ARTICLE

Check for updates

Investigating the mediating role of ethical issues and healthcare between the metaverse and mental health in Pakistan, China, and Saudi Arabia

Yineng Xiao [1,2✉], Sayed Fayaz Ahmad [3✉], Muhammad Irshad[4], Han Guo[2], Haitham A. Mahmoud[5], Emad Mahrous Awwad[6] & Yasser Khan[7]

This article examines the mediating role of ethical issues and healthcare on the relationship between the Metaverse and mental health. It also investigates the impact of the Metaverse on ethical issues and healthcare. It is based on quantitative methodology. Using a purposive sampling technique, a close-ended questionnaire was used to collect data from 392 nurses and doctors across Pakistan, China, and Saudi Arabia. The Partial Least Squares Structural Equation Modelling technique was used for the analysis. The findings show a significant mediating role of ethical issues between the Metaverse and mental health. The results do not support the mediating role of healthcare between the Metaverse and mental health. In addition, the findings also show a positive relationship between the Metaverse and ethical issues and between ethical issues and mental health. Similarly, the findings also support the relationship between the Metaverse and healthcare. The results do not support the relationship between healthcare and mental health. The study has many implications for technology developers, scientists, policymakers, and healthcare providers.

[1] The Global Intellectual Property Institute, Nanjing University, Suzhou, China. [2] Advanced Institute of Information Technology, Peking University, Hangzhou, China. [3] Head of Research/Assistant Professor, Institute of Business Management, Karachi, Pakistan. [4] Department of Management Sciences, University of Gwadar, Gwadar, Pakistan. [5] Department of Industrial Engineering, College of Engineering, Kind Saud Univerty, Riyadh, Saudi Arabia. [6] Department of Electrical Engineering, College of Engineering, Kind Saud Univerty, Riyadh, Saudi Arabia. [7] Post Doc Research Fellow, Multimedia University, Cyberjaya, Malaysia. ✉email: xiaoyineng@pku.edu.cn; fayaz.ahmed@iobm.edu.pk

Introduction

In the past two decades, digital technology has advanced significantly and transformed our lives (Cowie and O'Connor, 2022). It has allowed us to create, process, store, and access large amounts of data. With the help of digital technologies and the internet, we can interact on various platforms and engage in activities over long distances. There are approximately five billion internet users worldwide, with 93% using social media as of April 2022 (Bardus et al. 2022). On average, people spend 147 min daily on social media (Liu et al. 2023) and 6 h and 58 min online (Evenson et al. 2023). This highlights the need to examine the impact of the internet and social media on its users' mental health (MH).

Undoubtedly, digital technology is becoming an integral part of our lives, and its impact reshapes society and our behavior. Similarly, we cannot run from societal transformation due to these technological changes and advancements. It is so powerful that digital technology has become an important part of many societal functions (Hodson, 2018). As a result, no one can escape from using digital technology, and its adoption is becoming obligatory without any other choice.

Technological transformation always comes with its issues and challenges. And so the use of digital technology has also given rise to many MH problems and issues (Pandya and Lodha, 2021). For example, depression, anxiety, and suicide attempts increased among teens after the availability of smartphones. Most parents, children, friends, etc., interact with their devices, not with each other, even if they are physically together (Mindrescu and Enoiu, 2022). This leads to weakened human and societal relationships along with a sense of empathy, creativity, introspection, etc. The final target will be the social bonding and fabric that holds society and communities together (Sherry, 2015). Due to these issues, many researchers have stressed minimizing the use of digital technologies (Cal, 2019). Such concerns were increased when efforts were carried out to immediately stop the speed of COVID-19, and willingly or unwillingly, every aspect of society's business, including educational, professional, personal, cultural, etc., was shifted online (Marandi, 2023). This craving for virtual togetherness was made possible by the digital technological revolution, which developed dramatically during the epidemic under the phrase "social distancing." Meanwhile, the adoption and acceptability of DT expanded with time (Sayibu et al. 2022). Additionally, many scientists and researchers were attracted to enhance the technology further to meet an immediate need or create the Metaverse of the future (Zhang et al. 2022). Moreover, technological giants like facebook, etc., also started to invest in the Metaverse (Chen and Zhang, 2022).

Problem statement. "The issues related to MH due to the excessive use of DT and the internet became a significant challenge in the Metaverse." Its emergence has raised concerns regarding the possible effects of immersive digital platforms on human MH (Usmani et al. 2022). Although there is early optimism, it is necessary to look at the complex relationships connecting the Metaverse, ethical issues, healthcare availability, and its combined effect on MH (Benrimoh et al. 2022). Moreover, investigating these complex relationships is necessary for making policies, technological support systems, healthcare facilities, and service planning to increase the Metaverse's benefits and ensure MH. This study aims to determine how the Metaverse affects MH, emphasizing the mediating roles of healthcare and ethical concerns.

The objectives of the study are:

1. To find out the impact of the Metaverse on MH
2. To find out the role of the Metaverse in creating ethical issues in healthcare
3. To find out the impact of the Metaverse on healthcare

Research questions. The research addresses the following questions, which provide a base for examining the complex links among the Metaverse participation, ethical issues, healthcare, and MH.

1. How does the Metaverse affect human MH?
2. How does the Metaverse affect ethical issues?
3. Do the ethical issues and healthcare mediate the relationship between the Metaverse and MH?
4. Is there any role of the Metaverse in providing access to healthcare?

Research significance. The study has many significant aspects. It highlights a new and important issue in the current digital era. Understanding the possible effects of the Metaverse on MH is essential as it grows increasingly and integrates into everyday life (Benrimoh et al. 2022). This study also highlights the potential advantages, the considerable ethical issues, and the requirements for healthcare within this setting. The study also ties technological advances and well-being together, making it further important. It attempts to offer empirical evidence regarding whether the virtual world impacts MH, clarifying whether it worsens or reduces MH problems. It provides a comprehensive view of the intricate relationships between technology, ethics, and health essential to lawmakers, healthcare providers, and technologists by examining the intermediary role of ethical concerns and healthcare. The research has implications for individuals, firms, and managers associated with Metaverse development and MH. It provides insights regarding ethical guidelines, policies, and regulations to ensure responsible development and use of Metaverse and users' MH. Similarly, by exploring the mediating role of ethical issues and healthcare involvement, the study assists in making informed decisions, designing Metaverse technology responsibly, and supporting customized MH in the Metaverse digital world.

Hypotheses development and conceptual framework

Theories. The framework of the study is based on the integration of the Human-Computer Interaction Principles (HCI), Social Cognitive Theory (SCT), Technological Determinism Theory (TDT), and Digital Well-being frameworks (DW). These theories establish a foundation for an empirical investigation to examine the complex interactions among the Metaverse, ethical issues, access to healthcare, and MH. They were used to determine the Metaverse's effect on MH while considering healthcare and ethical issues as mediators.

Social cognitive theory. Albert Bandura presented the SCT. It explores how people learn from their society and environments (Bandura, 1986). It highlights the essential function that cognitive processes, self-efficacy beliefs, and observational learning influence a person's behavior. It argues that people learn through experiences and by observing and copying others and highlights the dynamic interaction between an individual's character, surroundings, and behavior. In sum, SCT offers a thorough framework for comprehending how people learn and use knowledge and behavior in everyday life, which makes it significant across numerous scientific fields (Bandura, 2002). In the context of this study, it can be used to investigate how ethical concerns and medical therapies mediate the effects of the Metaverse experiences on MH.

Technological determinism theory. This idea explores how technology affects both society and people. It asserts that technology fundamentally and inevitably influences the development of human culture, history, and society. This idea also argues that social development and changes in how individuals think, organize, and interact are driven by technological advances (Héder, 2021). Moreover, it says that technology has a transformative strength that shapes the structures of society and individuals' behavior in predictable manners (Jan et al. 2020). This opinion frequently minimizes the importance of social and cultural influences, accusing technological advancements and their inherent characteristics for the changes. Some scholars have disagreed on the usefulness of TDT as an approach to understanding how technology affects society, while some believe it is (Bibri, 2022). Others believe it oversimplifies the complicated relationship between technology and society (Bojic, 2022). In the context of this study, it provides useful insights to examine the role of the Metaverse in shaping healthcare and MH.

Human-computer interaction principles. It provides a comprehensive framework for developing and evaluating technology systems and interfaces (Alkatheiri, 2022). HCI is primarily user-centered, highlighting accessibility and usability through a user-centered design. It fosters simplicity, learnability, and consistency while offering clear feedback with error management (Hustak and Krejcar, 2016). The importance of ethics in HCI has grown, with a focus on security and privacy due to the wider societal effects of technology (Nie et al. 2023). Further, technology needs to be tested and evaluated regularly to fulfill its purpose, improve user satisfaction and interaction, and express the collaborative link between technological advancement and human interaction (Saltarella et al. 2023). In the context of this research, the Metaverse technology can be used to investigate the usability and design of the Metaverse platforms and how they affect MH.

Digital well-being frameworks. The DW frameworks evaluate how digital technology affects well-being and function as roadmaps to assist people in navigating the complicated realm of digital technology, focusing on balanced, healthy, and vigilant connections (Gennari et al. 2023). The basic concepts of these models cover anything from encouraging self-awareness and healthy time management to teaching consumers about online security, privacy, and digital literacy (Tinmaz et al. 2023). These frameworks promote practices prioritizing MH while using technology (Smith et al. 2023). People can establish a more harmonic connection with digital tools and platforms. They can improve the quality of their life in today's digital world by incorporating these frameworks into their individual and institutional strategies (Hamdoun et al. 2023; Li, 2023). In the context of this study, these frameworks can be used to measure the relationship between the Metaverse and MH.

The research applies HCI to examine the layout and usefulness of simulated environments of the Metaverse to find out the Metaverse's influence on MH. HCI guides investigating the influence of human interactions and experiences in the virtual world on MH. For instance, user interfaces and immersion in the Metaverse will either positively or negatively affect MH. Furthermore, it is not easy to comprehend the relationship between the Metaverse, ethics, and MH. The study uses SCT to comprehend more about the ethics and behaviors in virtual spaces and how they may impact the MH of people. This theory facilitates us to comprehend the perception of people regarding ethical conduct and its impact on MH in the Metaverse. For example, we examine whether experiencing or taking part in immoral activities leads to anxiety, guilt, etc., in the Metaverse or not.

