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Original Article

Development and Implementation of a Virtual Environment in VRChat to Promote Postnatal Psychoprophylaxis

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Abstract *- Psychoprophylaxis is a preparatory process provided to women while they are pregnant. Following childbirth, postpartum psychoprophylaxis refers to supportive activities, both physical and emotional support. This study discusses a development made for postnatal psychoprophylaxis in a virtual reality setting. The main goal was to create an immersive virtual experience, using VRChat, in the central plaza of Huancavelica, to provide psychoprophylaxis activities to mothers during the first weeks postpartum. A flexible methodology consisting of four phases was used, from research and planning to development of the environment, using tools such as Unity, Blender, Autodesk, VRChat, Creators Companion, and Steam. Internal validations of the environment permitted the creation of a functional virtual world in VRChat. To conclude, this study was successful in completing this work to set the stage for future research to facilitate testing the VR environment with end users.*

Keywords *- Metaverse, VRChat, Postnatal Psychoprophylaxis, Maternal Health, Huancavelica*.

1. Introduction

All women and newborns should have postnatal checkups during the first six weeks of life, according to the WHO. Intimate partner violence victims must receive support, healthy lifestyles must be encouraged, illness must be avoided, and access to family planning and other sexual and reproductive health services must be guaranteed. [1].

According to the Pan American Health Organization (PAHO), there is little to no postpartum care in the first days after childbirth for every 3 women and 10 babies, which is a critical timeframe for risk of death for both mothers and infants. During the postpartum timeframe, mothers can suffer the physical effects of pain and distress from childbirth that can be uncomfortable and disabling, but if women access the much-needed care, these same symptoms can be treated without concerns [2]. In Peru, the ENDES 2019-2020 identified that maternal age and complications during childbirth are related to the occurrence of postpartum complications, while educational level and marital status act as factors that decrease the probability of presenting them [3].

The postnatal period is defined as a stage that spans from the birth of the baby to the first 6 weeks, a time that is very important for women, the newborn, and other family members [4]. It is worth emphasizing that continuous postpartum care benefits mothers with mild or moderate depression by offering them support, guidance, and reassurance in the face of pregnancy symptoms [5].

The presence of insomnia and poor sleep quality after childbirth, as opposed to sleep patterns during pregnancy, is associated with an increase in symptoms of depression and anxiety in the first six months postpartum [6]. This finding highlights the need to strengthen postnatal programs, including both physical care and emotional support for mothers.

En contraste, se presenta el metaverso, que comprende un conjunto de tecnologías digitales que facilitan la interacción entre usuarios a través de avatares, destacando por su enfoque en la inmersión, el uso de computación avanzada, la socialización y la descentralización [7]. This technology is accelerating quickly in the health field, particularly in medical interventions, health services and diagnostic imaging, the latter of which is one of its primary applications [8].

To make postnatal psychoprophylaxis more accessible to new generations, it's essential to adapt it to current, immersive technologies, creating campaigns that appeal to young

audiences. Generation Z presents influential and defining characteristics for all areas of education that require and warrant adaptable instructional models and methodologies that incorporate technology and interactive learning, factors that engage with them to align with their lifestyle characterized by social engagement and digital living [9]. In this sense, new educational technologies improve teaching and self-learning by offering virtual tools that strengthen knowledge and critical thinking [10].

The aim of this study was to create an engaging virtual setting in VRChat located in Huancavelica, designed to facilitate education on postnatal psychoprophylaxis in a novel and immersive manner that aligns with contemporary generations. The work is divided as follows: the second part will address the literature review, the third will focus on the methodology, the fourth on the tools used, the fifth on the development and implementation of the scenario in the metaverse, the sixth on the results, and the last will discuss and conclude.

2. Literature Review

The following section focuses on analyzing and presenting the various previous studies related to the topic of this research and understanding the current state of the issue. These studies aimed to identify the main contributions and existing gaps in the field, which will justify the development of this work. The following articles focus on the application of virtual reality as a way to help manage pain, anxiety, and provide maternal psychological support.

The authors [11] described that the focus of this study was related to the adverse effects of anxiety on pregnant women and their fetuses because this anxiety can actually distort electronic fetal monitoring frequency, prolong the first stage of labor, and impede the physiological events that take place at birth. The objective of this research study was to study how both virtual reality and music therapy interventions will affect the anxiety levels and the physiological states of pregnant women during the third trimester, labor, and delivery. The authors utilized a randomized controlled trial to enroll 343 full-term pregnant women in Australia and New Zealand who were randomly assigned to one of three groups: a music therapy intervention group, a virtual reality intervention group, and a control group.

