A Pilot Study Evaluating the Effectiveness of Metaverse-Based Psychiatric Diagnosis: A Comparative Study with Traditional Clinic Settings

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Abstract: Over the past few decades, healthcare organizations worldwide have recognized the numerous ways information technologies might prove helpful. Metaverse, AI, and data science are three emerging technologies that are changing the smart health industry. Metaverse is a new advancement in smart health. It represents an integration of three main technologies: artificial intelligence (AI), augmented reality (AR), and virtual reality (VR). It opens new opportunities and options that are still being discovered. Artificial intelligence, in conjunction with machine learning and the metaverse, is revolutionizing the healthcare sector. As they enhance operational efficiency, they elevate patient care, reduce expenses, and decrease workloads for healthcare professionals. Mental health is among the different fields of healthcare that have already started to use these advanced technologies. This research is a pilot study aimed at evaluating the feasibility of using a metaverse-based environment for psychiatric diagnosis, specifically for assessing anxiety and depression. It is an initial exploration of a small sample size of four participants. This study used a within-subjects design, where each participant experienced two sessions: one in the pre-designed metaverse environment (MetaverseClinic) and the other in a traditional in-person clinic. Later participants asked to rate their experience using the STAR-P (Patient version) and the Satisfaction Scale questionnaires. They were selected to measure the therapeutic relationship, patient satisfaction, and the overall experience in both settings. The results show promising similarities in patient satisfaction and therapeutic relationships between the two settings.

Keywords: Metaverse; Virtual Reality; Psychiatric; Mental Health

1. Introduction

The healthcare sector is experiencing a great transformation with the advent of innovative technologies such as metaverse, Artificial Intelligence, and Virtual Reality [1]. They are reshaping how healthcare services, especially in mental health, are delivered [2]. The metaverse is an integrated environment that combines VR, AR, and AI[3]. This technology enables immersive virtual environments that allow patients and clinicians to interact. It offers an additional approach to treatment and diagnosis [15][16]. While the metaverse shows promise in several areas of healthcare, its application in mental health, specifically in diagnosing anxiety and depression, remains underexplored [4]. Particularly, when compared to traditional in-person settings. This research aims to explore the effectiveness of metaverse-based meetings in diagnosing mental health conditions. In addition to comparing it with the traditional

clinic experience.

Mental health disorders, including anxiety and depression, are among the most common psychological conditions worldwide [5], [6]. They affect millions annually. According to the World Health Organization (WHO) [7], depression and anxiety disorders contribute significantly to reduced quality of life and societal burden. Despite the availability of treatment options, many patients face barriers such as limited access to care, social stigma, and logistical difficulties in attending in-person therapy sessions. The emergence of metaverse-based interventions offers new possibilities for overcoming these barriers. It provides an immersive virtual space where patients can receive care remotely, in a controlled environment. This research is motivated by the need to evaluate whether metaverse-based therapy and diagnosis can provide the same level of accuracy, efficacy, and patient satisfaction as traditional, face-to-face psychiatric consultations.

The novelty of this research lies in its focus on the metaverse as a potential alternative for diagnosing anxiety and depression. As well as its application of advanced technologies, such as real-time emotion tracking and virtual avatars. While previous studies have explored the use of virtual platforms for therapeutic purposes, few have directly compared metaverse-based diagnostics with traditional clinical methods. This research addresses this gap by comparing these two environments to assess diagnostic consistency, patient satisfaction, and the quality of the therapeutic relationship.

This technology allowed for immersive and dynamic interactions between the participant and the psychiatrist, mediated through avatars. Metaverse offers immersive, interactive environments that enhance user engagement, allowing for multi-user interaction in real-time, which is ideal for psychiatric assessments and therapy. Unlike traditional virtual reality, the metaverse integrates various functionalities. Such as customizable avatars and advanced interaction models, making it more adaptable for personalized mental health care. This advanced interaction within the metaverse provides a more dynamic, patient-centered environment compared to traditional VR settings used in clinical settings.

The main aim of this pilot study is to answer the question: Can metaverse-based diagnostic sessions effectively replicate traditional clinical settings in diagnosing anxiety and depression? Specifically, the research seeks to test the following hypotheses:

Null Hypothesis (H_0): There is no significant difference in the diagnostic consistency, patient satisfaction, and therapeutic relationship between the metaverse and traditional clinic settings.