In addition, it is a complicated subject to discuss how the Metaverse impacts MH. Here, we apply the TDT to investigate how the technological entity that is the Metaverse may impact ethical issues and MH. TDT enables us to see if the technical characteristics of the Metaverse intrinsically influence ethics and, consequently, MH. For example, we examine if people act differently due to the immersive aspect of the Metaverse and if these actions affect their mental wellness. Similarly, the research uses DW to explore how the Metaverse facilitates healthcare access. DW frameworks provide a systematic approach to examining how well-being is affected by technological advancements. Using such frameworks, we investigate whether the Metaverse could be used as a platform for providing and supporting healthcare. For instance, considering the possible ethical issues raised by this special healthcare option, we examine if virtual healthcare provided via the Metaverse improves access to healthcare and patient MH. With the help of these theories, the study seeks to present a thorough understanding of the interplay of the Metaverse, healthcare, ethics, and MH in the currently evolving virtual landscape.

The Metaverse. The Metaverse is a digital world, an interconnected and interactive virtual reality where users may interact and navigate in real-time. With many distinctive features, including user content, a distinct digital economy, and smooth multi-platform accessibility, it differs from conventional online environments (Wang et al. 2023). Leading companies like Google and Meta have made significant investments in its development and consider it the next frontier for the web, where people can work, socialize, and play (Mosco, 2023). It also brings complex challenges, such as digital ownership rights, monopolistic control, accessibility, security, and privacy (Ooi et al. 2023). Overcoming these problems is essential as the Metaverse reshapes our lives and how we engage with the virtual world.

The development of the Metaverse accompanies a wide range of implications. Undoubtedly, it provides opportunities for improved social connectedness, new commercial opportunities, healthcare, and advanced learning possibilities. Nevertheless, it also prompts issues related to privacy, access (Letafati and Otoum, 2023), equal benefits, and the possibility of monopolistic domination of a few companies. Areas that need extra attention include intellectual property problems, challenges concerning content control, and the effect on in-person relationships (Wylde et al. 2023). These implications must be managed in the light of equality, ethics, and regulation while encouraging creativity and connectivity across the changing digital environment to fully utilize its potential for the common good (Arief et al. 2023).

The Metaverse will change our lives, working styles, and interactions by offering a virtual environment, enabling deep social connections, creative business options, and novel health and educational opportunities (Banaeian et al. 2023; Reibstein and Iyengar, 2023). It might revolutionize all walks of life and provide people with an environment for innovation, entrepreneurship, and cooperation (Calandra et al. 2023; Schiller et al. 2023). This makes it both beneficial and challenging. Its usefulness depends on managing major concerns like privacy, security, and accessibility and on the investing firms to develop and maintain the Metaverse that is accessible, ethical, and useful for society.

The Metaverse and mental health. MH is a person's ability to perceive, think, and behave in ways that enhance their living quality while respecting their personal, cultural, and social

boundaries (Manwell et al. 2015). Emotional, social, and psychological well-being are the parts of MH that influence human perception, behavior, and cognition. A person's MH determines how to handle stress, relationships, and the process of decision-making (Galluccio, 2019). Sleep disturbance, fatigue, and thoughts of harming oneself or others are early indicators of MH issues (Pappa et al. 2021). Mental disorders influence and change a person's cognitive functioning, behavior, and emotional reactions linked with distress or other impaired functioning (Goldman and Grob, 2006). It has a relationship with diet, stress, exercise, abuse, drugs, social interactions, and connections (Manger, 2019). Professionals like therapists, psychologists, psychiatrists, family physicians, etc., assist in MH treatment in various forms like counseling, therapy, etc. (Sass et al. 2022). Depression, anxiety, phobias, eating disorders, schizophrenia, obsessive-compulsive disorder, and personality disorders are major MH conditions that can cause psychosis, self-harm, panic attacks, suicidal thoughts, etc. (Solmi et al. 2022). A complex interaction of different factors causes any MH issue, and it is very difficult to identify as they may differ from person to person. Some of the common factors are abuse, lack of sleep, loneliness or social isolation, discrimination, social disadvantage, stress, drugs, violence, bullying, trauma, etc. Physical and environmental factors also affect behavior, such as injuries and neurological conditions (Limone and Toto, 2022).

It is unclear that technology always creates MH issues, and researchers are divided on this. For example, if technology leads to problems associated with behavior, attention, and self-regulation, it also minimizes depression and anxiety (Weinstein et al. 2021). Users with low socio-economic status are at higher risk of MH issues than those with high socio-economic status. Another reason for MH issues is the duration of using technology (Strutt et al. 2022). Those who spend more time using digital technology are more likely to suffer from fighting, lying, and other behavioral problems. It also leads to issues like "paying attention and exhibiting attention deficit-hyperactivity disorder symptoms." Similarly, self-regulation problems are also evident in frequent users (Liston et al. 2011). Digital technology also decreases the bonding between family members and society (Newman et al. 2019). People who spend more time using digital devices have less time for social activities, sports, or time with family members or relatives. This increases the chances of mental disorders in the form of behavior, psychosis, self-harm, panic attacks, and suicidal thoughts (Fegert et al. 2020). Perhaps the most severe challenge of using digital technology is that people can easily access and see the lifestyles of others, the different kinds of thoughts, and face bullying and harassment, etc., that often leads to feelings of discrimination or abuse (Ali and Shahbuddin, 2022). These are some of the problems digital technology brings to our lives, causing MH issues. On the other hand, many MH problems can be solved using digital technology (Areàn et al. 2016). For example, it minimizes the issues of isolation, depression, and anxiety and offers advanced treatment for various mental disorders.

The Metaverse brings both opportunity and risk for MH (Usmani et al. 2022). It provides avenues for social interaction, medical care, and artistic endeavors, enhancing MH (Cerasa et al. 2022). Virtual environments can minimize feelings of loneliness, offer support for those experiencing MH issues, and provide new methods of treatment (Ifdil et al. 2023). Despite this, it also brings worries regarding the possibility of addiction, separation from the real world, and the blurring of real and digital borders, which will increase MH issues (Situmorang, 2023). Achieving the right balance between utilizing the Metaverse's potential for treatment and minimizing its challenges is essential for an individual's MH (Curtis and Brolan, 2023).

Metaverse in healthcare. The Metaverse consists of two words: meta, which means "beyond," and the universe (Hollensen et al. 2023). It connects social media, AR, and VR technologies via high-speed internet (Ullah et al. 2018). It is a digital universe merging virtual and physical reality (Bibri, 2022). Advanced technologies like AR, VR, artificial intelligence, blockchain, cloud computing, and 5 G and 6 G internet are its building blocks (Wang and Zhao, 2022). The Metaverse refers to a collaborative, interactive, and immersive digital environment where people interact as online crowds (Dwivedi et al. 2022) to support work, play, and socialize (Askr et al. 2023; Wolf et al. 2013). It is a fact that our lives are becoming a mix of virtual and physical worlds (Meta, 2022). Some scientists believe the present social media and digital communication technologies are its primary form, while some say it is yet to come (Salar et al. 2023). In the Metaverse, people will enter through AR glasses or VR headsets, symbolizing avatars to interact with others and participate in various activities (Njoku et al. 2023). People in the Metaverse will experience a strange sense of presence and feel themselves in an environment without any technological perception that generates it (Oh et al. 2023). People will feel they perform tasks like they do in a real environment. The simulative progressions presented by VR, AR, and MR offer a potential basis for recognizing the Metaverse experience as a real-world experience (Smith et al. 2019). It is important to note that VR, AR, or MR embodied simulations will share human brain functions. The brain produces its body simulation to predict and represent actions and emotions. (Parsons et al. 2020). In the same way, humans will experience the sensory consequences of various scenarios in virtual spaces as in the real world (Riva and Wiederhold, 2022).

This shows that the Metaverse and human brains are working side by side, and their existence is made possible by the normal functions of the human brain (Islam Mozumder et al. 2023). The perceptions and feelings a human brain experiences in the real world are similar to those of a virtual one (De Borst and de Gelder, 2015). It can also have a significant psychological and behavioral impact on human beings (Ningning and Wenguang, 2023). Similarly, the brain's functions are strongly associated with MH and well-being. There are many risks associated with human behavior, psychological experience, and well-being from the Metaverse. Conversely, it has profound applications in rehabilitation, telemedicine operations, psychotherapy, etc. (Mozumder et al. 2023). It can further assist the healthcare system in enhancing personalized care at a lower cost, regardless of the patient's location. Telepresence, blockchain, and digital twining could also provide amazing possibilities and opportunities for MH care in the Metaverse (Shetty et al. 2022). Some MH applications are Mood Fit, Better Help, Mood Mission, Sanvello, Calm, Happify, Depression CBT Self-Help Guide, Shine, e-Moods, Bearable, Todoist, PTSD Coach, etc. Many hospital chains and fitness centers are adopting technologies beyond digital ones for the MH (Bansal et al. 2022). It is evident from the statistics that the global Metaverse market for healthcare was $5.06 billion in 2021 and is expected to reach $71.97 billion by 2030.

The Metaverse will significantly change healthcare access by eliminating geographical constraints and providing new approaches for distant healthcare (Ifdil et al. 2023; Chengoden et al. 2023). It will facilitate telemedicine sessions (Wiederhold, 2022), allowing patients to interact with health professionals from their homes, and will be especially useful for people living in underserved or distant locations. Furthermore, virtual medical training can help healthcare workers improve their expertise and abilities (Tan et al. 2022). Besides its benefits, issues like data security and privacy will emerge, and personal health data will be at risk of cyber assaults (Benjamins et al. 2023). Therefore,

reducing the potential risks associated with adopting the Metaverse in healthcare is necessary. A proper balance between using the Metaverse's potential to enhance healthcare access and securing medical information is necessary (Solaiman, 2023).

Ethical issue(s) of the Metaverse in healthcare. Adopting the Metaverse brings many ethical challenges that must be taken seriously (Kaddoura and Al Husseiny, 2023). The primary concern is digital privacy, which arises when people get involved in these virtual worlds, leaving a lot of private data behind (Smith et al. 2023). Secondly, the risk of being overly involved in digital environments (Chen, 2022). It also includes the legitimacy of virtual encounters, the risk of fraud, and the dissolving of fiction and reality (De Felice et al. 2023). There are also concerns about digital spying, surveillance capitalism, and the absolute power of a few technological giants in controlling the Metaverse (Qamar et al. 2023). Resolving these ethical issues is critical to ensure that the Metaverse is an environment that serves humanity rather than endangers our values and MH (Kshetri, 2022).

