Original Article

Development and Implementation of a Virtual Environment in the Huancavelica-Based Metaverse for the Treatment of Psychoprophylaxis in Pregnant Women

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Abstract - The neonatal mortality has remained one of the main problems, being even more recurrent in regions with vulnerable populations or high poverty rates, where most of these cases die due to inadequate, preventable care. This study seeks to explore the use of the metaverse to improve prenatal psychoprophylaxis by providing an immersive virtual environment that facilitates remote interaction between specialist physicians and pregnant women. A free methodology was used, ranging from planning and avatar selection to implementation and launch. The results demonstrated that the metaverse is a viable environment to improve accessibility, interaction, and prenatal care. In conclusion, this innovative approach could make prenatal care more interactive.

Keywords - Prenatal care, Neonatal mortality, Metaverse, Psychoprophylaxis.

1. Introduction

Globally, the neonatal mortality rate has proven to remain a critical point, as, according to the WHO, 2.4 million newborns died in their first month of life throughout 2021, which is estimated at an average of 6,700 deaths per day, of which 75% could have been prevented with only adequate minimum basic care, exposing the large gaps in health services, especially in the poorest regions [1].

In Latin America and parts of the Caribbean, the average neonatal mortality rate is around 11 deaths per 1,000 live births; however, countries such as Haiti (32 per 1,000) and Bolivia (19 per 1,000) face more worrying figures [1]. In addition, 88% of pregnant women in the Americas (approximately 12.9 million) received prenatal care with four or more visits.

In Latin America and the Caribbean, this figure was 86% [2]. In Peru, for example, between 2011 and 2019, neonatal mortality showed inequalities associated with poverty and educational level, being higher in regions with greater socioeconomic vulnerability [3].

Technological advances are profoundly transforming everyday life, with a growing reliance on digital tools to facilitate our activities [4]. Despite these advances, challenges remain to achieve a fully efficient and integrated system, especially in the field of health [5].

Prenatal psychoprophylaxis is a comprehensive theoretical, physical, and psychoaffective preparation during pregnancy, ideally initiated between the fifth and sixth month, although it can be performed at any time [6].

This technique prepares pregnant women to cope with the physical and emotional changes of pregnancy and childbirth. Despite its proven importance, there is still a lack of environments adapted to contemporary needs that allow adequate awareness of its relevance in the experience of motherhood.

In this context, emerging technologies, such as the metaverse, offer innovative opportunities to revolutionize healthcare. The metaverse differs from AR and VR in that it focuses more on sustainable and socially meaningful content, and that it does not necessarily rely on these technologies to be considered an application of the metaverse [7]. This makes it an isolated technological environment in an integrated space with real life, driving collaboration and action to address social and environmental challenges.

Virtual reality makes it possible to recreate different environments and simulate the physical presence of people and objects using three-dimensional graphic technology [8].

Thanks to virtual reality, you can immerse yourself in a digital world to transport yourself to another environment, isolated from the physical world.

That's why the metaverse, which is an online virtual world where it's possible to interact with multiple people through their avatars, differs from classic multiplayer games in that it doesn't rely on a competitive purpose or a leveling system [9]. Its potential in medicine is promising; however, it requires the creation of specific laws to address the different challenges and ensure their responsible development [10]. These regulations are vital to ensure patient safety, ethics, and protection, avoiding potential misuse.

In this context, the metaverse emerges as a revolutionary and innovative tool with the ability to transform access, quality, and the experience of healthcare [11]. While virtual interventions have been explored in other healthcare settings, their adaptation and efficacy in perinatal psychoprophylaxis, especially in vulnerable populations, remains an emerging area of research capable of overcoming these barriers and improving the quality of antenatal care.

Therefore, the objective of this research is to recreate a virtual environment in the metaverse, inspired by the Plaza de Armas in Huancavelica, which allows psychoprophylaxis practices to be carried out in an immersive way.

This work is structured as follows: in the second part the literature will be reviewed, the second part will focus on the methodology, the fourth part will focus on the tools used, the fifth part will focus on the development and implementation of the scenario in the metaverse, the sixth part will focus on the results, and finally, the discussions and conclusions.

2. Literature Review

In the metaverse healthcare environment in South Korea, the authors [12] identified a lack of resources in regional emergency centers due to a lack of operating rooms, intensive care units, and staffing during nights and holidays. In response, they proposed the creation of a hospital specializing in essential surgery that would operate continuously, without elective surgeries or outpatient clinics on weekdays, to improve the effectiveness of essential medical treatment compared to regional emergency centers. The approach pointed to an innovative proposal for a hospital structure, with at least half of the beds reserved for essential medicine patients and financial compensation for the under-occupancy of beds. The results indicated that this proposal could effectively mitigate current challenges by reserving resources and personnel exclusively for emergencies and essential operations, operating 24/7/365. This study concludes that a virtual surgery hospital could serve as a model to improve the effectiveness of essential medicine and expand to other regional contexts.