The interventions were tested 1) during a non-stress test in the third trimester and 2) during labor. The results demonstrated that the two intervention groups demonstrated lower anxiety levels, lower blood pressures, and lower maternal heart rates after the tests, while the fetuses also had improved reactivity over the control group. The results of both interventions showed to be effective in reducing anxiety levels and increasing maternal and fetal physiological parameters, thus indicating their usefulness in other aspects of perinatal care.

The authors' study [12] considered perinatal loss to be a traumatic experience for women that impacted their mental health, emphasizing the need for adequate psychological support and the limited scope of interventions. The aim of the study was to present a controlled trial evaluating a virtual reality intervention for mothers who had experienced loss. The methodological approach involved a number of sessions, where participants were randomized to receive either a more or less intense form of virtual reality treatment. The hypothesized results suggested that there would be a large reduction in depression and global psychopathy in the group receiving the larger treatment type. The study concluded that, in comparison to usual care, the virtual reality intervention significantly reduced indicators of grief, postnatal depression, and psychological distress among women who experienced perinatal loss.

Furthermore, the authors [13] mentioned that a considerable number of pregnant women experience high levels of anxiety, which compromises their emotional well-being and fetal development, and sparked the need for alternatives to anxiety management away from medication. The study aimed to evaluate the effects of virtual reality as a potential anxiolytic with pregnant women during routine intrapartum non-stress testing. The study included 286 participants, who were divided into a control and experimental group, with the experimental group receiving a 20-minute experience of relaxing 3-dimensional environments in specialized glasses. The authors, in fact, demonstrated a clinically significant decrease in anxiolytic scores (decreased subjective rating of anxiety), as well as a normalization in physiological parameters, such as blood pressure and heart rate, in virtual reality exposure when compared to the control group. The study concluded that virtual reality is an exciting, low-cost, and non-intrusive platform that can be integrated into practice as a non-pharmacologic resource for anxiety management in the clinical setting, where maternal-centered care is important and feasible.

In the same way, the same authors [14] concluded that bonding between the mother and fetus is crucial for the future mother-child relationship, and that the provision of more realistic images of the fetus could reinforce bonding. Their objective was to explore how fetal images obtained through ultrasound and subsequently supplemented with VR content affected fetal-maternal interaction and depressive symptoms during pregnancy. A randomized controlled trial was conducted, including 80 pregnant women, randomly assigned to two groups: one group (control) received only a prenatal coaching application, while the other group received fetal images with a VR overlay. The VR group had significantly higher scores on fetal-maternal interaction and on depressive symptoms. The authors concluded that virtual reality may be a beneficial practice for augmenting fetal-maternal bonding and maternal mental health practice.

On the other hand, [15] addressed the topic of pain and anxiety during labor, as traditional treatment options are designed to be pharmacological and are not always effective. The purpose of their study was to converge evidence of the efficacy of virtual reality for pain and anxiety treatment, as well as to explore the subjective experience of patients. The methodology was an integrative review of 13 studies, including randomized clinical trials, qualitative studies, and mixed studies chosen from a systematic database search. Their results indicated that patients consistently reported that virtual reality reduced pain, promoted relaxation, and enhanced control of their feelings in childbirth. The authors concluded that virtual reality is an encouraging, patient-centered, and non-pharmacological variant of treatment, but is still in need of further research for clinical uptake.

Nevertheless, the authors identified that, although the number of studies on virtual reality in pregnancy has increased, the body of evidence in the postpartum period, particularly supporting parents for the postpartum experience, was limited. Therefore, the objective of this study was to examine the state of knowledge regarding the application of Virtual Reality (VR) to support parents through pregnancy, childbirth, and the first year after birth. An exploratory review was completed with 251 studies documented in the search. A total of 10 studies met the inclusion criteria for further evaluation. The 10 studies were examined based on design and intervention characteristics, and the published outcomes. The findings indicated VR was effective in pain relief, anxiety, and depression, and improved satisfaction with childbirth, as well as many other positive outcomes. The study concluded that the use of VR has the potential to serve as a psychological and physiological support tool for parents, and further exploration of VR beyond the postpartum period was recommended.

Similar to this, the issue was that anxiety during pregnancy is common in pregnant women and can have a detrimental impact on both the fetus's and the pregnant woman's health. Finding out how virtual reality affected pregnant women's anxiety levels at term and the mother's and fetus's physiological parameters during the Non-Stress Test (NST) was the primary goal of this study. The methodology used was a clinical trial with 286 pregnant women; the virtual reality group received 20 minutes of 3D stimuli during the NST. Anxiety and physiological parameters were measured. The results showed that the VR group presented lower total, state, and trait anxiety than the control group, in addition to reductions in blood pressure and heart rate. It was concluded that virtual reality reduces anxiety and improves the physiological health of pregnant women, and is a safe and easy-to-implement technique within the healthcare system.

