh sağlığı üzerindeki etkileri hakkında henüz yeterli bilgiye sahip değiliz. Metaverse'in ruh sağlığı üzerindeki etkisi, psikolojik rahatsızlıkların tedavisi, stres azaltma, özgüven kazandırma, sosyal etkileşim becerilerinin geliştirilmesi gibi alanlarda kullanılabileceği yönünde birçok araştırmaya konu olmuştur. Metaverse'in psikiyatrik tedavi için kullanımının en büyük avantajı, sanal dünyanın gerçek dünyadan ayrılmış olmasıdır. Bu nedenle, tedavi sırasında yaşanan stres, kaygı ve diğer duygusal tepkilerin gerçek hayatta olabilecek sonuçları yoktur. Ayrıca, sanal dünyada terapiste erişim daha kolaydır ve hastaların tedaviye daha kolay uyum sağlamalarına yardımcı olabilir. Ancak, Metaverse'in psikiyatrik tedavi için kullanımının bazı dezavantajları da vardır. Örneğin, bu tedavi yöntemi bazı hastalar için gerçeklikten kopuk bir deneyim olabilir ve bazıları için de yeterince etkili olmayabilir. Ayrıca, bu tedavi yöntemi, yüksek maliyetli ekipman ve teknoloji gerektirdiğinden, erişilebilirliği sınırlıdır. Özellikle psikiyatrik hastalıkların tanı ve tedavisinde Metaverse kullanımıyla ilişkisi hakkında yeterli araştırma yapılmamıştır. Metaverse'in ruh sağlığı üzerindeki etkisi hakkında daha fazla araştırmaya ihtiyaç vardır. Özellikle, uzun vadeli etkileri ve farklı insanlar üzerindeki etkileri konusunda daha fazla çalışma yapılması gerekmektedir. Bu derlemede, Metaverse teknolojisi ile psikiyatri arasındaki potansiyel ilişkiyi inceleyerek, bu teknolojinin psikiyatrik alanda nasıl kullanılabileceğini araştıran çalışmalar gözden geçirilmiştir.

Anahtar sözcükler: Metaverse, psikiyatrik bozukluklar, ruh sağlığı, yapay zekâ

Introduction

From the end of 2019, when the Corona Virus Disease (COVID-19) pandemic began all over the world, to the present, a new change has occurred in our lives. In this process, some technological developments have also emerged in order to adapt to pandemic conditions, reduce limitations, and facilitate communication. As a result of current developments, the concept of the metaverse has started to gain popularity rapidly today (Yilmaz et al. 2022). This popularity, in 2021, the branding of Facebook as Meta with a new name by Mark Zuckerberg has

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further increased the interest in this concept (Usmani et al. 2022). Mental health diseases are one of the main causes of global and societal disability and are a growing public health problem. A recent study led by the World Health Organization (WHO) states that depression and anxiety disorders alone are a burden on the global economy, causing a loss of $1 trillion in productivity each year. In psychiatric treatments, psychotherapies and applied behavioral interventions are used as a support to drug treatment as well as drug treatment. It is widely used in applied interventions as well as drug treatments in psychiatry. In recent years, new methods have been added to applied interventions in psychiatry, thanks to technological developments (López-Ojeda and Hurley 2023). When we look at the history of medicine, it has required the physical interaction of the patient and the physician in the examination, diagnosis, and treatment stages of diseases while providing health services to humanity until today. However, technological developments that have occurred over time have caused some changes in the field of health, and the patient-physician relationship has changed. These current developments used in the health system are telehealth services. Technologies such as Augmented and Virtual Reality (AR / VR) affect the paradigms in health services. The advantages of these technologies in terms of compatibility, cost, accessibility, motivation, and convenience increase their potential for use in healthcare services. These technologies, which can provide users with realistic interactions and experiences, lead to an increase in efforts to integrate digital reality with Metaverse (Balasubramanian 2021, Liu et al. 2022). Digital technological advances have been used as a tool in the treatment of various mental health disorders for the last ten years. Studies have reported positive results in the diagnosis and treatment of mental health disorders. In this study, it is aimed to give information about the metaverse, which is an important development in recent years, and to discuss its relationship with the field of psychiatry.

Metaverse

The word metaverse means "beyond" by using the suffix "meta" and combining it with the word "universe" means "universe" (Lee et al. 2021). In some sources, the expressions "other universe" or "meta universe" are used as Turkish equivalents. Historically, the concept of Metaverse first appeared in two works published in 1974 and 1984. These works are the science fiction novels "Dungeons and Dragons" published in 1974 and "Neuromancer" published in 1984. The term metaverse was first used in the 1992 novel "Snow Crash" by Neal Stephenson. In this novel, the Metaverse is depicted as a virtual environment parallel to the real world, where users interact with pieces of software called "avatars". In the novel, avatars of real people live in a three-dimensional (3D) virtual world (Stephenson 1992). It all started with Web 1.0, the 'read-only' internet. Web 2.0 has taken its place as a more interactive version where the user can send information to servers. Then came the emergence of social media and soon after virtual/augmented/mixed reality was included. Now, the convergence of all these technological advances has given rise to the meta-universe touted as the Web 3.0 of the future. In 2021, Mark Zuckerberg started the idea of a new internet age called the metaverse of our body (Kim 2021). Metaverse is a digital world created using different technologies such as VR, AR, cryptocurrency and internet. With the development of augmented reality, virtual reality, and control tools between 2011-2017, the three-dimensional virtual environments era of smartphones and wearable technologies has begun for Metaverse. Recently, there has been a significant increase in interest in the metaverse, with "metaverse" and "non-fungible tokens (NFTs)" being among the most frequently searched tech terms in 2021, according to Google Trends (Lee et al. 2021).

The concept of the metaverse refers to a vast network of real-time 3D virtual simulations that allows users to have immersive experiences by digitally interacting with other users, objects, and environments. This virtual universe is designed to provide all the features of the real world, enabling people to meet, socialize, work, and play in a diverse physical space using unique avatars. As for emerging technologies, virtual reality (VR) and augmented reality (AR) have significant potential to impact psychiatric diagnosis, treatment, research, and education. By providing immersive experiences that allow users to explore and interact with virtual environments, these technologies can help improve mental health outcomes and enhance learning experiences (Torous et al. 2021). Virtual reality (VR) involves immersing the user in an interactive, computer-generated simulation through the use of a headset. This allows users to receive visual, auditory, and sometimes olfactory and tactile sensations from the environment, creating a sense of truly being immersed in a 3D digital world (Park et al. 2019, Torous et al. 2021). In contrast, augmented reality (AR) complements the real-world setting by superimposing digitally generated images on top of real-world images. Examples of AR include filters on social media platforms such as Snapchat (Hugues et al. 2011). Mixed reality (MR) refers to the interaction of real-world and virtual objects within an immersive space, allowing users to have more control over virtual objects than with pure augmented reality (Goharinejad et al. 2022). AR, VR, and MR are also known as extended reality (XR) or metaverse, which is sometimes referred to as "Web 3.0". As this field continues to evolve and integrate into widespread use, there may be changes in terminology and definitions (Andrews et al. 2019, Riva and Wiederhold

2022, Usmani et al. 2022). As this field continues to emerge and integrate into widespread use, there may be changes in terminology and definitions. The boundary between the virtual and physical world has become more blurred with the advancing technology. The creation of the Metaverse, which will remove this limit more broadly, will require extensive technology development efforts. If we talk about the metaverse ecosystem and technological developments, the most frequently used technologies are as follows.