Alternative Hypothesis (H_1): There is a significant difference in the diagnostic consistency, patient satisfaction and therapeutic relationship between the metaverse clinic and traditional clinic settings.

These hypotheses aim to test whether the metaverse environment can replicate or even improve upon the effectiveness of traditional psychiatric care in diagnosing anxiety and depression conditions and fostering positive therapeutic relationships.

2. Related work

Virtual reality in general has already begun to be explored in the mental health field, and many academic works have already been conducted. For example, Virtual Reality-based Theory of Mind Intervention (VR-ToMIS), is a promising effort[8]. It assisted users in trying out different types of simulated social communication. schizophrenia is one of the disorders that the VR-toMIS can help with. The treatment of phobias is another research area in psychiatric care that utilizes the metaverse [9]. They are building immersive and diverse virtual environments in which the patient is exposed to scenarios designed specifically for the patient's condition and controlled and monitored by the psychotherapist. In addition, patients with body dysmorphism symptoms and social deficits by using the metaverse, can overcome their problems, as highlighted in the research of [10]. Another example is the work of Cerasa et al., [11], which used the metaverse and virtual reality to train children with autism in social skills. They prove the effectiveness of this technology in treating behavioral symptoms, after a significant improvement in children's ability to interact with other individuals. For psychosocial support for cancer patients, Hasei et al.[12] highlights the potential of avatar-based support in managing emotional health. For training psychiatrists and enhancing their digital literacy in telepsychiatry, Nawaz et al.,[13] emphasized the adoption of digital health tools, including metaverse applications.

However, current research has predominantly focused on therapeutic interventions rather than diagnostic tools. Although VR tools like VRET have been applied to treat symptoms of anxiety and depression, the current use of these technologies remains confined to therapeutic interventions rather than diagnostic frameworks. For example, the research of [11] and [17] discusses the broader impact of

the metaverse on mental health, including therapeutic applications and immersive environments for treating conditions like anxiety and depression, but it does not focus specifically on diagnostic practices. They focus on therapy and treatment rather than the diagnostic process for conditions. While recent studies discussed and highlighted the effectiveness of virtual reality environments for treatment, such as the reduction of social isolation and alleviation of symptoms in disorders like social anxiety and depression through virtual platforms like Second Life, no comprehensive research has yet addressed the potential of the metaverse for direct diagnosis [4]. This gap in the literature emphasized the need for novel approaches to utilize the immersive and feature-rich capabilities of the metaverse for anxiety and depression diagnostic purposes.

3. Methodology

The goal of this article was to simulate a real-world clinical environment and assess how well the metaverse could facilitate psychiatric diagnosis. This research was conducted in agreement with the Medical and Bioethics Committee at King Abdulaziz University. Ethical approval references No 221-24 was gained from the Hospital of King Abdulaziz University (Jeddah, Saudi Arabia) ,. All participants provided written informed consent before participation.

Participants

This research aimed to evaluate the feasibility of using a metaverse-based environment for psychiatric diagnosis, specifically for assessing anxiety and depression. Due to the exploration nature of this study, a small sample size of four participants was chosen. This allows for an initial evaluation of the metaverse platform's potential in diagnosing anxiety and depression conditions.

The participants were new patients visiting the psychiatric clinic. The inclusion criteria required participants to be aged 18-50 years, fluent in either Arabic or English, and free from any intellectual disabilities or acute psychiatric disorders such as psychosis. The participants' characteristics and demographic information were collected before the experiment.

This pilot study used a within-subjects design, where each participant experienced two sessions: one in the pre-designed metaverse environment (MetaverseClinic) and the other in a traditional in-person setting. The order of the sessions was counterbalanced to avoid potential order effects, with each participant randomly assigned to begin with either the metaverse session or the traditional clinic session.

Environmental Design

The design of the metaverse environment for mental health care focuses on creating a therapeutic space that facilitates interaction and collaboration between psychiatrists and patients. For this research, key design considerations include clear visuals, sound, emotion, and movement tracking, safety, simplicity, usability, and a sense of presence. Experts suggested incorporating familiar elements from real clinics. It is designed using simple environments with few objects and employing basic colors to enhance patient comfort as described in Figure 1.