Undoubtedly, the Metaverse will benefit healthcare and provide tremendous solutions to various problems. Yet, it will also invite the issue of medical ethics (Leroy et al. 2022). Most ethical issues like safety, privacy, social, accessibility, identity control, and freedom of expression are also some of its concerns. Also, new technology brings new concerns (Quach et al. 2022). For example, deep fakes and manipulations might also be serious ethical concerns (Zhao et al. 2022). Data security is one of the most serious concerns in any healthcare system. It is very unethical if data regarding patients, etc., is shared or leaked with any unauthorized party. This could be its potential ethical threat to healthcare (Zeng et al. 2022). Harassment, bullying, and other impolite behavior are other serious concerns in the Metaverse (Wiederhold, 2022). Many people will disregard others and will also violate their freedom (Wang and Zhao, 2022). Mental and biological privacy will also be threatening when someone reads our minds, models our identity, and controls our behavior. Safety is another potential threat, as technology and devices can be attacked by hackers (Wiederhold, 2022). Another serious ethical concern is its unequal access. Many poor and developing nations cannot afford the technology, and the digital divide will increase (Kaur, 2022).

Perhaps the most important ethical issue in the Metaverse is the manipulation of reality. Pictures, videos, etc., can be used as deep fake videos. In other words, old videos can be deceived using the latest digital Metaverse technology in a forged reality. The question is, how will such videos impact the MH of the one associated with it? In addition, the Metaverse will also change the living habits of humans. Their social life will be highly impacted as they live in a joint real-virtual world. Their relationships will also be disturbed, and a negative change is expected in their behavior (Dwivedi et al. 2022). In short, it is a fact that the Metaverse in healthcare will bridge the real and virtual worlds and provide solutions to many of today's healthcare problems, but it also brings some ethical issues like information security, privacy, harassment, bullying, manipulation, unequal access, etc. (Kaur, 2022).

Mental health. MH encompasses an individual's social, psychological, and emotional state (WHO, 2023). It involves mental disorders, managing stress, upholding healthy relationships, dealing with challenges in life, and staying happy and contented (Hattie et al. 2004). From infancy to maturity, good MH is essential since it affects a person's ability to function well and live a satisfied life (van den et al. 2023). Factors contributing to MH are emotional well-being, psychological resilience, effective management of stress and anxiety, and quality relationships. Cultural and social factors, including societal norms, cultural values, and financial status, also help or hurt MH (Manger, 2019). Events in life can also have a significant effect on MH. MH is also influenced by deoxyribonucleic acid and other biological factors, such as brain chemistry and inheritance (Patalay and Demkowicz, 2023).

Promoting MH is essential for avoiding mental illnesses and improving quality of life (van den et al. 2023). There are various initiatives people take to improve their MH. Maintaining excellent MH requires keeping a healthy weight, eating a balanced diet, getting adequate sleep, and reducing (Arslan, 2023; LaBelle, 2019). Seeking medical care is necessary for successful MH treatment. Enhancing awareness and lowering the stigma associated with MH problems foster a more welcoming and encouraging community. It significantly impacts one's life, especially on a person's ability to work, establish and maintain relationships, and make decisions. It also leads to physical health issues like chronic illnesses, reduced immune systems, and cardiovascular disease. On the good side, it contributes to resilience and productivity and promotes happy relationships and successful living (Foster et al. 2023).

Theoretical mechanism. A theoretical framework integrating concepts from SCT, TDT, HCI Principles, and DW Frameworks can potentially be used to understand the influence of the Metaverse on MH, with moral issues and healthcare as mediators. According to SCT, social interactions are the sources of behavior adoption, and interactions in virtual settings influence how people learn and modify their behaviors and attitudes. Users engage and observe various content and avatars while immersed in the Metaverse, influencing their MH. Similarly, TDT highlights the impact of technology on human beings and society. It implies that the Metaverse inevitably influences users' interactions with digital environments and one another. It impacts individuals' encounters with ethical issues and their ability to access healthcare resources in the Metaverse.

Moreover, the study considers HCI principles when navigating the Metaverse's organization and interface, as it strongly emphasizes the importance of usability and user-centered design. Implementing HCI concepts in the Metaverse can help users access ethical norms and healthcare data. User's friendly design of the Metaverse technology and easy access to healthcare can improve users' engagement with healthcare facilities. Finally, DW Frameworks provides an organized approach for evaluating how digital technology impacts people's well-being. They can be used in the Metaverse to assess how ethical concerns and healthcare procedures fit with standards for fostering mental health. These frameworks provide a window to evaluate ethical issues and healthcare facilities in enhancing users' MH by considering elements like autonomy, relatedness, competence, and user satisfaction.

SCT focuses on the process during which people interact within the Metaverse, influencing the behaviors associated with their MH. TDT highlights the Metaverse's inherent influence on ethics and healthcare access. HCI principles ensure that the Metaverse is designed to make it easier for users to interact with moral and medically relevant material. The DW framework evaluates how the Metaverse affects' users' MH. These theories collectively provide a thorough knowledge regarding the influence of the Metaverse on MH through the mediating roles of ethical concerns and healthcare, as shown in Fig. 1. The Metaverse offers a new horizon for healthcare and MH. It can provide an appealing, interesting interface for users and healthcare professionals because of its user-centric design. The metaverse will be a
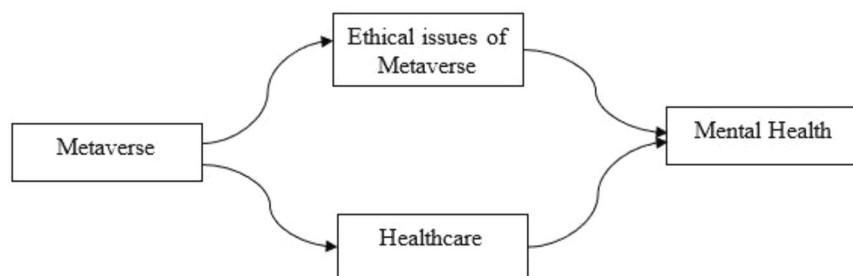
Fig. 1 Proposed theoritical framework of investigating the mediating role of ethical issues and healthcare between the metaverse and mental health.

lively environment for experiential learning, encouraging positive behaviors, and nurturing social networks that support one another and positively impact psychological well-being. Likewise, it will advance innovation in healthcare supply, expanding connectivity, professional collaboration, and healthcare access. However, ethical considerations and healthcare mediate the relationships between the Metaverse and MH. Establishing an equilibrium between ethical use and the Metaverse is essential to minimize problems like digital addiction, data breaches, etc. Furthermore, as the Metaverse can be accessed by a wide range of demographic groups, enhancing the healthcare system's current efficiency, healthcare also becomes an important mediator between the Metaverse and MH.

The study uses these theories to comprehend the relationships as given in the hypotheses.

Hypotheses. The above theoretical mechanism provides the foundation for the following hypotheses.

H_1: The perceived Metaverse has a significant impact on the healthcare

H_2: The perceived Metaverse has a significant impact on the ethical issues of the Metaverse

H_3: Ethical issues of the Metaverse have a significant impact on the MH

H_4: Healthcare has a significant impact on the MH

H_5: Ethical issues of the Metaverse mediate the relationship between the Metaverse and MH

H_6: Healthcare mediates the relationship between the Metaverse and MH

Methodology

Research philosophy. The philosophical foundation of social sciences research is often based on interpretivism and positivism (Babones, 2016). A positivism paradigm is recommended whenever a study is based on prior theories in a specific context to enhance its generalizability, and the researcher believes in a predetermined reality. On the other hand, when the researcher wants to explore a new dimension that has not been discovered and is not properly supported by a prior theory, then an interpretivism paradigm is recommended (Moon and Blackman, 2014). This study is based on previously established ideas that the researcher will test in specific contexts, so it follows the positivism paradigm. The Positivist paradigm is a scientific paradigm based on objective beliefs about social phenomena in research. The study is quantitative and was conducted with the help of a close-ended questionnaire adopted from prior studies.

Research population and sampling. The population of this study includes medical doctors and nurses in the health sector of Pakistan, China, and Saudi Arabia. There are two primary options for the researcher to adopt: probability sampling and non-probability sampling (Baker et al. 2013). When the exact

number of the population is known and every individual in the population is accessible, the probability sampling technique is recommended; otherwise, it is suggested to adopt a nonprobability sampling technique (Rahi, 2017). As in this study, the researchers adopt a non-probability sampling technique. Among the several types of nonprobability sampling techniques, a purposive sampling technique was used to select useful respondents for the research. Data was gathered from the 392 respondents across the research population.

Research instrument and statistical technique. The measures used in the study were adopted from the prior validated studies to ensure reliability and validity. A five-point Likert scale was used for the measurement where 1 denotes the lowest level of agreement, and 5 denotes the highest level of agreement. The partial least square technique by the SmartPLS software was used to analyze the gathered data. The list of the scales for all constructs with their items and sources is mentioned in Table 1.

Result and findings

Demographic profile of the respondent. Table 2 shows the demographic statistics of the respondents. The table's first section indicates the gender-wise distribution of the respondents. This section shows that among 392 respondents, 178 are males and 214 are females. The second section shows the country of the respondents. This section indicates that 119 respondents are from China, 149 are from Pakistan, and 124 are from Saudi Arabia. The last section shows the professional level of the medical respondents. This section shows that among the 392 respondents, 223 are nurses, and 169 are medical doctors.

Common method bias. Common method bias is a significant problem of primary survey data research. The main reason is the response tendency, in which the respondents intentionally rate all questions equally. It can be measured through the Variance Inflation Factor (VIF). The VIF values of any model are not limited to multicollinearity diagnostics, but they also denote the common method bias (Kock, 2015). If the VIF value of any construct is equal to or less than 3.3, then the model is believed to be free from the common method bias. Table 3 shows that all the values are less than 3.3, which shows that the collected data is free from the issues of common bias.

Reliability and convergent validity. Table 4 shows the statistics of reliability, construct reliability, and the convergent validity of the scales. The measure used for the item's reliability is outer loading values (Griffiths et al. 2022). The threshold value for the outer loading value is 0.7, but even a value of 0.6 or close to 0.6 is also acceptable if the convergent validity of the construct is established (Bagis, 2022). Table 4 shows that all the items have outer loading values greater than the threshold value, which

Table 1 Research instrument.