1. Virtual Reality (VR): Virtual reality is a constantly evolving set of technologies that offer users a different experience from the real world (Lin et al. 2019). This technology provides an immersive learning environment by including physical interfaces such as computer mice, keyboards, sounds and motion sensors, as well as other interfaces such as haptic devices and head-mounted displays. Using high visualization, speech recognition and three-dimensional features, it is possible to simulate real-life situations (Le et al. 2018).

2. Augmented Reality (AR): It is a technology formed by combining virtual objects with the real world. Users can see the AR world in real-time using portable devices. These virtual objects are integrated with the physical world, giving users a feeling of being among real objects. For example, the user can see a virtual glass standing next to a physical glass on a table. One of the most important features of AR is to make virtual objects look as real, solid and reliable as possible (Rebbani et al. 2021).

3. Extended reality (XR): It is a concept that includes a set of tools that combine physical and virtual environments. This concept consists of three sub-sections as virtual, augmented and mixed reality (Logeswaran et al. 2021).

4. Mixed reality (MR): It is a technology developed for merging real and virtual worlds. MR is defined as a hybrid reality where the real and virtual worlds coexist, combining physical and digital objects to create new environments in which they interact. Environments created with Mixed Reality are environments where real and virtual content coexist and interact in real-time (Yagol et al. 2018).

5. Artificial intelligence (AI): It is defined as the ability of a system to correctly interpret external data, learn from data and use these learnings flexibly to achieve specific goals and tasks (Kaplan and Haenlein 2019). However, the long-term goal of many researchers is for an AI to be human-level intelligent, with the ability to apply it to any problem, not just solve a specific problem. This type of artificial intelligence is expected to outperform humans in almost all cognitive tasks (Kumar et al. 2023).

6. Robotics, Machine learning (ML) and Internet of Things (IoT): It is aimed to create new generation technological systems by using robotics, machine learning (ML) and internet of things (IoT). While robotics is a technology in which programmed machines perform labor-intensive tasks, ML means that computers can learn without prior programming. Thanks to the use of these two technologies together, robots that can work independently can be created. ML techniques are used in a wide range from statistical pattern recognition, parametric or non-parametric algorithms, and supervised/semi-supervised learning to unsupervised learning. IoT, on the other hand, is a concept and paradigm that draws attention to the environment of various objects that can interact with each other and cooperate with other things/objects through wireless/wired connections and unique addressing schemes (Rayan et al. 2021).

Metaverse and Its Place in Medical Practices

Metaverse technologies have opened new horizons for innovations in medicine. Medical education and healthcare practices are embracing technological advances to improve patient care. A wide variety of subspecialties such as cardiology, emergency medicine, gastroenterology, gynecology, oncology, ophthalmology, and radiology use metaverse technologies. Mental health disciplines are also benefiting from metaverse innovations, particularly XR technologies (VR, AR, and mixed reality). VR technologies are among the most widely used developments in mental health interventions. VR exposure therapy (VRET) and AR exposure therapy have proven effective in treating specific phobias, post-traumatic stress disorder (PTSD), anxiety, attention deficit hyperactivity disorder, substance-related disorders, depression, and eating disorders (López-Ojeda and Hurley 2023). Metaverse and the technological developments it brings have made important contributions in the field of health care as well as in education, economy and social fields. These technological developments in the field of health care provide convenience in education, research, diagnosis, treatment, rehabilitation, and clinical applications (Bansal et al. 2022).

Metaverse can be used for medical education and simulations. For example, medical students can practice surgical procedures or the diagnosis and treatment of diseases in a realistic virtual environment. This allows students to practice before experimenting with real patients. John's Hopkins neurosurgeons performed augmented reality surgeries on patients undergoing spinal fusion surgery and excision of a malignant tumor known as a chordoma from the spine (Bansal et al. 2022). In the obstetrics field, too, the metaverse is used to help pregnant women have a better pregnancy by reducing their anxiety levels and teaching them how to successfully control their pain during labor. He used VR techniques to reduce anxiety during first trimester dilatation and curettage surgical procedures. In the field of obstetrics, too, the metaverse is used to help pregnant women have a better pregnancy by reducing their anxiety levels and teaching them how to successfully control their pain during labor. He used VR techniques to reduce anxiety during first trimester dilatation and curettage surgical procedures. In an appropriate sample of 30 women (15 in the intervention group and 15 in the control group), the study was conducted with a semi-structured interview. VR devices, headsets and smartphones were fitted to the intervention group. Anxiety scores were recorded before, during and after the procedure. They stated that the virtual reality applied group VR experience helped them divert their attention from the procedure, thereby reducing their anxiety, feeling that they were in a different environment from the operating room, and helping them reduce their anxiety and pain. Participants reported that VR was either very effective (53%) or somewhat effective (40%) in relieving anxiety during and after the procedure. This study demonstrated the potential of virtual reality use to reduce anxiety during first trimester dilatation and curettage. (Sridhar et al. 2020).

They used the metaverse to educate pregnant women about caesarean-section surgery and to reduce their anxiety before the procedure (Noben et al. 2019). Metaverse is also used in other medical fields such as pediatrics, neurology, orthopedics and dentistry (Bansal et al. 2022). Virtual reality and augmented reality technologies can make the use of medical imaging techniques more effective. Digital images such as MRI and CT scans can be viewed like real life using augmented reality devices. This allows doctors to have a more accurate understanding of the diagnosis and treatment of diseases. Also, metaverse technology can be used for remote medical consultation and telemedicine. Physicians can offer medical counseling and treatment services by interacting with their patients in virtual environments (Bansal et al. 2022). Metaverse can also provide a large data pool for research in the field of medicine. An online system such as a metadata repository can provide the ability to collect large amounts of personal health information, allow the creation of big data and machine learning systems that can aid health care and research. The recorded data can create national or international monitoring and surveillance systems that researchers can use in their studies to both obtain data and compare results. This digital data can be collected directly from the consumer, services, or wearables. At the same time, data can be shared with a doctor, medical professionals, or researchers. The Metaverse is an evolving online world, and its role in guiding the formation of behavioral health care providers and researchers and conducting unbiased research is significant. Therefore, it is essential to have a solid foundation of where to start and to try to understand the issue as soon as possible and get the right way around as much as possible (Petrigna and Musumeci 2022).

Relation Between Metaverse and Psychiatry

It is claimed that metaverse will provide an important part of the facilities it has provided in the field of health, in the field of psychiatry (Usmani et al. 2022). In neuroscience, there is a widely accepted concept known as predictive coding. This idea suggests that our brain actively creates an internal model or simulation of our body and its environment. Neural coding is a field of research that seeks to understand how nerve cells or neurons in the brain represent a particular stimulus. Predictive coding is an approach to understanding how neurons in the brain represent current or past events in order to predict future events. In this approach, nerve cells try to predict future states using previous states of a stimulus. Since the Metaverse is a complex and dynamic virtual world, artificial intelligence and neural networks with predictive capabilities can be used to improve the user experience. Predictive coding methods in neuroscience can be used to predict the actions and interactions that users perform in the virtual world. In this way, it can be used to customize the user experience in the metaverse environment, improve real-time interactions, and enable users to have a richer experience. This relationship may be further enhanced as research in neuroscience and artificial intelligence is combined with the development of the metaverse environment. However, as the concept of the metaverse is still an emerging field at the moment, more research and development is needed on the full potential and applications of this relationship (Clark 2013, Hohwy 2013).