The environment emphasizes ease of movement, minimizing stress, and tracking emotions. The use of avatars, clear voice communication, and hand tracking for manipulating objects ensures effective interaction. Additionally, the system is designed with a low number of user interfaces for simplicity and readability. In addition, it offers various locomotion options like teleportation. Human-like avatars were chosen to increase realism, with patients in seated positions to enhance comfort and engagement.

To enhance the functionality and interactivity of the MetaverseClinic, several advanced packages were integrated into the designed environment. The room was developed using Unity 2022.3.18f1. It utilizes the Standard Render Pipeline (SRP), which prioritizes performance by delivering realistic visuals without the need for complex rendering features such as ray tracing. To ensure cross-platform compatibility, the XR Management Plugin was incorporated., It enables seamless integration with various VR devices, especially the Meta Quest Pro.

To bring the virtual environment to life, the Meta XR Core SDK was added. This package allowed for the implementation of hand tracking, enabling users to interact naturally with the environment, and real-time facial expression tracking, which added emotional depth to the avatar interactions. It is built to reflect all of the facial emotions' details, such as a smile, closed eyes, etc. Furthermore, Photon Fusion 2 and Photon Voice 2 were integrated to provide low-latency, high-quality multiplayer capabilities. This ensures that users can communicate in real-time with 3D spatial audio, making interactions feel more authentic and immersive.

The inclusion of Inverse Kinematics (IK) was essential for realistic avatar movements. It allowed for automatic adjustments in avatar posture, ensuring that movements like walking or hand gestures appeared naturally within the virtual space. Finally, OVR Platform Tool was utilized to handle user authentication and avatar customization. This enabled users to have personalized avatars while ensuring secure and smooth access to the platform, completing the immersive experience.

Figure 1: Metaverse Clinic

Hardware

The experimental setup has a PC with configurations of MSI GT76 Titan DT 9SGS Gaming Laptop, Intel Core i9-9900K (9th Gen), NVIDIA GeForce RTX 2080 Super (8 GB), and 1 TB SSD/1 TB HDD. The user evaluated the proposed environment using the Meta Quest Pro VR [18]. It is a high-end headset designed with a range of advanced features. It offers a mixed reality and virtual reality experience, which includes a head-mounted display (HMD) and two touch controllers with 3 camera sensors per controller. In addition, it has Built-in rechargeable batteries, up to 10 hours of battery life, as seen in Figure 3,4. It has Real-time expression tracking with 5 infrared eye and face tracking sensors capable of a 120-degree field of view each. It supports work with PC by Link and Air Link. MSI GT76 Titan DT 9SGS Gaming Laptop

Figure 2: Meta Quest Pro Headset

Figure 3: Headset Controllers

Metaverse Session:

During the metaverse session, participants wore the Meta Quest Pro VR headset. It had advanced emotion-tracking capabilities and real-time facial expression recognition. The communication between the participant and the psychiatrist was mediated through avatars. The session was designed to mimic a traditional clinical setting. In addition, it applied metaverse features such as virtual meeting rooms, interactive and emotionally responsive avatars.

Traditional Clinic Session:

The traditional clinic session was conducted using conventional diagnostic methods, where participants interacted in person with a licensed psychiatrist. The session followed typical psychiatric interview protocols, with the psychiatrist asking questions based on established diagnostic criteria for anxiety and depression. The same set of diagnostic criteria and tools used in the metaverse session was applied here for consistency.

Each session lasted 30-45 minutes, ensuring sufficient time for participants. After completing both sessions, participants were asked to rate their experience using two questionnaires: the STAR-P (Patient version) [19]and the Satisfaction Scale [20]. These scales were selected to measure the therapeutic relationship, patient satisfaction, and the overall experience in both the metaverse and traditional clinic settings.

Data Collection

Two questionnaires were administered immediately after each session to capture participants' real-time reactions and experiences. The data collected from these instruments were used to assess diagnostic reliability, patient satisfaction, and the quality of the therapeutic relationship in both environments.