Metaverse	MV1	I enjoy my experience with Metaverse.
	MV2	I am keen to integrate technology into my healthcare tasks in the future.
	MV3	My preferred mode of the healthcare facility is face-to-face.
	MV4	I am confident in using future technology.
Mental health	MH1	Have you recently Been able to concentrate on whatever you are doing
	MH2	Have you recently Lost much sleep over worry
	MH3	Have you recently Felt that you are playing a useful part in things
	MH4	Have you recently felt capable of deciding things
	MH5	Have you recently Felt constantly under strain
	MH6	Have you recently Been able to enjoy your normal day-to-day activities
Ethical issues of Metaverse	EI1	There is honesty in the online healthcare services
	EI2	Online healthcare services are not considering the quality of patient life
	EI3	Online healthcare is not respecting patient confidentiality/privacy
	EI4	The online healthcare system is ignoring patient/family autonomy
Healthcare	HC1	Would you suggest an online healthcare facility for the treatment
	HC2	How would you rate the quality of treatment by online healthcare sources
	HC3	Patients are being treated with dignity and respect via online healthcare

Table 2 Respondent demography.

Gender	Numbers	Percentage
Male	178	45%
Female	214	55%
Total	392	100%

Country in Serving	Numbers	Percentage
China	119	30%
Pakistan	149	38%
Saudi Arabia	124	32%
Total	392	100%

Profession	Numbers	Percentage
Nurses	223	57%
Doctors	169	43%
Total	392	100%

Table 3 Variance inflation factor (VIF).

	Ethical Issues of MV	Healthcare	Mental health
Ethical issues of MV			1.218
Healthcare			1.218
Metaverse	1.000	1.000	

indicates that all the items are reliable. The measure used for the construct reliability is Cronbach alpha and composite reliability. Both have a threshold value of 0.7 or greater. Table 4 shows that all the constructs have Cronbach's alpha and composite reliability values more than the threshold value, indicating that all the study's constructs are reliable for further analysis. The measure used for the convergent validity is the Average Variance Extracted (AVE). The threshold value for the AVE is 0.5 or greater (Melkamu Asaye et al. 2022). Table 4 shows that all the constructs have AVE values greater than the threshold value, indicating that all the constructs are convergently valid.

Discriminant validity. In primary data analysis, three major measures are used for discriminant validity: cross-loading, HTMT values, and Fornell Larcker criteria (Alwi et al. 2022). However, most researchers suggest HTMT values as the most suitable measure for the discriminant validity of a structural equation model. The threshold value for the HTMT values is 0.85 or less. Table 5 shows that all the constructs have HTMT values smaller than the threshold value, which indicates that all the constructs are discriminately valid.

Structural model. Figure 2 shows the relationship among the variables.

Regression analysis. Table 6 shows the regression analysis of the hypotheses. The statistics show that five of the six hypotheses are significant. The following are the details.

H_1: The results give evidence in support of H_1 that there is a positive and significant relationship between the Metaverse and healthcare with a significant coefficient, a Beta value of 0.320, a T-statistic 7.277, and a p-value of 0.000. The statistics show a statistically significant relationship between the Metaverse and healthcare, showing that the Metaverse will facilitate healthcare in general.

H_2: The results give evidence in support of H_2 that there is a positive and significant relationship between the Metaverse and its ethical issues with a significant coefficient, a Beta value of 0.484, a T-statistic 9.60, and a p value of 0.000. The statistics show that a statistically significant relationship between the Metaverse and its ethical issues and the increase of the Metaverse adoption will lead to more ethical issues.

Table 4 Reliability and convergent validity.

Construct	Items	Loading	CA	CR	AVE
Ethical issues of MV	EI1	0.825	0.876	0.915	0.730
	EI2	0.856			
	EI3	0.88			
	EI4	0.855			
Healthcare	HC1	0.767	0.814	0.875	0.637
	HC2	0.715			
	HC3	0.877			
	HC4	0.825			
Mental health	MH1	0.594	0.805	0.855	0.500
	MH2	0.689			
	MH3	0.736			
	MH4	0.779			
	MH5	0.765			
	MH6	0.741			
Metaverse	MV1	0.795	0.830	0.886	0.661
	MV2	0.814			
	MV3	0.851			
	MV4	0.791			

Table 5 HTMT values.

	Ethical Issues of MV	Healthcare	Mental health
Healthcare	0.494		
Mental health	0.39	0.137	
Metaverse	0.565	0.359	0.346

H_3: The results give evidence in support of H_3 that there is a positive and significant relationship between the ethical issues of the Metaverse and MH with a significant coefficient, a Beta value of 0.383, a T-statistic of 8.82, and a p value of 0.000. The statistics show a statistically significant relationship between the ethical issues of the Metaverse and MH, and with the increase of ethical issues, mental health problems will increase.

H_4: The results do not support H_4 that there is a positive and significant relationship between healthcare and MH. The statistics show a Beta value of -0.053, a T-statistic of 0.99, and a p value of 0.319 for the hypothesis.

Mediation analysis. Table 6 also shows the mediation relationship of the model. It indicates that there are two mediation relationships. These relationships show the mediation of the ethical issues between the Metaverse and MH and the healthcare mediation between the Metaverse and MH. Using a mediator variable, a mediation analysis using PLS-SEM examines the indirect effect of an independent variable on a dependent variable. Using this method, the researcher develops mediating hypotheses between independent and dependent variables. After finding the validity and reliability and other necessary tests as discussed in other sections of the study, the mediating analysis is assessed by finding the significance and interpreted accordingly. A p value, beta, and T-statistics are the common measures used in the interpretation. The P-value must be less or equal to 0.005 for a significant relationship, otherwise, there will be no relationship. The following are the details.

H_5: The results show evidence in support of H_5 that there is a mediating influence of ethical issues between the Metaverse and MH with a significant coefficient, a Beta value of 0.185, a
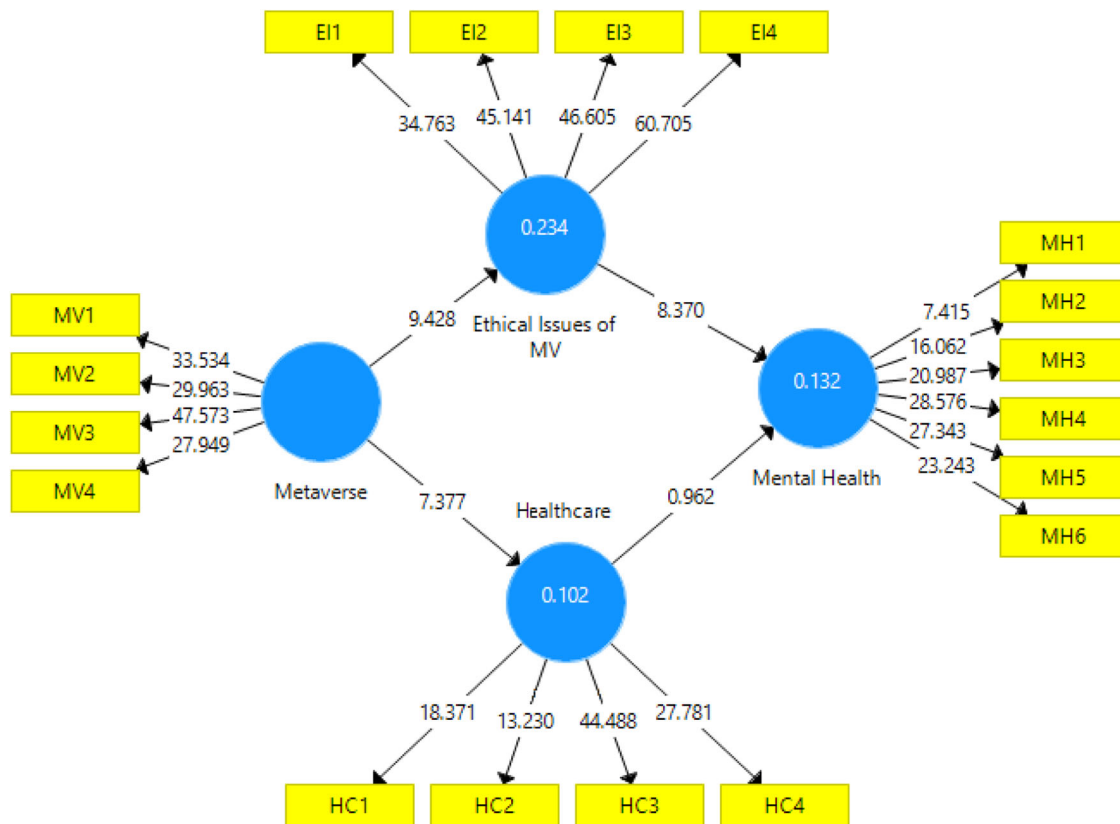

Fig. 2 Tested theoritical framework of investigating the mediating role of ethical issues and healthcare between the metaverse and mental health.

Table 6 Hypothesis Testing.

	Beta	T state	P values	Remarks
H1: Metaverse -> Healthcare	0.320	7.277	0.000	Supported
H2: Metaverse -> Ethical Issues of MV	0.484	9.609	0.000	Supported
H3: Ethical issues of MV -> Mental health	0.383	8.828	0.000	Supported
H4: Healthcare -> Mental health	−0.053	0.997	0.319	Not Supported
Metaverse -> Ethical Issues of MV -> Mental Health	0.185	5.618	0.000	Supported
Metaverse -> Healthcare -> Mental Health	−0.017	0.990	0.322	Not Supported

Table 7 Model Fitness.

	Saturated Model	Estimated Model
SRMR	0.070	0.095
d_ULS	0.827	1.545
d_G	0.245	0.276
Chi-Square	575.139	625.064
NFI	0.813	0.797

T-statistic 5.61, and a p-value of 0.000. This means that the relationship between the Metaverse and MH will be mediated by the ethical issues of the Metaverse. The threshold value for the significance of a relationship based on the mediation relationship is the p-value, which must be 0.05 or less and the t-value is 1.96 or above. These values show a significant mediation between the Metaverse and MH by the ethical issues. The beta value shows the strength of the relationship and how much the Metaverse impacts mental health.

H_6: The results show against evidence in support of H_5 that there is no mediating influence of healthcare between the Metaverse and MH with a Beta value of −0.017, a T-statistic 0.99, and a p-value of 0.322. The threshold value for the significance of a relationship based on the mediation relationship is the p value, which must be 0.05 or less and the t-value is 1.96 or above. These values show an insignificant mediation between the Metaverse and MH by the ethical issues.