To reduce prediction errors, our brain creates an internal model or simulation that predicts incoming sensory input. This simulation includes an embodied representation of the body, which allows for efficient interaction with the environment. The simulation involves two main aspects. The first aspect is a comprehensive simulation of sensory-motor experiences, utilizing sources such as visceral/autonomic (interoceptive), motor (proprioceptive), and sensory (e.g., visual, auditory) input. The second aspect is that because these simulations are based on the individual's expectations, they activate multimodal brain networks responsible for the expected or previously simulated outcomes (Riva and Dakanalis 2018, Riva et al. 2021a, Riva et al. 2021b). A new conceptual framework in neuroscience suggests that the processing of multisensory bodily signals is linked to various mental health disorders. Recent advances in this field have led to the development of this framework (Blanke et al. 2015, Riva et al. 2018). As Paulus and colleagues recently noted, these conceptual models suggest that a general feature of mental illness is the failure to calculate and integrate over time representations of the body's internal and external worlds. According to this view, an error signal is generated when results are detected, causing mood swings in theory. In these cases, anxiety occurs due to the preconceived interpretation of what the brain expects against what actually happens (Paulus et al. 2019).

The use of the metaverse platform to treat bodily mental health issues is still an unknown area of research. In this case, the metaverse can be used for clinical purposes to shape, augment, and/or alter body experience. Virtual reality exposure therapy has often been shown to be useful in the treatment of pain, phobias, and post-traumatic mental disorders (Carl et al. 2019, Deng et al. 2019a, Georgescu et al. 2020). Although no studies have been reported on the use of therapeutic tools in the metaverse for psychiatric disorders, the use of VR, AR and MR is increasing in the diagnosis and treatment of mental health disorders. In addition, the use of these tools and the metaverse are still not included in the current diagnosis and treatment protocols (Goharinejad et al. 2022). VR simulations offer an advantage in replicating real-life situations that are otherwise difficult to recreate in person. This becomes particularly useful in the field of mental health where the shortage of mental health professionals can be challenging. With VR, certain simulations can eliminate the need for the physical presence of providers, enabling them to participate remotely from any location (Freeman et al. 2017).

Metaverse and Psychiatric Disorders

Major Depressive Disorder

It has been shown that virtual worlds can reduce social isolation and alleviate symptoms of depression (Díaz-Chieng et al. 2022). In a study, it was found that the feelings of social isolation of individuals with depression symptoms who came together in the virtual world called Second Life decreased and their general quality of life increased (Good et al. 2013). In a study, it was determined that the feelings of social isolation of individuals with social anxiety disorder accompanied by depression symptoms, which come together in the virtual world called Second Life, decrease and their general quality of life increases. 14 adults were included in the study, and the participants entered the second life application. The Social Phobia and Anxiety Inventory, the Social Phobia Sub-Scale, the Beck Depression Inventory, the Quality of Life Inventory, the Liebowitz Social Anxiety Inventory, the Short Version of the Fear of Negative Evaluation Scale, and the Sheehan Disability Scale were administered to the participants before, during and after the treatment. Individual therapy consisted of 12 weekly 1-hour sessions. Therapists and patients met in a private, secure virtual room, communicating vocally through headphones and visually with avatars. Beginning with Session 3, in-session exposure exercises such as starting a conversation with a stranger in a virtual bar or giving a presentation in a virtual conference room were performed in the virtual world. Repeated ANOVA measurements were performed for primary outcome measures before treatment, mid-treatment, post-treatment, and during the 12-week follow-up. The results show that treatment using acceptance-based exposure therapy in this virtual environment in Second Life is highly effective in reducing symptoms of social anxiety as well as avoidance and disability, improving depression and improving quality of life. According to the results of the study, the participants' depression and anxiety symptoms decreased while their quality of life increased (Yuen et al. 2013).

Virtual therapy can be effective in treating depression and other mental health disorders. Virtual therapy is a type of remote therapy in which the therapist and patient communicate through their virtual characters on the Metaverse. One study found that individuals who received virtual therapy had a significant reduction in symptoms of depression and anxiety. In a study on the elderly, it was emphasized that it may be a protective factor from depression by increasing metaverse social communication (Liang et al. 2023). It is known that Metaverse, like other technological tools, can cause problems such as digital addiction. Long hours on the metaverse can cause social isolation and loneliness in real life, ultimately increasing the risk of depression (Usmani et al. 2022). Cyberbullying on the metaverse, similar to online bullying, can cause depression and other

mental health disorders. Anxiety, depression and other emotional problems may be seen in individuals exposed to cyberbullying (Dwivedi et al. 2022).

Finally, reality perception disorder on the metaverse can blur the distinction between the virtual world and the real world and ultimately lead to mental health problems such as depression (Benrimoh et al. 2022). To summarize, although the relationship between the metaverse and depression is not yet fully understood, it seems to have negative as well as positive sides. Virtual therapy on the metaverse may have the potential to reduce social isolation and alleviate symptoms of depression. But, on the other hand, the metaverse overuse can cause problems such as cyberbullying and reality perception disorder and increase the risk of depression.

Post Traumatic Stress Disorder

There has not been enough scientific research yet on the relationship between the metaverse and post-traumatic stress disorder (PTSD). However, some virtual world applications such as VR therapy are thought to be effective in the treatment of PTSD. VR therapy is therapy using a virtual world environment to simulate stressful situations that cause PTSD symptoms. This therapy may be effective in reducing PTSD symptoms and may also make patients feel more comfortable with exposure therapy (Üzümcü et al. 2018, Ahmadi Marzaleh et al. 2022). In a study of people who developed PTSD as a result of the September 11 Attack, a virtual environment was created in which planes flew over the World Trade Center and crashed, and the towers collapsed. The virtual environment is enriched with explosions and sound effects. VR grade exposure therapy was successful in reducing acute PTSD symptoms. Depression and PTSD symptoms, as measured by the Beck Depression Inventory and the Clinician-Administered PTSD Scale, showed a large (83%) reduction in depression and a large (90%) reduction in PTSD symptoms after completing VR exposure therapy (Difede and Hoffman 2002). These studies with individuals exposed to trauma reveal that virtual reality-based exposure, in addition to imaginary exposure and relaxation exercises, is effective in the treatment of this disorder (Rothbaum et al. 1999, Difede and Hoffman 2002). Similarly, in studies of war veterans, virtual environments including helicopter noises and violent explosions appear to evoke the amount of emotion and create a high level of anxiety necessary for successful treatment. Despite the effectiveness of psychological interventions, including exposure therapy, a major drawback is the difficulty in getting subjects fully immersed in traumatic scenes (Deng et al. 2019b). This disadvantage may adversely affect the effects of interventions, resulting in high dropout rates (Cottraux et al. 2008).

Alternative intervention approaches are necessary for the treatment of PTSD as it remains a difficult disorder to treat. Virtual reality (VR) exposure therapy has been suggested as having potential efficacy in the treatment of PTSD as it can address the limitations of existing psychological interventions (Heo and Park 2022). VR-based exposure therapy for PTSD allows soldiers to customize the virtual environment to simulate the combat scenarios most relevant to the trauma experienced (Bell et al. 2022). This enables the patient to develop appropriate responses and coping mechanisms. Some health centers have begun to treat soldiers with PTSD using a VR exposure therapy system called 'Bravemind' (Dellazizzo et al. 2020). It shows promise in alleviating trauma and reducing suicidal ideation, depression and anger. However, these VR-based therapies appear to have comparable efficacy to standard evidence-based interventions (Park et al. 2019, Dellazizzo et al. 2020). Studies indicate that the success rates of cognitive behavioral treatments enriched with virtual reality-based exposure practices in reducing PTSD symptoms vary between 66% and 90% (Tarnanas and Manos 2004, Wood et al. 2008, Wiederhold et al. 2014). In this respect, it is thought that virtual reality-based applications can be an effective, functional, safe and powerful resource in the treatment of PTSD. As a result, the relationship between Metaverse and PTSD is still not clearly understood. However, some applications such as virtual reality therapy are thought to be effective in the treatment of PTSD. However, it should be kept in mind that overuse and negative experiences can trigger PTSD symptoms.