1. STAR-P (Patient Version) Questionnaire: The STAR-P questionnaire was used to assess the therapeutic relationship between the participants and the psychiatrist. This includes evaluating aspects such as rapport, trust, communication, and collaboration. Each of the 12 items in the questionnaire was rated on a 5-point Likert scale (0 = Never, 1 = Rarely, 2 = Sometimes, 3 = Often, 4 = Always), providing a comprehensive assessment of the participant’s perception of the quality of the therapeutic interaction.
2. Satisfaction Scale: The Satisfaction Scale was used to assess the participant’s overall satisfaction with the psychiatric session. This scale measures factors such as service quality, fulfillment of expectations, and likelihood to recommend the service. It provides valuable feedback on the user experience and engagement with both the metaverse platform and the traditional clinic environment.

The data from the STAR-P and Satisfaction Scale questionnaires were entered into SPSS for analysis. Given the small sample size of four participants, a paired t-test was conducted to compare the differences in scores between the metaverse and traditional clinic sessions. The primary focus of the analysis was to determine whether there was any statistically significant difference in patient satisfaction, diagnosis consistency, and therapeutic relationship scores between the two environments.

4. Results and Discussion

A paired samples t-test was conducted to compare satisfaction with services between the metaverse app and traditional clinic settings. The mean score for satisfaction with the metaverse clinic was 3.50 (SD = 0.58), while the mean score for satisfaction with the traditional clinic was also 3.50 (SD = 0.58). The paired samples t-test results indicated that there were no significant differences in satisfaction scores between the two environments, with a p-value = 0.391 (two-tailed). The t-value was 1.000 with 3 degrees of freedom, suggesting that the difference in satisfaction scores between the two settings is not statistically significant.

Additionally, the effect size calculated using Cohen's d was 0.5, indicating a medium effect size. This supports the conclusion that the difference, though meaningful, is not large enough to be statistically significant in this small sample.

The results suggest that the metaverse and traditional clinic settings provide similar levels of patient satisfaction, with no evidence to reject the null hypothesis that there is no significant difference between the two environments in terms of satisfaction.

Table 1: Descriptive Statistics for Satisfaction Scores in Metaverse App and Traditional Clinic Settings

Satisfaction Measure	Metaverse App	Traditional Clinic	Mean Difference
Rate the quality of service you received	3.50 (0.58)	3.50 (0.58)	0.00
Get the kind of service you wanted	3.50 (0.58)	3.50 (0.58)	0.00
If you were to seek help again, would you return?	3.75 (0.50)	3.25 (0.50)	0.50
Satisfied with the amount of help you received	3.25 (0.96)	3.25 (0.96)	0.00
Overall satisfaction with the service	3.50 (0.58)	3.50 (0.58)	0.00

Table 1 shows that there are no significant differences in satisfaction scores between the metaverse app and traditional clinic settings, with the exception of a higher willingness to return for services in the metaverse clinic (mean difference = 0.50). Overall, satisfaction levels were comparable across both environments.

In addition, a paired samples t-test was conducted to assess the difference in therapeutic relationship scores as measured by the STAR-P questionnaire between the metaverse and traditional clinic settings, AS described in Table 2. The mean scores for both the metaverse and traditional clinic sessions were compared across multiple pairs of items in the STAR-P scale.

The results of the t-test for Pair 1 ("My clinician speaks with me about my personal goals and thoughts about treatment") showed no significant difference, $t(3) = 1.000$, $p = 0.391$, suggesting that both environments were perceived similarly in terms of communication about personal goals. The mean difference between the two environments was -1.750, with a standard deviation of 3.500 and a confidence interval ranging from -7.319 to 3.819.

The effect size (Cohen's d) for this pair was 0.5, indicating a medium effect size, suggesting that the difference between the two environments was not large enough to be statistically significant but may still have practical relevance. Similar results were found for other pairs, such as Pair 7 ("My clinician is stern with me when I speak about things that are important to me and my situation"), where the t-test again yielded $p = 0.391$, indicating no significant difference.

For Pair 8 ("If you were to seek help again, would you come back to our service?"), there was a statistically significant difference, $t(3) = 3.000$, $p = 0.029$, suggesting that participants were more likely to return to the service in the metaverse environment. The effect size for this pair was Cohen's $d = 1.128$, indicating a large effect size, reinforcing that participants were more satisfied with the metaverse in terms of their future willingness to use the service.