Model fitness. Once the reliability and validity of the measurement model are confirmed, the structural model fitness must be measured. For the model fitness, several measures are available in the SmartPLS, like SRMR, Chi-square, NFI, etc., but most of the researcher recommends the SRMR for the model fitness in the PLS-SEM. When applying PLS-SEM, a value less than 0.08 is generally considered a good fit (Hu and Bentler, 1998). Table 7 shows that the SRMR value is 0.06, less than the threshold value of 0.08, indicating the model's fitness.

R square. Table 8 shows the value of the coefficient of the determination of the model of study, which describes the percentage of the variation in the dependent variable due to independent variables. For the primary data analysis, even an R square value equal to 0.1 or greater is considered a good coefficient of determination. Table 8 shows that MH has an R square value of 0.132, which shows that 13.2% of the variation in MH is due to the model's independent variables.

Predictive relevance of the model. Table 8 also shows the predictive power of the model of the study. A model is considered good for predicting social sciences based on primary data if its predictive relevance value is greater than zero. Table 8 shows the MH having a predictive power of 0.058, which shows that the

model has 5.8% prediction power if the same model is applied in a different context.

IPMA analysis. Table 9 shows each variable's importance and performance for the model's target variable. According to the statistics, ethical issues of the Metaverse have an importance value of 53.6%, the most important variable of the model for MH. At the same time, healthcare, which has a performance value of 77.8%, has the highest but least important value. Based on this model, it is recommended that ethical issues of the Metaverse must be addressed properly to improve the users' MH.

Multigroup analysis. Table 10 shows the categorical comparison of the model based on gender and profession. Gender includes male and female, including 178 males and 214 females, while profession also includes two categories, including 169 doctors and 223 nurses. The p value of the Table 10 shows the significance of the relationships. The threshold value for this is 0.05 or less. Table 10 shows no statistically significant difference in responses between the gender (either males or females) and profession (either doctors or nurses).

Discussion

The study investigates the impact of the Metaverse technology on the MH, considering the ethical issues and healthcare as mediating factors in the healthcare industry of Pakistan, China, and Saudi Arabia. The first hypothetical argument claims that the Metaverse significantly impacts healthcare. The findings of this study support this argument ($\beta = 0.320$, $p < 0.05$). If we look at the prior research, we also see the same pattern where the researchers have tested the same argument in a different context (Sun et al. 2022) (Bhugaonkar et al. 2022). The second hypothetical argument claims that the Metaverse in the healthcare industry will lead to different ethical issues. The results of this study also support this argument ($\beta = 0.484$, $p < 0.05$). If we look at the prior research, the same pattern of findings exists. Even ethics means different in different cultures. Still, it prevails as a significant cause for people to avoid healthcare facilities based on the Metaverse technology (Grote and Berens, 2020). The third hypothetical argument claims that ethical issues will lead to MH problems. The findings of this study support the argument that ethical concerns will lead to MH issues ($\beta = 0.383$, $p < 0.05$). According to several researchers, ethics always remains a problem in healthcare. It is not only limited to digital healthcare but also a challenge faced by the physical healthcare system (Bucci et al. 2019). The fourth hypothetical argument claims that healthcare access significantly impacts people's MH. The findings of this study in the context of Pakistan, China, and Saudi Arabia do not support this argument ($\beta = -0.053$, $p > 0.05$). Still, according to many other researchers, this remains a problem for people's MH. This may be due to culture or the acceptance of the new technology because people resist new technologies and their applications (Marx, 1998) even if the new technology is more reliable and economical (Ratten, 2020).

Table 8 R Square and Q Square.					
	R Square	R Square Adjusted	SSO	SSE	Q² (=1-SSE/SSO)
Ethical issues of MV	0.234	0.232	1568	1310.053	0.165
Healthcare	0.102	0.1	1568	1478.693	0.057
Mental health	0.132	0.128	2352	2215.52	0.058

Table 9 IPMA Matrix.		
	Importance	Performances
Ethical issues of MV	0.536	72.438
Healthcare	−0.086	77.808
Metaverse	0.237	67.496

The study's model proposes mediation relationships. First, with the introduction of the Metaverse in the healthcare sector, various ethical issues will arise, ultimately impacting healthcare professionals' mental health (MH). The study's findings also support this ($\beta = 0.185$ and a p value $= 0.000$). Previous research supports this hypothesis, revealing consistent findings in the empirical analyses of researchers like Dwivedi et al. (2023). Second, the study explores the idea that healthcare itself could mediate the impact of the Metaverse on people's MH. Surprisingly, the results do not support this hypothesis ($\beta = -0.017$, a p value $= 0.322$). Past research, represented by studies such as Michie and West (2004), has shown mixed findings, with some aligning with our results and others presenting opposite conclusions. This is surprising and noteworthy because it goes against the consensus of the present understanding regarding how healthcare affects mental health problems in an era of modern technologies. It indicates that conventional healthcare services do not mediate the Metaverse's impacts on mental health; rather, virtual and immersive digital experiences directly impact it. It provides new directions for future studies to explore the relationships between advance technologies, healthcare, and MH.

Whether we accept it or not, technology has intensely changed healthcare (Shrestha and Kim, 2019). Some of the contributions include introducing new medicines, new ways of treating patients, new operating instruments and theatres, lower costs, addressing the problem of distance, and so on (Matricardi et al. 2020). Fortunately, technology is also assisting in the treatment of MH problems. Its outcomes will increase further with the adoption of this new technology. Companies like "Brain lab AG, Novarad Corporation, GE Healthcare, Siemens Healthiness, Meta Platforms Inc., Nvidia, Microsoft, Roblox, Game Change, VR, AR," etc., are continuously driving this shift for improvement (Pillai and Mathew, 2019).

A significant section of the public is unable to receive treatment for mental disorders due to financial constraints, long wait times, lack of professionals and healthcare facilities, burden on doctors, and other factors. The Metaverse could treat and minimize these concerns (Corrigan et al. 2014). Telehealth, VR, AR, MR, etc., will provide an environment that could assist MH patients. Loneliness, anxiety, depression, etc., could be lessened with the help of the Metaverse (Dwivedi et al. 2023). Specialists of various kinds could be approached remotely, and mental disorders could be treated effectively (Mohr et al. 2013). More options could be available for patients to get a doctor of their choice and avail themselves of more personalized therapy and treatment. Patients and the general public should also be monitored and directed 24/7 by digital healthcare assistants in the Metaverse (Ghazal et al. 2021). Their data and readings could be recorded through various applications and shared at the right time with their therapist,

increasing the timeliness of treatment (Vismara et al. 2012). In short, the Metaverse will take mental healthcare to the next level through high-speed internet, applications, AR, VR, MR, etc. It should be welcomed by addressing ethical concerns, digital divide, interconnectivity, availability, and convergence.

Theoretical implications. The results provide credence to the framework that tested the relationships among the Metaverse, ethics, healthcare, and MH. It advances the understanding by stressing the influence of the Metaverse on moral, ethical, and healthcare concerns and their influence on MH in the virtual world.

Managerial implications.

1. The study suggests that using the Metaverse in mental healthcare is crucial. Healthcare organizations should use the Metaverse's technologies, such as virtual reality therapy, remote healthcare delivery, etc., for improved healthcare.
2. Strong ethical rules must be developed and implemented due to the Metaverse's enormous impact on ethical concerns.
3. Organizations should prioritize the Metaverse's MH support systems (peer assistance, online counseling services, and MH resources) because of the relationship between ethical concerns and MH.

Practical implication.

1. It is necessary to educate and train the users of the Metaverse regarding its impact on MH to ensure its responsible use, awareness about risks, and support. It is important to support the promotion of digital well-being and a healthy balance between virtual and real-life activities.
2. Ethical concerns should be given priority during the design and development of the Metaverse by platform providers and developers. Virtual environments will become safer and more inclusive when privacy features, content control tools, and inclusive features are implemented.
3. Collaboration among technological professionals and healthcare practitioners is essential. To develop and incorporate virtual reality-based therapies into healthcare practices, healthcare professionals and technology experts should work together. This partnership will result in ground-breaking innovations for improving MH assistance in online settings.

Conclusion

The study investigated the complex relationship of the Metaverse, healthcare, ethical issues, and MH. The study found positive relationships between the Metaverse and healthcare, the Metaverse, and ethical issues. This highlights the importance and need for incorporating ethics into the Metaverse healthcare services. However, the assumed relationship between healthcare and MH was not supported, underlining the importance of a comprehensive approach to MH treatments beyond digital technology.

Table 10 MGA Analysis.

	Beta (Male-Female)	p value	Beta (Nurses-Doctor)	p value
Ethical issues of MV -> Mental health	0.037	0.671	−0.038	0.677
HC/MH/EI -> Mental health	−0.043	0.682	0.077	0.452
Healthcare -> Mental health	−0.062	0.594	0.026	0.813
Metaverse -> Ethical issues of MV	0.065	0.499	−0.089	0.360
Metaverse -> Healthcare	0.104	0.241	−0.033	0.721

As the Metaverse evolves, prioritizing ethical issues, improving healthcare provisions, and recognizing the broader landscape of MH is essential to ensure that the Metaverse can drive a positive shift while adhering to ethical principles and dealing with the diverse aspects of MH.

Future work.

1. The Metaverse is a relatively new concept in healthcare; research is needed to explore its opportunities and threats further in the mental healthcare system.
2. The ethical issue may be a major concern for the Metaverse in mental healthcare, and further research is needed to explore the most important ethical factors.
3. Research is needed on the Metaverse regulatory framework for its better use in mental healthcare.

Limitations.

1. The Metaverse is a relatively new concept in mental healthcare; people know little about it, which may have impacted the study.
2. The study stresses on ethical issues of the Metaverse, and it is necessary for future studies to explore this aspect of the Metaverse further. It is essential for researchers from different areas, policy makers and innovators to collaborate in future studies and address this limitation.
3. The results may differ for technologically advanced societies or from culture to culture or country to country.

Data availability

The data set generated during and/or analyzed during the current study is attached as supplementary material.