Specific Phobia

Specific phobia (SP) is characterized by marked fear/anxiety about a particular object or situation (for example, flying, heights, animals, needles, or blood. VR-based interventions have been extensively studied in the context of specific phobias (SPs), with flight phobia being one of the most researched disorders. In fact, two studies using an in-group design have demonstrated significant reductions in flight-related anxiety and an increased likelihood of flying following treatment (Ferrand et al. 2015, Kahan et al. 2000). The relationship between metaverse and phobia has been proven by some studies in the literature. In a study examining the effectiveness of virtual reality therapy in people with acrophobia, it was shown that virtual reality therapy reduced phobia symptoms and participants were less anxious about high places in real life (Rimer et al. 2021). It has also been

shown to be effective in arachnophobia (fear of spiders) and fear of driving (Wald and Taylor 2003, Michaliszyn et al. 2010, Meyerbröker and Morina 2021). It has been shown that virtual reality therapy in agoraphobia reduces agoraphobia symptoms and participants respond less anxiously and fearfully to agoraphobic situations in real life (Meyerbröker and Morina 2021). However, virtual reality therapy should only be considered as a treatment option, and the type and duration of treatment should be tailored to the patient's condition and needs (Maples-Keller et al. 2017).

Social Anxiety Disorder

There are not many scientific studies yet on the relationship between social anxiety disorder (SAD) and the metaverse. However, some studies show that social anxiety disorder is also effective in virtual environments such as virtual reality technology. The Metaverse is also a kind of virtual environment, and therefore some possible links to social anxiety disorder have been explored. In a study examining the effectiveness of treatment for social anxiety disorder with virtual reality exposure therapy, it was shown that virtual reality therapy reduced symptoms of social anxiety and treated people responded less anxiously and fearfully in real life (Anderson et al. 2013). Another study examined how symptoms of social anxiety disorder occur in a virtual reality environment. The results showed that social anxiety disorder is also valid in the virtual reality environment and this environment can be used as a diagnosis and treatment tool for people with social anxiety disorder (Emmelkamp et al. 2020). In a study examining the effectiveness of virtual reality therapy and social anxiety disorder treatment, it was shown that virtual reality therapy reduced social anxiety symptoms and participants responded less anxiously and fearfully in real life (Scheurich et al. 2019). These studies show that people with social anxiety disorder also show symptoms in virtual reality environments and that virtual reality therapy can be effective in the treatment of social anxiety disorder. It can be assumed that virtual reality environments such as Metaverse can also be used as a treatment tool for social anxiety disorder.

Schizophrenia and Psychotic Disorders

It has been suggested that some virtual environments, such as virtual reality technology, can help people with schizophrenia overcome difficulties they experience in the real world. For example, virtual reality therapy can help patients face and overcome their real-world fears and paranoia (Freeman et al. 2016). Many studies show that virtual reality therapies have positive results for people with schizophrenia. Virtual reality therapies provide patients with exposure therapy in a more controlled environment by addressing the fears, anxieties and anxieties they may encounter in real life. This can help patients perform better in real life (Park et al. 2019). It has been shown that VR application using three-dimensional virtual reality glasses in 12 schizophrenia patients can be effective in improving social dysfunction. The use of the VR program contributed to the generalization of new skills to the patient's daily functioning (Rus-Calafell et al. 2014). By using virtual reality glasses in 55 people diagnosed with psychosis, it was aimed to reduce the daily social stress of the people with the scenes prepared in the virtual environment. The findings showed a decrease in anxiety levels (Veling et al. 2016). Metaverse may help schizophrenic patients improve their social skills by allowing them to interact in virtual worlds. In addition, activities in virtual worlds can improve patients' self-expression, creative thinking and problem-solving skills. However, more research is needed on this subject (Rus-Calafell et al. 2018, Torous et al. 2021).

Obsessive Compulsive Disorder

Obsessive-compulsive disorder (OCD) is an anxiety disorder characterized by repetitive obsessions and compulsive behaviors that develop due to obsessions. Metaverse is being explored as a potential tool in the treatment of OCD. Some studies show that virtual reality therapies provide positive results in the treatment of OCD. Virtual reality therapies allow patients to be exposed to their obsessions, allowing them to deal with these obsessions in a more controlled environment and feel less anxiety. In addition, virtual reality therapies enable patients to better prepare for situations that trigger their obsessions (Javaherirenani et al. 2022). Metaverse can offer OCD sufferers the opportunity to encounter different situations and be exposed to their obsessions. This can help patients cope with their obsessions and gain better control. In addition, activities in virtual worlds can improve patients' ability to cope with stress (Cullen et al. 2021).

Autism

The relationship between the metaverse and autism has been studied in many studies investigating the use of virtual reality technologies that could potentially be beneficial in improving social skills and increasing social interactions in individuals with autism. In the last few years, various commissions and committees have

recommended applying AR/VR to promote new ways of interpersonal skills and abilities in autism (Zhang et al. 2022). When the studies were examined, it was tried to provide a virtual reality environment to 8 people who were followed up with the diagnosis of autism in 2013 to help them cope with the weaknesses in their social relationships. The result of the study shows that the virtual reality platform is a promising tool for improving social skills, cognition and functioning in autism (Kandalaft et al. 2013). In another study, he used a virtual reality application for 36 people with autism. After the application, a decrease in anxiety levels was found in people with autism (Crowell et al. 2020). Augmented reality application was tested on 96 people with autism and it was found that it increased the basic skills and motivation of individuals with autism (Antão et al. 2020).

People with certain medical or mental conditions may have difficulty caring for themselves or managing their behavior and may also feel uncomfortable around other people in social situations. Therefore, it is important for these subjects to rehabilitate their social interaction skills, especially during adolescence. VR technology offers a safe, controllable environment where therapies can be carried out gradually and individually under the direction of therapists. Behavioral therapies mediated by VR technology have been shown to improve motivation, attention, and social skills (Lord et al. 2022). Some studies suggest the use of virtual reality technologies to help individuals with autism learn to recognize and interpret facial expressions and body language cues (Hutson 2022). Virtual reality technologies can be effective in improving social skills by simulating the social interactions that individuals with autism may encounter in real life. In virtual reality environments, individuals with autism can strengthen their social skills by keeping their social interactions under control and practicing repeatedly. In addition, virtual reality therapies may be effective in reducing the symptoms of social phobia and anxiety in individuals with autism (Hutson 2022, Lee et al. 2022). A recent study will investigate whether a metaverse-based child social skills training program can improve the social interaction abilities of children with autism. In this study, researchers will record 24 children and young people with autism who will be subjected to an internet-based virtual world game program for 4 months to improve their social interaction skills (Lee et al. 2022).

Dementia

Metaverse is a concept that often includes technologies such as virtual reality, augmented reality, and social media. Dementia is a disease that occurs due to impaired brain functions. Although there is no scientific connection between these two issues, metaverse technologies could have some interesting applications that could be used in dementia research and treatment. In a study conducted using an augmented reality tool for 3 people with dementia, tasks such as preparing food and creating orders were given. The status and duration of performing the given tasks were compared. It is stated that it was concluded that the participants were able to engage in cognitively challenging tasks, perform their own work individually, and improve the quality of life for individuals with disabilities (Chang et al. 2013). Augmented reality technology can be used to improve the memory and cognitive functions of people with dementia. Augmented reality can stimulate brain function by enabling dementia patients to interact with virtual objects and environments that interact with the real world. In addition, metaverse technologies can also be used to reduce the social isolation of dementia patients. By offering dementia patients social interaction and activities in virtual environments, Metaverse can increase their social connections and thus protect their brain health. One study designed a system to prevent disappearances using augmented reality software for 10 people with Alzheimer's symptoms, Asperger's symptoms, and age-related cognitive deficits (Hervás et al. 2014).