On the other hand, in a study on one of the stages of motherhood, the authors [13] noted that the problem was the increase in postpartum depression during the COVID-19 pandemic, which affected one in eight women in the U.S., with additional barriers to accessing mental health services, especially among women of color and low-income women. The aim of the research was to explore the acceptability of virtual therapy among women in the postpartum period.

The methodology employed was a mixed-methods cross-sectional study, using an online survey with a national sample of 479 women who gave birth in the past 12 months. The results showed that 66% of women reported symptoms of possible depression during the pandemic, but only 27% accessed therapy services. While 88% were open to virtual therapy, 12% expressed concerns such as a preference for in-person therapy, lack of perceived need, discomfort with virtual therapy, and lack of privacy. The results indicated that while there is a strong openness to virtual therapy, there are significant concerns that need to be addressed to improve the accessibility and effectiveness of these services for women with postpartum depression.

Delving a little deeper into psychoprophylaxis itself, the authors [14] noted that their problem lay in the need to evaluate the different types of prenatal education and their impact on birth outcomes, given the increasing rate of caesarean sections. This study sought to determine if there were differences in the type of delivery between women, depending on the type of prenatal education received. The methodology used was a cross-sectional observational study that included nulliparous women with a pregnancy of at least 28 weeks of gestation. The information was collected through prenatal and postnatal surveys, and education was classified into four groups: psychoprophylaxis, childbirth and parenting, other, or none.

The results indicated that a higher percentage of women who participated in psychoprophylactic education had vaginal births compared to those who received other types of education or none at all. The findings suggest that antenatal education based on psychoprophylaxis could increase vaginal birth rates, but randomised trials are needed to confirm these results and assess their effectiveness in reducing caesarean births.

In the Peruvian national context, the authors [15] pointed out that the problem was the lack of updated evidence on the behaviors of pregnant women with psychoprophylactic preparation during the three stages of labor. The objective of this study was to identify the characteristics and perinatal maternal behavior during labor in Peruvian pregnant women with training in obstetric psychoprophylaxis. The methodology used was an observational, descriptive, cross-sectional study, with the participation of 64 primiparous adult women with psychoprophylactic training in a hospital in

Lima, Peru, evaluating their behavior through a validated checklist and obtaining characteristics from their medical history. The results showed that 82.81% of the pregnant women had adequate controls, 95.31% did not present complications during the second stage of labor, and 96.88% had skin-to-skin contact with the newborn, with adequate management predominating in the three stages of labor. The findings indicated that pregnant women with psychoprophylactic preparation showed healthy maternal-perinatal characteristics and appropriate behavior during each stage of labor.

3. Methodology

The development of the psychoprophylaxis environment in the VRChat metaverse was carried out using a free methodology. The key phases of this methodology will be presented below.

3.1. Research and Planning

The purpose of the 3D psychoprophylaxis environment was established, focusing on relaxation techniques. The environment where it will be implemented using Google Maps was also analyzed.

3.2. Avatar Selection

At this stage, avatars related to psychoprophylaxis were selected.

3.3. Integration and Programming

The models were exported to Unity, configuring the elements of the environment and adding the proposed features. To ensure interactivity and real-time synchronization in VRChat, specific components will be included.

3.4. Testing and Adjustments

Tests and tweaks were made to ensure cross-platform functionality and compatibility with PC and Meta Quest.

3.5. Final Implementation and Launch

The environment and avatars will be uploaded to a VRChat world, accessible on both PC and Meta Quest. Ongoing support and updates will be provided based on user feedback to improve the overall experience.

4. Tools

4.1. Blender

Blender is a free and open-source computer graphics software used to develop animated films, visual effects, interactive 3D content, and virtual reality applications [16].

4.2. Unity

Unity is a real-time 3D engine that enables creatives and developers to collaborate on creating interactive and immersive experiences that are compatible with Windows, Mac, and Linux [17].

4.3. VRchat

On VRChat, a virtual reality social platform, users interact with each other using custom avatars tracked by virtual reality hardware, within virtual worlds created by the community [18].

4.4. Autodesk Fusion

Autodesk Fusion 360 offers robust tools that streamline the design-to-manufacturing workflow, enabling designers and engineers to efficiently create, modify, simulate, and visualize redesigned products [19].