In summary, the paired samples t-test revealed that, overall, the metaverse app and traditional clinic settings were perceived similarly across most therapeutic relationship measures. However, there was a significant difference in the likelihood of returning to the service, with the metaverse showing higher satisfaction. These findings suggest that metaverse-based interventions could offer a comparable therapeutic experience to traditional clinic settings.

Table 2: STAR-P Questionnaire between the Metaverse and Traditional clinic

Item	Metaverse Clinic	Traditional Clinic	Mean Difference	t-value	p-value (Two-Tailed)	Cohen's d	Hedges' d
Pair 1: Clinician speaks about personal goals and treatment	3.00 (0.816)	3.00 (0.816)	0.00	-1.000	0.391	0.5	0.691
Pair 2: Clinician and I are open with each other	3.25 (0.500)	3.25 (0.957)	0.00	0.000	1.000	0.5	0.691
Pair 3: Clinician and I share a trusting relationship	3.25 (0.500)	3.50 (0.577)	-0.25	-1.299	0.196	0.577	0.798
Pair 5: Clinician and I share an honest relationship	2.75 (1.500)	2.75 (1.258)	0.00	0.000	1.000	0.5	0.691
Pair 6: Clinician and I work towards agreed goals	2.75 (0.957)	3.25 (0.500)	-0.50	-1.299	0.196	0.577	0.798
Pair 9: Clinician is impatient with me	3.75 (0.500)	3.75 (0.500)	0.00	0.000	1.000	0.5	0.691
Pair 10: Clinician seems to like me regardless of actions	3.25 (0.500)	3.50 (0.577)	-0.25	-0.500	0.182	0.5	0.691
Pair 11: We agree on what is important to work on	3.50 (0.577)	3.75 (0.500)	-0.25	-0.500	0.391	0.5	0.691
Pair 12: Clinician has understanding of my experiences	3.25 (0.500)	3.50 (0.577)	-0.25	-1.299	0.196	0.5	0.691

For Diagnosis consistency, a paired samples t-test was conducted to compare the diagnosis consistency between both settings. The diagnosis was coded as 1 for anxiety, 2 for depression, and 0 for other diagnoses. The mean diagnosis consistency, in Table 3, in the metaverse clinic was 1.25 (SD = 0.5), while the mean in the traditional clinic setting was 1.00 (SD = 0.82).

The results indicated that the difference in diagnosis consistency between the two settings was not statistically significant, $t(3) = 1.000$, $p = 0.391$, with a mean difference of 0.25. The 95% confidence interval for the difference in means was [-7.319, 3.819], suggesting that the observed difference could be due to chance.

The Cohen's d for this comparison was 0.5, indicating a medium effect size. While the effect size suggests a moderate difference in the consistency of diagnoses, the p-value of 0.391 indicates that the difference between the metaverse and the traditional clinic in terms of diagnosis consistency was not statistically significant.

Table 3: Diagnosis Consistency Between Metaverse and Traditional Clinic

Variable	Metaverse Clinic	Traditional Clinic	Mean Difference	t-value	p-value	Effect Size (Cohen's d)
Diagnosis Consistency (1 = Anxiety, 2 = Depression, 0 = Other)	1.25 (0.5)	1.00 (0.82)	0.25	1.000	0.391	0.5

These results suggest that there is no significant difference in the diagnostic consistency between the metaverse and the traditional clinic. Both environments yielded similar diagnostic outcomes, with only a small, non-significant difference in diagnosis consistency. This finding suggests that the metaverse clinic provides comparable diagnostic reliability to traditional clinic settings, although further research with a larger sample size is necessary to draw more definitive conclusions.

5. Conclusion and future work

In this pilot study, the metaverse clinic was found to offer a comparable experience to traditional clinic settings in most aspects of the therapeutic relationship and satisfaction. However, there was a significant

difference in future engagement, with participants expressing a stronger willingness to return to the metaverse environment. This indicates that metaverse-based psychiatric sessions can be as effective as traditional ones, with added benefits in terms of patient engagement and future willingness to use the service. Further research with a larger sample size is needed to validate these findings and assess the long-term feasibility of using metaverse environments in psychiatric care.

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