AR software, which aims to increase driver safety for older people, has been used for 20 people with cognitive impairment by increasing the perception of danger without interfering with the driver's duties for safe driving (Schall et al. 2013). Mirelman and his team studied 300 people by dividing them into three groups: Control, Cognitive Disorder, and Parkinson's patients. Their research concluded that an intervention combining virtual reality and augmented treadmill training reduced the risk of falls, improved mobility and improved cognitive function in different groups of older adults (Mirelman et al. 2013). Augmented reality environment is designed for Alzheimer's patients. In this environment, eating and drinking, one of the daily activities of the patients, was carried out in the real environment, and tea making was carried out in the virtual environment. The implementation times of the steps given in the tea making process in virtual and real environments were recorded and compared. As a result of the application, it was seen that the patients' ability to perform their daily activities independently could be regained (Rohrbach et al. 2019). It is stated that VR-based exercise can be used to improve the quality of life for people affected by mental illness or dementia (Yilmaz et al. 2021).

Eating Disorders

There is no scientific article stating any direct link or association between the metaverse and eating disorders.

However, a more effective approach can be achieved by combining research and treatment of eating disorders with metaverse technologies. For example, virtual reality therapy can be used in the treatment of eating disorders. Virtual reality therapy can be used to alleviate anxiety, fear, and obsessive thoughts that cause eating disorders. Virtual reality environments can be combined with therapy programs designed to combat eating disorders, allowing patients with eating disorders to access treatment in a safe environment (Cerasa et al. 2022). VR exposure therapies are currently used to improve body satisfaction and appearance in eating disorders (Clus et al. 2018). Additionally, some studies have shown that VR seems particularly useful in solving body image problems (Ciążyńska and Maciaszek 2022). VR systems help patients integrate new body information and learn how to distinguish cognitive and emotional experience from real body (Matamala-Gomez et al. 2021). In addition, metaverse technologies can also be used to monitor the eating behavior of patients with eating disorders. These technologies can be used to imitate the eating behaviors of patients with eating disorders in virtual environments, to analyze their behavior and to monitor their adherence to treatment (Matsangidou et al. 2022). In conclusion, there is no direct link between eating disorders and metaverse technologies, but metaverse technologies can provide effective tools that can be used for eating disorder treatment. More research is needed to better understand the effects of these technologies on eating disorder treatment.

Metaverse and Psychiatry Education

The increasing use of AR/VR for medical education has been important in recent years (Sandrone 2022). Medical education can benefit from interventions based on VR, AR and MR tools, as they can help simulate physician roles and medical procedures, including obtaining medical history, physical examination, diagnosis and therapeutic management of various diseases. Augmented reality technology can be a particularly useful tool in medical education, providing an immersive and informative experience for rare diseases that medical students, residents, and experts may not encounter frequently (Groft et al. 2021). The utilization of Metaverse and XR in medical education can offer learning opportunities for the advancement of clinical knowledge and ensure patient safety by minimizing risks and ethical concerns associated with exposing individuals to healthcare professionals who are currently in training (Ziv et al. 2003). Various role-playing training technologies using avatars have been used in different medical specialties such as neurology, internal medicine, and general surgery (Sandrone and Carlson 2021). Virtual reality and video/tele-conference-based applications hold promise as effective tools for psychiatry education, as physical examination is not the primary diagnostic tool in this medical specialty. However, exceptions exist, such as in the diagnosis and treatment of neuropsychiatric disorders like functional neurological disorder (Garden 2005).

XR/Metaverse applications in psychiatric teaching have the potential to build on previous attempts to use digital games and online resources. For instance, Second Life, an online video game that simulates life in a built world, was used in 2006 to build an inpatient psychiatry unit to help psychiatry residents understand psychosis. This effort resulted in an increased understanding of visual and auditory hallucinations among participants (Yellowlees and Cook 2006). Integrating XR and metaverse technologies in medical education and for the general public could support a wide range of learning paths. In addition to psychiatric disorders like functional neurological disorder, other mental disorders such as attention deficit/hyperactivity disorder (Goharinejad et al. 2022), autism spectrum disorder (Kandalaft et al. 2013), anxiety disorders, specific phobias (Rothbaum et al. 2010, Botella et al. 2017, Deng et al. 2019), and post-traumatic stress disorder have potential clinical applications in the metaverse and AR/VR (Rothbaum et al. 2010).

Traditionally, procedural treatments in psychiatry have been limited to electroconvulsive therapy and, more recently, repetitive transcranial magnetic stimulation (rTMS), both of which are typically performed in specialized services. However, as new neurotechnologies emerge and interventional psychiatry becomes a recognized subspecialty, there will be a growing demand for broader training in such procedures for psychiatric residents. The use of XR and metaverse technology may provide a useful platform for this expanded training (Trapp and Williams 2021). The tutorials in the metaverse can be recorded, allowing trainees to review them for mistakes and share them with others. This feature is especially useful for brain stimulation procedures, where AR and VR can assist practitioners in training for non-invasive brain stimulation techniques such as transcranial direct current stimulation (tDCS) and more advanced transcranial magnetic stimulation (TMS) such as Stanford Neuromodulation Therapy (SNT). AR/VR tools can also help medical students, residents, and specialists learn more precise positioning of non-invasive neuromodulation devices on the head to expand their skills (Cole et al. 2020). By offering trainees the ability to generate reports that analyze their performance and provide feedback, these technologies can facilitate training and enable personalized, efficient, and comprehensive skill acquisition (Sandrone 2022). In addition, exposing trainees to AR/VR content of the most common side effects of these

techniques can create opportunities to develop therapeutic skills in a risk-free decision-making environment (Stultz et al. 2020).

Risks and Disadvantages of Using Metaverse

In the future, it is thought that the integration of Metaverse in health services will bring some difficulties as well as advantages and opportunities. The perception of virtual reality in the metaverse universe can create addiction in people and cause psychological disorders by disrupting the perception of reality and time. In addition, there is a concern that virtual reality may lead to reduced opportunities for socialization and physical social isolation (Slater et al. 2020). Measures were taken by WHO to limit smartphone use in schools after the publication of results pointing to the role of heavy digital media use in reducing working memory capacity and developing depression, anxiety and sleep disorders (Korte 2022). The constant exposure to virtual profiles can lead to unintended comparison with others, which can negatively impact mental well-being. This is exemplified by social media platforms such as Instagram and Snapchat, which include photo filters that can distort reality and create unrealistic expectations around beauty and lifestyle. Studies have shown that excessive use of photographic filters is associated with the development of body dysmorphia (Abbas and Dodeen 2022). Body dysmorphia can result in negative outcomes, including an elevated risk of mental illnesses such as eating disorders, obsessive behavior, and mood disorders (Schulte et al. 2020). Metaverse use can be addictive. In particular, experiences in the virtual world can create a sense of satisfaction that cannot be obtained in real life and may lead the person to spend more time in the virtual world. This addiction can lead to social isolation and other psychological problems over time (Korte 2022).