4.5. Creator's Companion

VRChat Creator Companion (VCC) is now the starting point for content creation in VRChat. It includes the new VRChat Package Manager (VPM) and provides access to official packages, community contributions, educational resources, tools, and more. [20]

4.6. Steam

Steam, developed by Valve Corporation, was initially created to provide automatic updates to its games. However, it evolved to host third-party titles, becoming a video game sharing platform [21]. Users establish their identity in a virtual world by designing their original characters, i.e., the appearance and personality of their avatars [22].

5. Development and Implementation of the Scenario in the Metaverse

This section describes the creation of a virtual psychoprophylactic environment inspired by the Plaza de Huancavelica, detailing its 3D design, implementation of interactive avatars, and programming of objects in VRChat using tools such as Unity and Autodesk Fusion 360. It also explains the tests and adjustments made to ensure its functionality.

5.1. Research and Planning

The iconic Plaza Huancavelica was the inspiration for the psychoprophylactic environment. This immersive space seeks to recreate this space in every detail, including a tent specially designed for scheduled activities.

Fig. 1 Image of the plaza de armas of huancavelica on google maps

To recreate the environment according to its proportions, we use images from Google Maps as shown in Figure 1.

5.2. Avatar Selection

Two interactive avatars were included in the environment: one representing the baby and one representing the mother. Both avatars can be manipulated directly using a Virtual Reality Avatar Pedestal (VRC Avatar Pedestal), allowing for precise and dynamic interaction. Two specific avatars were used: the baby and the mother.

Fig. 2 Baby avatar

Fig. 3 Mom's avatar

Figures 2 and 3 show the avatars that were used to recreate the psychoprophylactic virtual environment.

5.3. 3D Modeling of the Environment

Autodesk Fusion 360 was used to design the structures, creating a scalable model that faithfully replicates the dimensions and features of the actual structure.
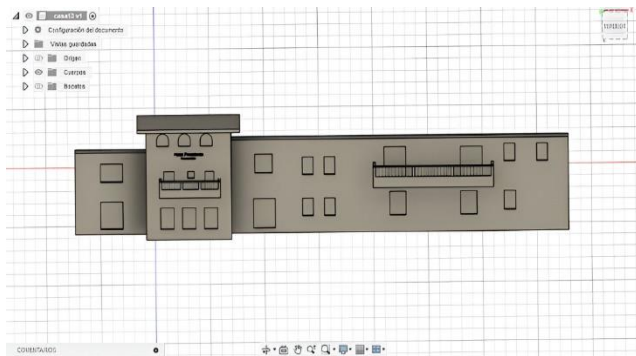

Fig. 4 Design of the huancavelica structure

Figure 4 shows a three-dimensional model of a house located in the Plaza de Huancavelica, made using Autodesk Fusion 360 software. For its construction, images obtained from Google Maps were taken as a reference.

5.4. Integration and Programming

In a Huancavelica-inspired VRChat environment, psychoprophylactic ball objects were made interactive and can be picked up by avatars, requiring the addition of specific components.
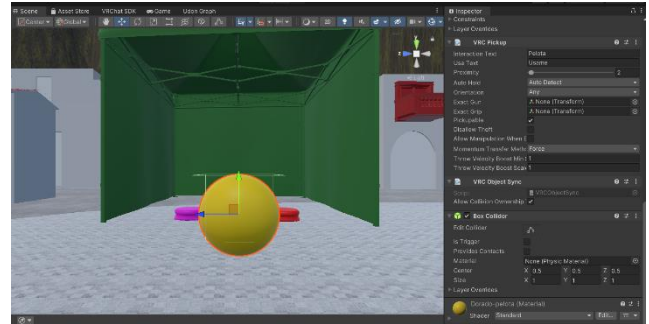

Fig. 5 Integration of the grip on the ball

Figure 5 shows the VRC Pickup component, which allows users to pick, hold, and operate objects. For proper functioning, the object must also have a collider and a rigid body. In this case, a box collider was used, which generates a cubic collision and allows the object to detect physical interactions with other elements. The rigid body, on the other hand, is responsible for managing the physical properties of the object, such as its movement and the application of forces.