References

Ali SI, Shahbuddin NB (2022) The Relationship between Cyberbullying and Mental Health among University Students. Sustainability 14(11):6881. https://doi.org/10.3390/su14116881

Alkatheiri MS (2022) Artificial intelligence assisted improved human-computer interactions for computer systems. Computers Electr Eng 101:107950. https://doi.org/10.1016/j.compeleceng.2022.107950

Alwi, NH, Osman, Z, Nabi Ahmad Khan, B (2022) Tax Evasion Behavior among Salaried Worker in Malaysia: A Socio- Psychological Framework. International Journal of Academic Research in Accounting, Finance and Management Sciences, 12(4). https://doi.org/10.6007/IJARAFMS/v12-i4/15716

Areàn PA, Hoa Ly K, Andersson G (2016) Mobile technology for mental health assessment. Dialogues Clin Neurosci 18(2):163–169. https://doi.org/10.31887/DCNS.2016.18.2/parean

Arief R, Satrio PS, Irfan M (2023) The Fundamentals of Metaverse: A Review on Types. Compon Opportunities Preliminary Commun 47(1):153–165

Arslan G (2023) Psychological maltreatment predicts decreases in social wellbeing through resilience in college students: A conditional process approach of positive emotions. Curr Psychol 42(3):2110–2120. https://doi.org/10.1007/s12144-021-01583-0

Askr H, Darwish A, Hassanien AE (2023) The Future of Metaverse in the Virtual Era and Physical World: Analysis and Applications (59–75). https://doi.org/10.1007/978-3-031-29132-6_4

Babones S (2016) Interpretive Quantitative Methods for the Social Sciences. Sociology 50(3):453–469. https://doi.org/10.1177/0038038515583637

Bagis AA (2022) Building students' entrepreneurial orientation through entrepreneurial intention and workplace spirituality. Heliyon 8(11):e11310. https://doi.org/10.1016/j.heliyon.2022.e11310

Baker R, Brick JM, Bates NA, Battaglia M, Couper MP, Dever JA, Gile KJ, Tourangeau R (2013) Summary Report of the AAPOR Task Force on Non-probability Sampling. J Surv Stat Methodol 1(2):90–143. https://doi.org/10.1093/jssam/smt008

Banaeian FS, Imani Rad A, Hosseini Bamakan SM, Rajabzadeh Asaar M (2023) Toward Metaverse of everything: Opportunities, challenges, and future directions of the next generation of visual/virtual communications. J Netw Computer Appl 217:103675. https://doi.org/10.1016/j.jnca.2023.103675

Bandura (1986) Social foundations of thought and action: A social cognitive theory. Prentice-Hall, Inc

Bandura (2002) Media Effects (J Bryant, D Zillmann, J Bryant, M Beth Oliver, Eds). Routledge. https://doi.org/10.4324/9781410602428

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. https://doi.org/10.1109/ACCESS.2022.3219845

Bardus M, Keriabian A, Elbejjani M, Al-Hajj S (2022) Assessing eHealth literacy among internet users in Lebanon: A cross-sectional study. DIGITAL HEALTH 8:205520762211193. https://doi.org/10.1177/20552076221119336

Benjamins R, Rubio Viñuela Y, Alonso C (2023) Social and ethical challenges of the Metaverse. AI Ethics 3(3):689–697. https://doi.org/10.1007/s43681-023-00278-5

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(10):e40410. https://doi.org/10.2196/40410

Bhugaonkar K, Bhugaonkar R, Masne N (2022) The Trend of Metaverse and Augmented & Virtual Reality Extending to the Healthcare System. Cureus. https://doi.org/10.7759/cureus.29071

Bibri SE (2022) The Social Shaping of the Metaverse as an Alternative to the Imaginaries of Data-Driven Smart Cities: A Study in Science, Technology, and Society. Smart Cities 5(3):832–874. https://doi.org/10.3390/smartcities5030043

Bojic L (2022) Metaverse through the prism of power and addiction: what will happen when the virtual world becomes more attractive than reality? Eur J Futures Res 10(1):22. https://doi.org/10.1186/s40309-022-00208-4

Bucci S, Schwannauer M, Berry N (2019) The digital revolution and its impact on mental health care. Psychol Psychotherapy: Theory, Res Pract 92(2):277–297. https://doi.org/10.1111/papt.12222

Cal, N (2019) Digital Minimalism: Choosing a Focused Life in a Noisy World. Portfolio Penguin

Calandra D Oppioli M, Sadraei R, Jafari-Sadeghi V, Biancone PP (2023) Metaverse meets digital entrepreneurship: a practitioner-based qualitative synthesis. Int J Entrepren Behav Res. https://doi.org/10.1108/IJEBR-01-2023-0041

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(11):e11762. https://doi.org/10.1016/j.heliyon.2022.e11762

Chen D, Zhang R (2022) Exploring Research Trends of Emerging Technologies in Health Metaverse: A Bibliometric Analysis. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3998068

Chen Z (2022) Exploring the application scenarios and issues facing Metaverse technology in education. Interact Learn Environ. 1–13. https://doi.org/10.1080/10494820.2022.2133148

Chengoden R, Victor N, Huynh-The T, Yenduri G, Jhaveri RH, Alazab M, Bhattacharya S, Hegde P, Maddikunta PKR, Gadekallu TR (2023) Metaverse for Healthcare: A Survey on Potential Applications, Challenges and Future Directions. IEEE Access 11:12765–12795. https://doi.org/10.1109/ACCESS.2023.3241628

Corrigan PW, Druss BG, Perlick DA (2014) The Impact of Mental Illness Stigma on Seeking and Participating in Mental Health Care. Psychological Sci Public Interest 15(2):37–70. https://doi.org/10.1177/1529100614531398

Cowie MR, O'Connor CM (2022) The Digital Future Is Now. JACC: Heart Fail 10(1):67–69. https://doi.org/10.1016/j.jchf.2021.11.003

Curtis C, Brolan CE (2023) Health care in the Metaverse. Med J Aust 218(1):46–46. https://doi.org/10.5694/mja2.51793

De Felice F, Rehman M, Petrillo A, Baffo I (2023) A metaworld: Implications, opportunities and risks of the Metaverse. IET Collaborative Intelligent Manufacturing, 5(3). https://doi.org/10.1049/cim2.12079

De Borst AW, de Gelder B (2015) Is it the real deal? Perception of virtual characters versus humans: an affective cognitive neuroscience perspective. Front Psychol 6:576

Dwivedi YK, Hughes L, Baabdullah AM, Ribeiro-Navarrete S, Giannakis M, Al-Debei MM, Dennehy D, Metri B, Buhalis D, Cheung CMK, Conboy K, Doyle R, Dubey R, Dutot V, Felix R, Goyal DP, Gustafsson A, Hinsch C, Jebabli I, Wamba SF (2022) Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. Int J Inf Manag 66:102542. https://doi.org/10.1016/j.ijinfomgt.2022.102542

Dwivedi YK, Hughes L, Wang Y, Alalwan AA, Ahn SJ, Balakrishnan J, Barta S, Belk R, Buhalis D, Dutot V, Felix R, Filieri R, Flavián C, Gustafsson A, Hinsch C, Hollensen S, Jain V, Kim J, Krishen AS, Writz J, (2023) Metaverse marketing: How the Metaverse will shape the future of consumer research and practice. Psychol Mark 40(4):750–776. https://doi.org/10.1002/mar.21767

Evenson KR, Alhusseini N, Moore CC, Hamza MM, Al-Qunaibet A, Rakic S, Alsukait RF, Herbst CH, AlAhmed R, Al-Hazzaa HM, Alqahtani SA (2023) Scoping Review of Population-Based Physical Activity and Sedentary Behavior in Saudi Arabia. J Phys Act Health 20(6):471–486. https://doi.org/10.1123/jpah.2022-0537

Fegert JM, Vitiello B, Plener PL, Clemens V (2020) Challenges and burden of the Coronavirus 2019 (COVID-19) pandemic for child and adolescent mental health: a narrative review to highlight clinical and research needs in the acute phase and the long return to normality. Child Adolesc Psychiatry Ment Health 14(1):20. https://doi.org/10.1186/s13034-020-00329-3

Foster S, Estévez-Lamorte N, Walitza S, Dzemaili S, Mohler-Kuo M (2023) Perceived stress, coping strategies, and mental health status among adolescents during the COVID-19 pandemic in Switzerland: a longitudinal study. Eur Child Adolesc Psychiatry 32(6):937–949. https://doi.org/10.1007/s00787-022-02119-y

Galluccio, M (2019) Hydrometeorological Extreme Events' Effects on Populations. In Facing Hydrometeorological Extreme Events (pp. 483–497). Wiley. https://doi.org/10.1002/9781119383567.ch28

Gennari R, Matera M, Morra D, Melonio A, Rizvi M (2023) Design for social digital well-being with young generations: Engage them and make them reflect. Int J Hum-Computer Stud 173:103006. https://doi.org/10.1016/j.ijhcs.2023.103006

Ghazal TM, Hasan MK, Alshurideh MT, Alzoubi HM, Ahmad M, Akbar SS, Al Kurdi B, Akour IA (2021) IoT for Smart Cities: Machine Learning Approaches in Smart Healthcare—A Review. Future Internet 13(8):218. https://doi.org/10.3390/fi13080218

Goldman HH, Grob GN (2006) Defining 'Mental Illness' In Mental Health Policy. Health Aff 25(3):737–749. https://doi.org/10.1377/hlthaff.25.3.737

Griffiths P, Terluin B, Trigg A, Schuller W, Bjorner JB (2022) A confirmatory factor analysis approach was found to accurately estimate the reliability of transition ratings. J Clin Epidemiol 141:36–45. https://doi.org/10.1016/j.jclinepi.2021.08.029

Grote T, Berens P (2020) On the ethics of algorithmic decision-making in Healthcare. J Med Ethics 46(3):205–211. https://doi.org/10.1136/medethics-2019-105586

Hamdoun S, Monteleone R, Bookman T, Michael K (2023) AI-Based and Digital Mental Health Apps: Balancing Need and Risk. IEEE Technol Soc Mag 42(1):25–36. https://doi.org/10.1109/MTS.2023.3241309

Hattie JA, Myers JE, Sweeney TJ (2004) A Factor Structure of Wellness: Theory, Assessment, Analysis, and Practice. J Counsel Dev 82(3):354–364. https://doi.org/10.1002/j.1556-6678.2004.tb00321.x

Héder M (2021) AI and the resurrection of Technological Determinism. Infációs Társadalom 21(2):119. https://doi.org/10.22503/inftars.XXI.2021.2.8

Hodson R (2018) Digital revolution. Nature 563(7733):S131–S131. https://doi.org/10.1038/d41586-018-07500-z

Hollensen S, Kotler P, Opresnik MO (2023) Metaverse – the new marketing universe. J Bus Strategy 44(3):119–125. https://doi.org/10.1108/JBS-01-2022-0014

Hu L, Bentler PM (1998) Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. Psychol Methods 3(4):424–453. https://doi.org/10.1037/1082-989X.3.4.424