It is thought that the metaverse universe may cause people to lose their sense of time by attracting them, and as a result, may cause them to neglect their responsibilities regarding their physical health and family. Also, people can develop trauma and stress disorders as they may be exposed to unexpected fear-inducing situations in the virtual reality world. They may also develop some behavioral disorders by performing actions that they would not do in the real world through imitation. For this reason, it is necessary to be careful about providing health services with the metaverse integration and to evaluate possible risks beforehand (Slater et al. 2020). In the use of Metaverse, there are ethical dilemmas about turning the avatar on and off at any time and who can access user data. For this reason, while considering the benefits of the metaverse in terms of health services, it is also important to protect the personal data of users and to take security measures against privacy violations. For this purpose, technology companies need to work in multidisciplinary cooperation with legal experts (Thomason 2021). While the metaverse is potentially promising with technological advancements for those who need mental health support most, not everyone will be able to use the VR devices needed to enter the metaverse as cost and other constraints will limit access. Additionally, vulnerable groups that could potentially benefit from VR technology, such as older adults, may not accept or have the ability to use these new devices, even if their benefits are proven (Usmani et al. 2022).

Conclusion

Technological developments have created a great transformation by providing convenience in many fields such as education, business life, socialization, communication, economy and health. As a result of this transformation, healthcare has also been improved by leveraging different fields such as artificial intelligence, augmented reality, augmented reality, internet of things, blockchain and other technologies. Metaverse, on the other hand, draws attention as one of the latest technological developments and has also become the focus of attention in the field of health. These technologies can also be used in the field of psychiatry, such as treating patients, solving problems and meeting expectations. However, the use of new technologies such as the metaverse in the field of health care also poses some difficulties. In this study, potential uses, opportunities and challenges of the metaverse for mental health services were evaluated. We believe that this study will contribute to the limited literature and awareness of potential future opportunities in mental health services.

References

Abbas L, Dodeen H (2022) Body dysmorphic features among snapchat users of “Beauty-Retouching of Selfies” and its relationship with quality of life. Media Asia, 49:196-212.

Ahmadi M, Peyravi M, Shaygani F (2022) A revolution in health: Opportunities and challenges of the Metaverse. EXCLI J, 21:791-792.

Anderson PL, Price M, Edwards SM, Obasaju MA, Schmertz SK, Zimand E et al. (2013) Virtual reality exposure therapy for social anxiety disorder: a randomized controlled trial. J Consult Clin Psychol, 81:751-760.

Andrews C, Southworth MK, Silva JNA, Silva JR (2019) Extended reality in medical practice. Curr Treat Options Cardiovasc Med, 21:1-12.

Antão J, Abreu LC, Barbosa RTA, Crocetta TB, Guarnieri R, Massetti T et al. (2020) Use of augmented reality with a motion-controlled game utilizing alphabet letters and numbers to improve performance and reaction time skills for people with autism spectrum disorder. Cyberpsychol Behav Soc Netw, 23:16-22.

Balasubramanian S (2021) The next frontier for healthcare: Augmented reality, virtual reality, and the metaverse. https://www.forbes.com/sites/saibala/2021/11/29/the-next-frontier-for-healthcareaugmented-reality-virtual-reality-and-the-metaverse/?sh=11b7f67c2894 (Accessed 07.04.2023)

Bansal G, Rajgopal K, Chamola V, Xiong Z, Niyato D (2022) Healthcare in metaverse: a survey on current metaverse applications in healthcare. IEEE Access, 10:119914-119946.

Bell IH, Nicholas J, Alvarez-Jimenez M, Thompson A, Valmaggia L (2022) Virtual reality as a clinical tool in mental health research and practice. Dialogues Clin Neurosci, 22:169-177.

Benrimoh D, Chheda FD, Margolese HC (2022) The best predictor of the future the metaverse, mental health, and lessons learned from current technologies. JMIR Ment Health, 9:e40410.

Blanke O, Slater M, Serino A (2015) Behavioral, neural, and computational principles of bodily self-consciousness. Neuron, 88:145-166.

Botella C, Fernández-Álvarez J, Guillén V, García-Palacios A, Baños R (2017) Recent progress in virtual reality exposure therapy for phobias: a systematic review. Curr Psychiatry Rep, 19:42.

Carl E, Stein AT, Levihn-Coon A, Pogue JR, Rothbaum B, Emmelkamp P, et al. (2019) Virtual reality exposure therapy for anxiety and related disorders: a meta-analysis of randomized controlled trials. J Anxiety Disord, 61:27-36.

Cerasa A, Gaggioli A, Marino F, Riva G, Pioggia G (2022) The promise of the metaverse in mental health: the new era of MEDverse. Heliyon, 8:e11762.

Chang YJ, Kang YS, Huang PC (2013) An augmented reality (AR)-based vocational task prompting system for people with cognitive impairments. Res Dev Disabil, 34:3049-3056.

Ciążyńska J, Maciaszek J (2022) Various types of virtual reality-based therapy for eating disorders: a systematic review. J Clin Med, 11:4956.

Clark A (2013) Whatever next? Predictive brains, situated agents, and the future of cognitive science. Behav Brain Sci, 36:181-204.

Clus D, Larsen ME, Lemey C, Berrouiguet S (2018) The use of virtual reality in patients with eating disorders: systematic review. J Med Internet Res, 20:e157.

Cole EJ, Stimpson KH, Bentzley BS, Gulser M, Cherian K, Tischler C et al. (2020) Stanford accelerated intelligent neuromodulation therapy for treatment-resistant depression. Am J Psychiatry, 177:716-726.

Cottraux J, Note I, Yao SN, de Mey-Guillard C, Bonasse F, Djamoussian D et al. (2008) Randomized controlled comparison of cognitive behavior therapy with Rogerian supportive therapy in chronic post-traumatic stress disorder: a 2-year follow-up. Psychother Psychosom, 77:101-110.

Crowell C, Sayis B, Benitez JP, Pares N (2020) Mixed reality, full-body interactive experience to encourage social initiation for autism: Comparison with a control nondigital intervention. Cyberpsychol Behav Soc Netw, 23:5-9.

Cullen AJ, Dowling NL, Segrave R, Carter A, Yücel M (2021) Exposure therapy in a virtual environment: Validation in obsessive compulsive disorder. J Anxiety Disord, 80:102404.

Dellazizzo L, Potvin S, Luigi M, Dumais A (2020) Evidence on virtual reality-based therapies for psychiatric disorders: Meta-review of meta-analyses. J Med Internet Res, 22:e20889..

Deng W, Hu D, Xu S, Liu X, Zhao J, Chen Q et al. (2019) The efficacy of virtual reality exposure therapy for PTSD symptoms: A systematic review and meta-analysis. J Affect Disord, 257:698-709.

Díaz-Chieng LY, Auza-Santiváñez JC, Castillo JIR (2022) The future of health in the metaverse. Metaverse Basic and Applied Research, 1:1.

Difede J, Hoffman HG (2002) Virtual reality exposure therapy for world trade center post-traumatic stress disorder: A case report. Cyberpsychol Behav, 5:529-535.

Dwivedi YK, Hughes L, Baabdullah AM, Ribeiro-Navarrete S, Giannakis M, Al-Debei MM et al. (2022) Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. Int J Inf Manage, 66:102542.

Emmelkamp PMG, Meyerbröker K, Morina N (2020) Virtual reality therapy in social anxiety disorder. Curr Psychiatry Rep, 22:32.

Ferrand M, Ruffault A, Tytelman X, Flahault C, Négovanska V (2015) A cognitive and virtual reality treatment program for the fear of flying. Aerosp Med Hum Perform, 86:723-727.

Freeman D, Bradley J, Antley A, Bourke E, DeWeever N, Evans N et al. (2016) Virtual reality in the treatment of persecutory delusions: Randomised controlled experimental study testing how to reduce delusional conviction. Br J Psychiatry, 209:62-67.

Freeman D, Reeve S, Robinson A, Ehlers A, Clark D, Spanlang B et al. (2017) Virtual reality in the assessment, understanding, and treatment of mental health disorders. Psychol Med, 47:2393-2400.