The authors [16] addressed the problem that pregnant and postpartum women are at high risk of depression and mental health problems, facing barriers to accessing traditional care. The aim of this research was to analyze the effectiveness of telemedicine interventions (apps, websites, telephone, etc.) in reducing mental health problems in these women. An examination of randomized controlled studies was conducted that included expectant mothers or those with babies (up to one year old), who participated in a telehealth intervention (incorporating applications, messaging, or phone calls) aimed at addressing or mitigating mental health issues. The search was conducted in several databases following the PRISMA guidelines. The results showed that, of 44 studies, 62% demonstrated significant improvements, especially with online cognitive-behavioral therapy and peer support; preventive interventions were the most effective, although anxiety showed little improvement. It was concluded that telemedicine interventions are effective, but they must be tailored to each specific mental health problem; further research is needed, particularly on anxiety.

Similarly, according to [17], the problem addressed by this research was the lack of solid evidence on the effectiveness and safety of Virtual Reality (VR) in supporting parents during and after childbirth, limiting its use in clinical practice. The objective of this research was to examine the fact that while VR is widely used in healthcare and has shown utility during pregnancy and childbirth, studies on its use in the postpartum period were lacking. The methodology involved reviewing research that applied VR during childbirth and the first postpartum year; of 251 studies, only 10 met the inclusion criteria, and their characteristics and results were analyzed. The findings showed that VR was effective in reducing depression, anxiety, and pain, and improving satisfaction with childbirth; all studies reported positive experiences. It was concluded that VR is effective in both physical and psychological aspects and is emerging as an accessible tool for improving maternal and infant health.

Finally, the authors [18] identified postpartum depression and anxiety as common problems exacerbated by the pandemic, making treatment more difficult and affecting both mothers and babies. This study aimed to determine whether an intervention combining virtual reality, yoga, and mindfulness could reduce these symptoms in postpartum women. To this end, they conducted a group study with 90 women, using VR sessions and measuring symptoms, cortisol levels, and cognitive function, with a 4-week follow-up. The results showed that the intervention, including VR, was more effective, improving symptoms in the study population along with cortisol levels and cognitive abilities, with lasting effects. It was concluded that combining VR with traditional therapeutic interventions has proven to be effective and accessible for improving the mental health of mothers in this context.

Previous evidence suggests that virtual reality can be a valuable tool for women going through the prenatal, delivery, and postpartum periods. Results from these applications have shown consistent and promising effects. However, previous

research has not focused on developing an immersive virtual environment that promotes postnatal psychoprophylaxis practices, which are crucial and should not be overlooked.

3. Methodology

In conducting this study, a supportive setting for psychoprophylaxis within the VRChat metaverse was utilized, employing a cost-free approach segmented into four essential stages that facilitated its successful advancement.

3.1. Research and Planning

An investigation was carried out to define the purpose of the development of the virtual environment for postnatal psychoprophylaxis to help mothers, as well as the place where it will be developed, for which the Bing Maps tool was used.

3.2. Integration and Programming

Once the 3D designs were obtained, they were exported to Unity to be configured with the characteristics defined in the project objective. The system logic was also developed to ensure interactivity and synchronization with VRChat.

3.3. Tests and Adjustments

To ensure compatibility with various systems, tests and adjustments were made both for virtual environments using Meta Quest glasses and in desktop mode using a PC.

3.4. Final Implementation and Launch

The virtual reality environment developed in Unity, along with the avatars, was uploaded to a VRChat world available to all users and accessible from Meta Quest and PC. As part of the launch, and to ensure an excellent user experience, support and updates based on feedback are planned.

4. Tools

4.1. Blender

Blender is a software for creating 3D graphics, allowing 2D and 3D animation, and containing tools for texturing, rendering, and video processing [19]. It is a versatile and robust tool for creating 3D models and animations, compatible with multiple platforms and user-friendly [20].

4.2. Unity

Unity is a multi-platform compatible graphics development engine that allows collaboration within the environment, contains physics systems that allow collisions between objects and particles that combine visual effects to create an immersive experience [21].

4.3. VRChat

It is a platform for virtual reality that enables real-time engagement among numerous users located globally. It works with various devices, including VR headsets, smartphones, and PCs. Additionally, it offers tools for users to build their own virtual worlds through a development kit [22].

4.4. Autodesk Fusion

It is a software that includes tools for the design of 3D models, machined and high-quality parts, allows modeling of complex shapes, geometric shapes, mesh modeling, etc., and also allows 3D printing of its generated models [23].

4.5. Creator's Companion

It is a VR Chat SDK that allows the creation of projects in Unity as well as avatars in a simple way [24].

4.6. Steam

Steam is a digital platform for distributing video games, offering digital rights management, game publishing, streaming, social networking, and more [25].

4.7. Google Earth

Google Earth promotes the development of geospatial thinking by facilitating the visualization of data and the understanding of spatial patterns and relationships [26].