Hustak T, Krejcar O (2016) Principles of Usability in Human-Computer Interaction (51–57). https://doi.org/10.1007/978-3-662-47895-0_7

Ifdil I, Situmorang DDB, Firman F, Zola N, Rangka IB, Fadli RP (2023) Virtual reality in Metaverse for future mental health-helping profession: an alternative solution to the mental health challenges of the COVID-19 pandemic. J Public Health 45(1):e142–e143. https://doi.org/10.1093/pubmed/fdac049

Islam Mozumder MA, Athar A, Theodore Armand TP, Sheeraz MM, Imtiyaj Uddin SM, Kim H-C (2023) Technological Roadmap of the Future Trend of Metaverse based on IoT, Blockchain, and AI Techniques in Metaverse Education. 2023 25th International Conference on Advanced Communication Technology (ICACT), 1414–1423. https://doi.org/10.23919/ICACT56868.2023.10079464

Jan A, Shakirullah, Naz S, Khan O, Khan AQ (2020) Marshal mcluhan's technological determinism theory in the arena of social media. Theor Pract Res Econ Fields 11(2):133. https://doi.org/10.14505/tpref.v11.2(22).07

Kaddoura S, Al Husseiny F (2023) The rising trend of Metaverse in education: challenges, opportunities, and ethical considerations. PeerJ Comput Sci 9:e1252. https://doi.org/10.7717/peerj-cs.1252

Kaur M (2022) Cyber Security Challenges in the Latest Technology (655–671). https://doi.org/10.1007/978-981-16-8862-1_43

Kock N (2015) Common Method Bias in PLS-SEM. Int J E-Collab 11(4):1–10. https://doi.org/10.4018/ijec.2015100101

Kshetri N (2022) Policy, Ethical, Social, and Environmental Considerations of Web3 and the Metaverse. IT Profess 24(3):4–8. https://doi.org/10.1109/MITP.2022.3178509

LaBelle B (2019) Positive Outcomes of a Social-Emotional Learning Program to Promote Student Resiliency and Address Mental Health. Contemp School Psycho. https://doi.org/10.1007/s40688-019-00263-y

Leroy F, Abraini F, Beal T, Dominguez-Salas P, Gregorini P, Manzano P, Rowntree J, van Vliet S (2022) Animal board invited review: Animal source foods in healthy, sustainable, and ethical diets – An argument against drastic limitation of livestock in the food system. Animal 16(3):100457. https://doi.org/10.1016/j.animal.2022.100457

Letafati M, Otoum S (2023) On the privacy and security for e-health services in the Metaverse: An overview. Ad Hoc Netw 150:103262. https://doi.org/10.1016/j.adhoc.2023.103262

Li J (2023) Digital technologies for mental health improvements in the COVID-19 pandemic: a scoping review. BMC Public Health 23(1):413. https://doi.org/10.1186/s12889-023-15302-w

Limone P, Toto GA (2022) Factors That Predispose Undergraduates to Mental Issues: A Cumulative Literature Review for Future Research Perspectives. Front Public Health, 10. https://doi.org/10.3389/fpubh.2022.831349

Liston C, Cohen MM, Teslovich T, Levenson D, Casey BJ (2011) Atypical Prefrontal Connectivity in Attention-Deficit/Hyperactivity Disorder: Pathway to Disease or Pathological End Point? Biol Psychiatry 69(12):1168–1177. https://doi.org/10.1016/j.biopsych.2011.03.022

Liu Z, Hu R, Bi X (2023) The effects of social media addiction on reading practice: a survey of undergraduate students in China. J Document 79(3):670–682. https://doi.org/10.1108/JD-05-2022-0111

Manger S (2019) Lifestyle interventions for mental health. Aust J Gen Pract 48(10):670–673. https://doi.org/10.31128/AJGP-06-19-4964

Manwell LA, Barbic SP, Roberts K, Durisko Z, Lee C, Ware E, McKenzie K (2015) What is mental health? Evidence towards a new definition from a mixed methods multidisciplinary international survey. BMJ Open 5(6):e007079–e007079. https://doi.org/10.1136/bmjopen-2014-007079

Marandi, SS (2023). Virtual supremacy and electronic imperialism: the hegemonies of e-learning and computer assisted language learning (CALL). Learn Media Technol, 1–17. https://doi.org/10.1080/17439884.2023.2207832

Marx GT (1998) Ethics for the New Surveillance. Inf Soc 14(3):171–185. https://doi.org/10.1080/019722498128809

Matricardi PM, Dramburg S, Alvarez-Perea A, Antolín-Amérigo D, Apfelbacher C, Atanaskovic-Markovic M, Berger U, Blaiss MS, Blank S, Boni E, Bonini M, Bousquet J, Brockow K, Buters J, Cardona V, Caubet J, Cavkaytar Ö, Elliott T, Esteban-Gorgojo I, Agache I (2020) The role of mobile health technologies in allergy care: An EAACI position paper. Allergy 75(2):259–272. https://doi.org/10.1111/all.13953

Melkamu Asaye M, Gelaye KA, Matebe YH, Lindgren H, Erlandsson K (2022) Valid and reliable neonatal near-miss assessment scale in Ethiopia: a psychometric validation. Global Health Action, 15(1). https://doi.org/10.1080/16549716.2022.2029334

Meta (2022) Metaverse: Technology that merges virtual, physical worlds soon to become a reality, Meta says A visitor is pictured in front of an immersive art installation titled 'Machine Hallucinations — Space: Metaverse' by media artist Refik Anadol, which will be c. Mint. https://www.livemint.com/technology/tech-news/Metaverse-technology-that-merges-virtual-physical-worlds-soon-to-become-a-reality-meta-says-11645408692319.html

Michie S, West MA (2004) Managing people and performance: an evidence based framework applied to health service organizations. Int J Manag Rev 5–6(2):91–111. https://doi.org/10.1111/j.1460-8545.2004.00098.x

Mindrescu V, Enoiu R-S (2022) Deconstructing the Parent–Child Relationship during the COVID-19 Pandemic through Tech-Wise Outlets Such as the Internet and Media Consumption. Sustainability 14(20):13138. https://doi.org/10.3390/su142013138

Mohr DC, Burns MN, Schueller SM, Clarke G, Klinkman M (2013) Behavioral Intervention Technologies: Evidence review and recommendations for future research in mental health. Gen HospPsychiatry 35(4):332–338. https://doi.org/10.1016/j.genhosppsych.2013.03.008

Moon K, Blackman D (2014) A Guide to Understanding Social Science Research for Natural Scientists. Conserv Biol 28(5):1167–1177. https://doi.org/10.1111/cobi.12326

Mosco V (2023) Into the Metaverse: Technical Challenges, Social Problems, Utopian Visions, and Policy Principles. Javn - Public 30(2):161–173. https://doi.org/10.1080/13183222.2023.2200688

Mozumder MAI, Armand TPT, Imtiyaj Uddin SM, Athar A, Sumon RI, Hussain A, Kim H-C (2023) Metaverse for Digital Anti-Aging Healthcare: An Overview of Potential Use Cases Based on Artificial Intelligence, Blockchain, IoT Technologies, Its Challenges, and Future Directions. Appl Sci 13(8):5127. https://doi.org/10.3390/app13085127

Newman K, Wang AH, Wang AZY, Hanna D (2019) The role of internet-based digital tools in reducing social isolation and addressing support needs among informal caregivers: a scoping review. BMC Public Health 19(1):1495. https://doi.org/10.1186/s12889-019-7837-3

Nie Z, Yu Y, Bao Y (2023) Application of human–computer interaction system based on machine learning algorithm in artistic visual communication. Soft Comput 27(14):10199–10211. https://doi.org/10.1007/s00500-023-08267-w

Ningning W, Wenguang C (2023) The effect of playing e-sports games on young people's desire to engage in physical activity: Mediating effects of social presence perception and virtual sports experience. PLOS ONE 18(7):e0288608. https://doi.org/10.1371/journal.pone.0288608

Njoku JN, Nwakanma CI, Amaizu GC, Kim D (2023) Prospects and challenges of Metaverse application in data-driven intelligent transportation systems. IET Intell Transp Syst 17(1):1–21. https://doi.org/10.1049/itr2.12252

Oh HJ, Kim J, Chang JJC, Park N, Lee S (2023) Social benefits of living in the Metaverse: The relationships among social presence, supportive interaction, social self-efficacy, and feelings of loneliness. Comput Hum Behav 139:107498. https://doi.org/10.1016/j.chb.2022.107498

Ooi K-B, Wei-Han Tan G, Al-Emran M, Al-Sharafi MA, Arpaci I, Zaidan AA, Lee V-H, Wong L-W, Deveci, M, Iranmanesh M (2023) The Metaverse in Engineering Management: Overview, Opportunities, Challenges, and Future Research Agenda. IEEE Transactions on Engineering Management, 1–8. https://doi.org/10.1109/TEM.2023.3307562

Pandya A, Lodha P (2021) Social Connectedness, Excessive Screen Time During COVID-19 and Mental Health: A Review of Current Evidence. Front Human Dynam, 3. https://doi.org/10.3389/fhumd.2021.684137

Pappa S, Barnett J, Berges I, Sakkas N (2021) Tired, Worried and Burned Out, but Still Resilient: A Cross-Sectional Study of Mental Health Workers in the UK during the COVID-19 Pandemic. Int J Environ Res Public Health 18(9):4457. https://doi.org/10.3390/ijerph18094457

Parsons TD, Gaggioli A, Riva G (2020) Extended Reality for the Clinical, Affective, and Social Neurosciences. Brain Sci 10(12):922. https://doi.org/10.3390/brainsci10120922

Patalay P, Demkowicz O (2023) Debate: Don't mind the gap – why do we not care about the gender gap in common mental health difficulties? Child Adolesc Ment Health 28(2):341–343. https://doi.org/10.1111/camh.12647

Pillai AS, Mathew PS (2019) Impact of Virtual Reality in Healthcare (17–31). https://doi.org/10.4018/978-1-5225-7168-1.ch002

Qamar S, Anwar Z, Afzal M (2023) A systematic threat analysis and defense strategies for the Metaverse and extended reality systems. Computers Security 128:103127. https://doi.org/10.1016/j.cose.2023.103127

Quach S, Thaichon P, Martin KD, Weaven S, Palmatier RW (2022) Digital technologies: tensions in privacy and data. J Acad Mark Sci 50(6):1299–1323. https://doi.org/10.1007/s11747-022-00845-y