In addition, the VRC Object Sync component was added, which synchronizes changes in object position, rotation, and scale between all users connected to the same world. This ensures that any modifications made to the object are reflected in real-time and visible to all avatars present.
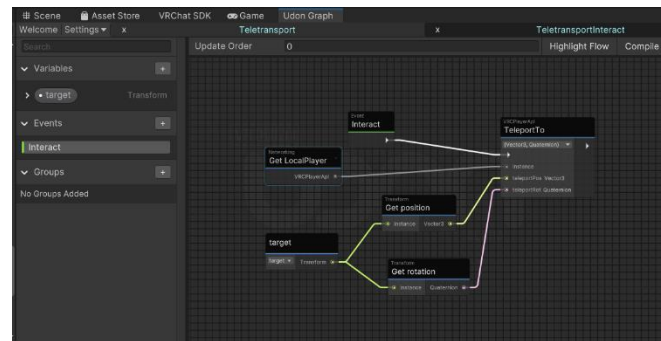

Fig. 6 Teleporter logic

For teleportation, a cube with a Box Collider, an invisible area designed to detect collisions, was used. When the "Is trigger" option is enabled, the collider will not block objects, but it will detect when something passes through its area, which is ideal for triggering events or interactions. As shown in Figure 6, a section was created to host the Udon Graph Program Asset component, which allows you to create a visual

program in Udon, the visual scripting language used in VRChat. To use this component, you'll add the Udon Behavior component, which serves as a container for associating a Udon program (such as those created with the Udon Graph Program Asset) with a GameObject in the scene.

5.5. *Testing and Adjustments*

After you create the environment, the VRChat environment will load. It's important to note that each world has a Unique Identifier (ID), which makes it easier to manage and ensures that updates are applied correctly to each world.

Fig. 7 Process of uploading the created world to VRChat

To upload the metaverse to the VRChat virtual environment, you will first need to integrate the VRChat SDK into the project created with VRChat Creator Companion, a tool that makes it easy to create worlds, as shown in Figure 7. Once the SDK is integrated, we proceed to develop the design of the world and upload it to VRChat for the first time. If you're looking to make upgrades in the future, there's no need to create a new project; the SDK update option is recommended to modify the original world.

6. Results

The 3D modeling process resulted in a rough representation of the environment, based on satellite imagery provided by Google Maps. This reference allows precise adjustments of proportions and locations, achieving a faithful recreation of the terrain and structures. In addition, using modeling tools such as Blender and Autodesk made it possible to highlight key objects.

Fig. 8 Process of uploading the created world to VRChat

Figure 8 shows the environment that simulates the Huancavelica square. This environment was created using Unity's Terrain tool. This demonstrates that virtual worlds and emerging metaverses can be effective platforms for knowledge transfer, using collective and social techniques that promote shared and collaborative learning [23]. This environment, created in VRChat, allows the connection of numerous users. A teleporter was developed that allows immediate travel to the recreational center designed within the environment of psychoprophylaxis.

Fig. 9 Teleporting Cube

Fig. 10 Psychoprophylaxis environment

Figure 9 shows a teleportation cube that allows users, when interacting with it, to go directly to the psychoprophylaxis shop illustrated in Figure 10. In this store, you can see interactive elements, such as a yellow ball and two pedestals with avatars representing a mother and a baby.

Fig. 11 Virtual environment interface

Figure 11 shows the metaverse environment designed to be compatible with both Android devices, including their adaptability for use on Meta Quest, and Desktop Computers (PCs).

7. Discussions and Conclusion

This research met the objective of recreating a multiplatform and interactive metaverse environment, allowing the environment based on the Plaza de Huancavelica to be replicated for psychoprophylaxis in an immersive way. The implementation of this environment demonstrated the potential of the metaverse as a complementary tool in prenatal education.

In the international context in Asia, Kim [12] proposed a smart essential surgery metaverse hospital that would operate 24 hours a day, ensuring constant and effective care in critical situations. Unlike this research, the present work was oriented to the preventive and educational field, as well as its implementation in the metaverse.

In the national context, Guevara [24] documented the adaptation of Peru's National Maternal and Perinatal Institute to a hybrid model of telemedicine and face-to-face consultations to ensure prenatal care and reduce maternal and neonatal risks during the pandemic. However, its approach was in the form of telemedicine; instead, in the present research, a space in the metaverse was documented and implemented.

This work lays the groundwork for the use of the metaverse as a support tool in prenatal care. Its application can be key to the dissemination of the importance of psychoprophylaxis. However, the use of the metaverse in health entails relevant challenges. Neves et al. [26] pointed out that telemedicine systems face obstacles related to socioeconomic factors, although strategies are simultaneously being developed to minimize risks by strengthening follow-up and personalized prenatal counseling. Historically, the doctor-patient relationship has been considered fundamental. However, the integration of the metaverse could reduce human interaction and affect trust between the patient, doctor, and students [25].

In conclusion, this virtual environment not only met the objectives set, but also proved to be a promising tool to transform the way prenatal education is provided, integrating technology, culture, and health in a single experience.

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