Garden G (2005) Physical examination in psychiatric practice. Adv Psychiatr Treat, 11:142-149.

Georgescu R, Fodor LA, Dobrean A, Cristea IA (2020) Psychological interventions using virtual reality for pain associated with medical procedures: a systematic review and meta-analysis. Psychol Med, 50:1795-1807.

Goharinejad S, Goharinejad S, Hajesmaeel-Gohari S, Bahaadinbeigy K (2022) The usefulness of virtual, augmented, and mixed reality technologies in the diagnosis and treatment of attention deficit hyperactivity disorder in children: an overview of relevant studies. BMC Psychiatry, 22:4.

Good A, Gnanayutham P, Sambhanthan A, Panjganj V (2013) HCI considerations in designing a second life virtual therapeutic community for the support & treatment of people with borderline personality disorder. arXiv, doi: arXiv.1302.5497.

Groft SC, Posada M, Taruscio D (2021) Progress, challenges and global approaches to rare diseases. Acta Paediatr, 110:2711-2716.

Heo S, Park JH (2022) Effects of virtual reality-based graded exposure therapy on ptsd symptoms: a systematic review and meta-analysis. Int J Environ Res Public Health, 19:15911.

Hervás R, Bravo J, Fontecha J (2014) An assistive navigation system based on augmented reality and context awareness for people with mild cognitive impairments. IEEE J Biomed Health Inform, 18:368-374.

Hohwy J (2013) The Predictive Mind. Oxford, Oxford University Press.

Hugues O, Fuchs P, Nannipieri O (2011) New augmented reality taxonomy: Technologies and features of augmented environment. In Handbook of Augmented Reality (Ed B Furht): 47-63. New York, Springer.

Hutson J (2022) Social virtual reality: neurodivergence and inclusivity in the metaverse. Societies, 12:102.

Javaherirenani R, Mortazavi SS, Shalbafan M, Ashouri A, Farani AR (2022) Virtual reality exposure and response prevention in the treatment of obsessive-compulsive disorder in patients with contamination subtype in comparison with in vivo exposure therapy: a randomized clinical controlled trial. BMC Psychiatry, 22:740.

Kahan M, Tanzer J, Darvin D, Borer F (2000) Virtual reality-assisted cognitive-behavioral treatment for fear of flying: acute treatment and follow-up. Cyberpsychol Behav, 3:387-392.

Kandalaft MR, Didehbani N, Krawczyk DC, Allen TT, Chapman SB (2013) Virtual reality social cognition training for young adults with high-functioning autism. J Autism Dev Disord, 43:34-44.

Kaplan A, Haenlein M (2019) Siri, siri, in my hand: who's the fairest in the land? on the interpretations, illustrations, and implications of artificial intelligence. Bus Horiz, 62:15-25.

Kim J (2021) Advertising in the metaverse: research agenda. Journal of Interactive Advertising, 21:141-144.

Korte M (2022) The impact of the digital revolution on human brain and behavior: where do we stand? Dialogues Clin Neurosci, 22:101-111.

Kumar P, Chauhan S, Awasthi LK (2023) Artificial intelligence in healthcare: review, ethics, trust challenges & future research directions. Eng Appl Artif Intell, 120:105894.

Le DN, Van Le C, Tromp JG, Nguyen GN (2018) Emerging Technologies For Health And Medicine: Virtual Reality, Augmented Reality, Artificial Intelligence, Internet of Things, Robotics, Industry 4.0. Hoboken, NJ, Wiley.

Lee J, Lee TS, Lee S, Jang J, Yoo S, Choi Y et al. (2022) Development and application of a metaverse-based social skills training program for children with autism spectrum disorder to improve social interaction: protocol for a randomized controlled trial. JMIR Res Protoc, 11:e35960.

Lee LH, Braud T, Zhou P, Wang L, Xu D, Lin Z et al. (2021) All one needs to know about metaverse: a complete survey on technological singularity, virtual ecosystem, and research agenda. Journal of Latex Class Files, 14:1-66.

Liang H, Li J, Wang Y, Pan J, Zhang Y, Dong X (2023) Metaverse virtual social center for the elderly communication during the social distancing. Virtual Reality & Intelligent Hardware, 5:68-80.

Lin HT, Li YI, Hu WP, Huang CC, Du YC (2019) A scoping review of the efficacy of virtual reality and exergaming on patients of musculoskeletal system disorder. J Clin Med, 8:791.

Liu Z, Ren L, Xiao C, Zhang K, Demian P (2022) Virtual reality aided therapy towards health 4.0: a two-decade bibliometric analysis. Int J Environ Res Public Health, 19:1525.

Logeswaran A, Munsch C, Chong YJ, Ralph N, McCrossnan J (2021) The role of extended reality technology in healthcare education: towards a learner-centred approach. Future Healthc J, 8:79-84.

López-Ojeda W, Hurley RA (2023) The medical metaverse, part 1: introduction, definitions, and new horizons for neuropsychiatry. J Neuropsychiatry Clin Neurosci, 35:1-4.

Lord C, Charman T, Havdahl A, Carbone P, Anagnostou E, Boyd B et al. (2022) The Lancet Commission on the future of care and clinical research in autism. Lancet, 399:271-334.

Maples-Keller JL, Bunnell BE, Kim SJ, Rothbaum BO (2017) The use of virtual reality technology in the treatment of anxiety and other psychiatric disorders. Harv Rev Psychiatry, 25:103-113.

Matamala-Gomez M, Maselli A, Malighetti C, Realdon O, Mantovani F, Riva G (2021) Virtual body ownership illusions for mental health: a narrative review. J Clin Med, 10:139.

Matsangidou M, Otkhmezuri B, Ang CS, Avraamides M, Riva G, Gaggioli A et al. (2022) "Now i can see me" designing a multi-user virtual reality remote psychotherapy for body weight and shape concerns. Hum Comput Interact, 37:314-340.

Meyerbröker K, Morina N (2021) The use of virtual reality in assessment and treatment of anxiety and related disorders. Clin Psychol Psychother, 28:466-476.

Michaliszyn D, Marchand A, Bouchard S, Martel MO, Poirier-Bisson J (2010) A randomized, controlled clinical trial of in virtuo and in vivo exposure for spider phobia. Cyberpsychol Behav Soc Netw, 13:689-695.

Mirelman A, Rochester L, Reelick M, Nieuwhof F, Pelosin E, Abbruzzese G et al. (2013) V-TIME: a treadmill training program augmented by virtual reality to decrease fall risk in older adults: study design of a randomized controlled trial. BMC Neurol, 13:15.

Noben L, Goossens SMTA, Truijens SEM, Van Berckel MMG, Perquin CW, Slooter, GD et al. (2019) A virtual reality video to improve information provision and reduce anxiety before cesarean delivery: randomized controlled trial. JMIR Mental Health, 6:e15872.

Park MJ, Kim DJ, Lee U, Na EJ, Jeon HJ (2019) A literature overview of virtual reality (VR) in treatment of psychiatric disorders: recent advances and limitations. Front Psychiatry, 10:505.

Paulus MP, Feinstein JS, Khalsa SS (2019) An active inference approach to interoceptive psychopathology. Annu Rev Clin Psychol, 15:97-122.

Petrigna L, Musumeci G (2022) The metaverse: a new challenge for the healthcare system: a scoping review, J Funct Morphol Kinesiol, 7:63.

Rayan RA, Tsagkaris C, Zafar I (2021) IoT-integrated robotics in the health sector. In Robotic Technologies in Biomedical and Healthcare Engineering (Eds D Gupta, M Sharma, V Chaudhary, A Khanna): 1-11. Oxon, CRC Press.