Rahi S (2017) Research Design and Methods: A Systematic Review of Research Paradigms, Sampling Issues and Instruments Development. Int J Econ Manage Sci, 06(02). https://doi.org/10.4172/2162-6359.1000403

Ratten V (2020) Coronavirus (covid-19) and entrepreneurship: changing life and work landscape. J Small Bus Entrepre 32(5):503–516. https://doi.org/10.1080/08276331.2020.1790167

Reibstein DJ, Iyengar R (2023) Metaverse—will it change the world or be a whole new world in and of itself? AMS Rev 13(1–2):144–150. https://doi.org/10.1007/s13162-023-00258-2

Riva G, Wiederhold BK (2022) What the Metaverse Is (Really) and Why We Need to Know About It. Cyberpsychol Behav Soc Netw 25(6):355–359. https://doi.org/10.1089/cyber.2022.0124

Salar HC, Başarmak U, Sezgin ME (2023) Educational Integration of the Metaverse Environment in the Context of Web 3.0 Technologies (154–173). https://doi.org/10.4018/978-1-6684-6513-4.ch009

Saltarella M, Desolda G, Lanzilotti R, Barletta VS (2023) Translating Privacy Design Principles Into Human-Centered Software Lifecycle: A Literature Review. Int J Human–Comp Interaction, 1–19. https://doi.org/10.1080/10447318.2023.2219964

Sass C, Brennan C, Farley K, Crosby H, Rodriguez Lopez R, Romeu D, Mitchell E, House A, Guthrie E (2022) Valued attributes of professional support for people who repeatedly self-harm: A systematic review and meta-synthesis of first-hand accounts. Int J Ment Health Nurs 31(2):424–441. https://doi.org/10.1111/inm.12969

Sayibu M, Chu J, Akintunde TY, Rufai OH, Amosun TS, George-Ufot G (2022) Environmental conditions, mobile digital culture, mobile usability, knowledge of app in COVID-19 risk mitigation: A structural equation model analysis. Smart Health 25:100286. https://doi.org/10.1016/j.smhl.2022.100286

Schiller S, Nah FF-H, Luse A, Siau K (2023) Men are from Mars and women are from Venus: dyadic collaboration in the Metaverse. Internet Research. https://doi.org/10.1108/INTR-08-2022-0690

Sherry T (2015) Reclaiming Conversation: The Power of Talk in a Digital Age. Penguin Press

Shetty A, Kulkarni GS, Babu SN R, Paarakh PM (2022) A Review on: Metaverse in Health Care and Pharma. J Community Pharm Pract 31:1–11. https://doi.org/10.55529/jcpp.31.1.11

Shrestha R, Kim S (2019) Integration of IoT with blockchain and homomorphic encryption: Challenging issues and opportunities (293–331). https://doi.org/10.1016/bs.adcom.2019.06.002

Situmorang DDB (2023) Metaverse as a new place for online mental health services in the post-COVID-19 era: Is it a challenge or an opportunity? J Public Health 45(2):e379–e380. https://doi.org/10.1093/pubmed/fdac159

Smith, Lane RD, Parr T, Friston KJ (2019) Neurocomputational mechanisms underlying emotional awareness: Insights afforded by deep active inference and their potential clinical relevance. Neurosci Biobehav Rev 107:473–491. https://doi.org/10.1016/j.neubiorev.2019.09.002

Smith N, Peters D, Jay C, Sandal GM, Barrett EC, Wuebker R (2023) Off-World Mental Health: Considerations for the Design of Well-being–Supportive Technologies for Deep Space Exploration. JMIR Format Res 7:e37784. https://doi.org/10.2196/37784

Solaiman B (2023) Telehealth in the Metaverse: Legal & Ethical Challenges for Cross-Border Care in Virtual Worlds. J Law Med Ethics 51(2):287–300. https://doi.org/10.1017/jme.2023.64

Solmi M, Radua J, Olivola M, Croce E, Soardo L, Salazar de Pablo G, Il Shin J, Kirkbride JB, Jones P, Kim JH, Kim JY, Carvalho AF, Seeman MV, Correll CU, Fusar-Poli P (2022) Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. Mol Psychiatry 27(1):281–295. https://doi.org/10.1038/s41380-021-01161-7

Strutt PA, Johnco CJ, Chen J, Muir C, Maurice O, Dawes P, Siette J, Botelho Dias C, Hillebrandt H, Wuthrich VM (2022) Stress and Coping in Older Australians During COVID-19: Health, Service Utilization, Grandparenting, and Technology Use. Clin Gerontol 45(1):106–119. https://doi.org/10.1080/07317115.2021.1884158

Sun M, Xie L, Liu Y, Li K, Jiang B, Lu Y, Yang Y, Yu H, Song Y, Bai C, Yang D (2022) The Metaverse in current digital medicine. Clin EHealth 5:52–57. https://doi.org/10.1016/j.ceh.2022.07.002

Tan TF, Li Y, Lim JS, Gunasekeran DV, Teo ZL, Ng WY, Ting DSW (2022) Metaverse and Virtual Health Care in Ophthalmology: Opportunities and Challenges. Asia-Pac J Ophthalmol 11(3):237–246. https://doi.org/10.1097/APO.0000000000000537

Tinmaz H, Fanea-Ivanovici M, Baber H (2023) A snapshot of digital literacy. Libr Hi Tech N. 40(1):20–23. https://doi.org/10.1108/LHTN-12-2021-0095

Ullah F, Sepasgozar S, Wang C (2018) A Systematic Review of Smart Real Estate Technology: Drivers of, and Barriers to, the Use of Digital Disruptive Technologies and Online Platforms. Sustainability 10(9):3142. https://doi.org/10.3390/su10093142

Usmani SS, Sharath M, Mehendale M (2022) Future of mental health in the Metaverse. Gen Psychiatry 35(4):e100825. https://doi.org/10.1136/gpsych-2022-100825

van den BW, Marra E, van der Vliet N, Elberse J, van Dijken S, van Dijk M, Euser S, Derks M, Leurs M, Albers C, Sanderman R, de Bruin M (2023) General Mental Health, Loneliness, and Life Satisfaction in the Context of COVID-19 Policies: A 2-Year Cohort Study in the Netherlands, April 2020–January 2022. Public Health Rep. 138(5):812–821. https://doi.org/10.1177/00333549231176000

Vismara LA, Young GS, Rogers SJ (2012) Telehealth for Expanding the Reach of Early Autism Training to Parents. Autism Res Treat 2012:1–12. https://doi.org/10.1155/2012/121878

Wang H, Ning H, Lin Y, Wang W, Dhelim S, Farha F, Ding J, Daneshmand M (2023) A Survey on the Metaverse: The State-of-the-Art, Technologies, Applications, and Challenges. IEEE Internet Things J 10(16):14671–14688. https://doi.org/10.1109/JIOT.2023.3278329

Wang Y, Zhao J (2022) Mobile Edge Computing, Metaverse, 6G Wireless Communications, Artificial Intelligence, and Blockchain: Survey and Their Convergence. 2022 IEEE 8th World Forum on Internet of Things (WF-IoT), 1–8. https://doi.org/10.1109/WF-IoT54382.2022.10152245

Weinstein E, Kleiman EM, Franz PJ, Joyce VW, Nash CC, Buonopane RJ, Nock MK (2021) Positive and negative uses of social media among adolescents hospitalized for suicidal behavior. J Adolesc 87(1):63–73. https://doi.org/10.1016/j.adolescence.2020.12.003

WHO (2023) *Health and Well-Being.* World Health Organization. Health and Well-Being. World Health Organization. https://www.who.int/Data/Gho/Data/Major-Themes/Health-and-Well-Being

Wiederhold BK (2022) Metaverse Games: Game Changer for Healthcare? Cyberpsychol Behav Soc Netw 25(5):267–269. https://doi.org/10.1089/cyber.2022.29246.editorial

Wolf EJ, Harrington KM, Clark SL, Miller MW (2013) Sample Size Requirements for Structural Equation Models. Educ Psychol Meas 73(6):913–934. https://doi.org/10.1177/0013164413495237

Wylde V, Prakash E, Hewage C, Platts J (2023) Post-Covid-19 Metaverse Cybersecurity and Data Privacy: Present and Future Challenges. In Data Protection in a Post-Pandemic Society (1–48). Springer International Publishing. https://doi.org/10.1007/978-3-031-34006-2_1

Zeng Y, Zeng L, Zhang C, Cheng ASK (2022) The Metaverse in cancer care: Applications and challenges. Asia-Pac J Oncol Nurs 9(12):100111. https://doi.org/10.1016/j.apjon.2022.100111

Zhang, X, Chen, Y, Hu, L, & Wang, Y (2022) The Metaverse in education: Definition, framework, features, potential applications, challenges, and future research topics. Front Psychol 13. https://doi.org/10.3389/fpsyg.2022.1016300

Zhao Y, Jiang J, Chen Y, Liu R, Yang Y, Xue X, Chen S (2022) Metaverse: Perspectives from graphics, interactions and visualization. Vis Inform 6(1):56–67. https://doi.org/10.1016/j.visinf.2022.03.002

Acknowledgements

Author contributions

Conceptualization, Y.X., S.F.A. and X.G.; methodology, H.A.M. and M.I.; resources, Y.K., M.I.; data curation, E.M.A., X.G. ; Data Collection and Data Analysis; E.M.A. and M.I.; writing—original draft preparation, Y.X., S.F.A., H.A.M. ; writing—review and editing, X.J. S.F.A.; supervision, S.F.A.; project administration, Y.X., Y.K.; funding acquisition, E.M.A. and H.A.M. All authors have read and agreed to the published version of the manuscript.

Competing interests

The authors declare no competing interests.

Ethical approval

The research ethics committee examined, approved and endorsed the evaluation survey questionnaire and methodology by the University of Gwadar on 1 March 2021 (see supplementary information). The study meets the requirements of the National Statement on Ethical Conduct in Human Research (2007). The procedures used in this study adhere to the tents of the declaration of Helsinki.

Informed consent

Informed consent was obtained from all participants before the data was collected. We informed each participant of their rights, the purpose of the study, and to safeguard their personal information.

Additional information

Supplementary information The online version contains supplementary material available at https://doi.org/10.1057/s41599-024-02643-z.

Correspondence and requests for materials should be addressed to Yineng Xiao or Sayed Fayaz Ahmad.

Reprints and permission information is available at http://www.nature.com/reprints

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.