Rebbani Z, Azougagh D, Bahatti L, Bouattane O (2021) Definitions and applications of augmented/virtual reality: A survey. Int . Emer. Trends Eng, 9:279-285.

Rimer E, Husby LV, Solem S (2021) Virtual reality exposure therapy for fear of heights: clinicians' attitudes become more positive after trying VRET. Front Psychol, 12:671871.

Riva G, Dakanalis A (2018) Altered processing and integration of multisensory bodily representations and signals in eating disorders: a possible path toward the understanding of their underlying causes. Front Hum Neurosci, 12:49.

Riva G, Di Lernia D, Sajno E, Sansoni M, Bartolotta S, Serino S et al. (2021a) Virtual reality therapy in the metaverse: merging VR for the outside with VR for the inside. Annual Review of Cybertherapy and Telemedicine, 19:3-8.

Riva G, Serino S, Di Lernia D, Pagnini F (2021b) Regenerative virtual therapy: the use of multisensory technologies and mindful attention for updating the altered representations of the bodily self. Front Syst Neurosci, 15:749268.

Riva G, Wiederhold BK (2022) What the metaverse is (really) and why we need to know about it. Cyberpsychol Behav Soc Netw, 25:355-359.

Riva G, Wiederhold BK, Chirico A, Di Lernia D, Mantovani F, Gaggioli A (2018) Brain and virtual reality: what do they have in common and how to exploit their potential. Annual Review of CyberTherapy and Telemedicine, 16:3-7.

Rohrbach N, Gulde P, Armstrong AR, Hartig L, Abdelrazeq A, Schröder S et al. (2019) An augmented reality approach for ADL support in Alzheimer's disease: a crossover trial. J Neuroeng Rehabil, 16:66.

Rothbaum BO, Hodges L, Alarcon R, Ready D, Shahar F, Graap K et al. (1999) Virtual reality exposure therapy for PTSD Vietnam veterans: a case study. J Trauma Stress, 12:263-271.

Rothbaum BO, Rizzo AS, Difede J (2010) Virtual reality exposure therapy for combat-related posttraumatic stress disorder. Ann N Y Acad Sci, 1208:126-132.

Rus-Calafell M, Garety P, Sason E, Craig TJK, Valmaggia LR (2018) Virtual reality in the assessment and treatment of psychosis: a systematic review of its utility, acceptability and effectiveness. Psychol Med, 48:362-391.

Rus-Calafell M, Gutiérrez-Maldonado J, Ribas-Sabaté J (2014) A virtual reality-integrated program for improving social skills in patients with schizophrenia: a pilot study. J Behav Ther Exp Psychiatry, 45:81-89.

Sandrone S (2022) Medical education in the metaverse. Nat Med, 28:2456-2457.

Sandrone S, Carlson C (2021) Gamification and game-based education in neurology and neuroscience: Applications, challenges, and opportunities. Brain Disorders, 1:100008.

Schall MC, Jr Rusch ML, Lee JD, Dawson JD, Thomas G, Aksan N et al. (2013) Augmented reality cues and elderly driver hazard perception. Hum Factors, 55:643-658.

Scheurich JA, Beidel DC, Vanryckeghem M (2019) Exposure therapy for social anxiety disorder in people who stutter: an exploratory multiple baseline design. J Fluency Disord, 59:21-32.

Schulte J, Schulz C, Wilhelm S, Buhlmann U (2020) Treatment utilization and treatment barriers in individuals with body dysmorphic disorder. BMC Psychiatry, 20:69.

Slater M, Gonzalez-Liencres C, Haggard P, Vinkers C, Gregory-Clarke R, Jelley S et al. (2020) The ethics of realism in virtual and augmented reality. Front Virtual Real, 1:1.

Sridhar A, Shiliang Z, Woodson R, Kwan L (2020) Non-pharmacological anxiety reduction with immersive virtual reality for first-trimester dilation and curettage: a pilot study. Eur J Contracept Reprod Health Care, 25:480-483.

Stephenson N (1992) Snow Crash. New York, Bantam Books.

Stultz DJ, Osburn S, Burns T, Pawlowska-Wajswol S, Walton R (2020) Transcranial magnetic stimulation (TMS) safety with respect to seizures: a literature review. Neuropsychiatr Dis Treat, 16:2989-3000.

Tarnanas I, Manos G (2004) A clinical protocol for the development of a virtual reality behavioral training in disaster exposure and relief. Annual Review of CyberTherapy and Telemedicine, 2:71-83.

Thomason J (2021) Ethics in the metaverse: maximizing benefit and minimizing harm. Corp Invest Times, 12:67-70.

Torous J, Bucci S, Bell IH, Kessing LV, Faurholt-Jepsen M, Whelan P et al. (2021) The growing field of digital psychiatry: current evidence and the future of apps, social media, chatbots, and virtual reality. World Psychiatry, 20:318-335.

Trapp NT, Williams NR (2021) The future of training and practice in neuromodulation: an interventional psychiatry perspective. Front Psychiatry, 12:734487.

Usmani SS, Sharath M, Mehendale M (2022) Future of mental health in the metaverse. Gen Psychiatr, 35:e100825.

Üzümcü E, Akın B, Nergiz H, İnözü M, Çelikcan U (2018) Anksiyete bozukluklarında sanal gerçeklik. Psikiyatride Güncel Yaklaşımlar, 10:99-117.

Veling W, Pot-Kolder R, Counotte J, van Os J, van der Gaag M (2016) Environmental social stress, paranoia and psychosis liability: a virtual reality study. Schizophr Bull, 42:1363-1371.

Wald J, Taylor S (2003) Preliminary research on the efficacy of virtual reality exposure therapy to treat driving phobia. Cyberpsychol Behav, 6:459-465.

Wiederhold BK, Bouchard S (2014) Virtual reality for posttraumatic stress disorder. In Advances in Virtual Reality and Anxiety Disorders (Eds. BK Wiederhold, S Bouchard): 211-233, Boston, Springer.

Wood DP, Murphy JA, Center KB, Russ C, McLay RN, Reeves D et al. (2008) Combat related post traumatic stress disorder: a multiple case report using virtual reality graded exposure therapy with physiological monitoring. Stud Health Technol Inform, 132:556-561.

Yagol P, Ramos F, Trilles S, Torres-Sospedra J, Perales FJ (2018) New trends in using augmented reality apps for smart city contexts. ISPRS International Journal of Geo-Information, 7:478.

Yellowlees PM, Cook JN (2006) Education about hallucinations using an internet virtual reality system: a qualitative survey. Acad Psychiatry, 30:534-539.

Yilmaz F, Mete AH, Türkön BF, Özgür İ (2022) Sağlık hizmetlerinin geleceğinde metaverse ekosistemi ve teknolojileri: uygulamalar, fırsatlar ve zorluklar. Eurasian Journal of Health Technology Assessment, 6:12-34.

Yilmaz NÖ, Duran F, Fidan U (2021) Virtual reality and augmented reality in psychiatric disorders. Gazi University Journal of Science Part C: Design and Technology, 9:516-532.

Yuen EK, Herbert JD, Forman EM, Goetter EM, Comer R, Bradley JC (2013) Treatment of social anxiety disorder using online virtual environments in second life. Behav Ther, 44:51-61.

Zhang M, Ding H, Naumceska M, Zhang Y (2022) Virtual reality technology as an educational and intervention tool for children with autism spectrum disorder: current perspectives and future directions. Behav Sci, 12:138.

Ziv A, Wolpe PR, Small SD, Glick S (2003) Simulation-based medical education: an ethical imperative. Acad Med, 78:783-788.

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