5. Creation and Execution of the Situation within the Virtual World

In this section, we are going to showcase the design of the virtual psychoprophylactic environment based on the dimensions of the Plaza de Huancavelica and its respective 3D design. Figure 1 shows the dimensions of the Plaza de Huancavelica, which served as the model of the VR environment for psychoprophylaxis. The Udon Graph tool was utilized to program the sounds.

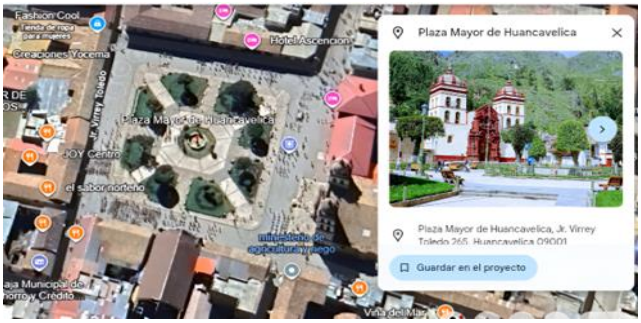

Fig. 1 Image of the Plaza de Armas of Huancavelica on Google Earth

Figure 2 shows a logic for toggling the playback of a sound: when the user interacts, it is checked whether the AudioSource is playing audio; if so, it stops (Stop), and if not, it starts playing (Play), using a condition (Branch) that evaluates the current state of the audio and executes the corresponding action on the TargetAudioSource.

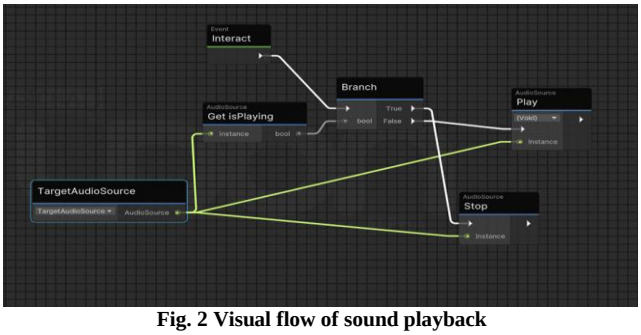

Fig. 2 Visual flow of sound playback

Figure 3 shows the VRChat SDK interface that allows you to compile the world and then publish it in the VRChat online environment, where users can access it.

Fig. 3 Compilation and publishing interface

A functional and accessible virtual environment was obtained in VRChat that integrates visual, sound, and interactive elements, recreating the Plaza de Huancavelica to offer an immersive and culturally significant experience, which facilitates education on postnatal psychoprophylaxis topics in a realistic and participatory context.

6. Results

This section describes the results of this research, conducted using the proposed methodology. A virtual environment was developed to promote postnatal psychoprophylaxis. Figure 4 shows the mother's avatar viewing the environment, which was constructed based on the main square of Huancavelica.

Fig. 4 Environment based on the Plaza de Armas of Huancavelica

Figure 5 shows 2 modules, the first a space to improve relaxation, and the second a module where the newborn is located.

Fig. 5 Postnatal psychoprophylaxis environment

Figure 6 shows the space for postnatal psychoprophylaxis, where we can see the avatar of the mother with an interactive baby.

Fig. 6 Interactive baby

Figure 7 shows a 3D element in the shape of a sphere that serves as a button to activate the audio, as well as to deactivate it.

Fig. 7 Object to activate audio in the environment

These results confirm the technical and conceptual feasibility of applying virtual environments for postnatal psychoprophylaxis, laying the groundwork for a subsequent evaluation of its effectiveness in clinical or educational contexts.

7. Discussions and Conclusions

This study successfully achieved its objective, developing an immersive virtual environment in VRChat, set in the Plaza de Huancavelica, that promotes postnatal psychoprophylaxis education in an innovative, interactive way, adapted to new generations. The result was a functional and accessible virtual space.

In contrast to other similar studies, we note that study [13] used virtual reality in the prenatal context with the unique goal of reducing pregnancy anxiety. Conversely, the present research targeted the postnatal period with a goal of psychoprophylaxis and maternal well-being in an immersive environment in the metaverse.

The authors [14] used a valid randomized controlled trial with two groups of pregnant women and only focused on assessing the effects of fetal imaging using virtual reality during pregnancy. The present research employed a free, multidisciplinary framework structured in four phases (research, integration, testing, and implementation), which allowed the entire development of a fully functional virtual environment in VRChat.

In a similar fashion, in the previous study employed traditional virtual reality to reduce postpartum anxiety and depression in controlled, individual environments. In contrast, this work employs the metaverse, which adds the dimensions of social interaction, cultural identity, and collective learning in an immersive environment in Huancavelica.

On the other hand, the authors [18] focused on demonstrating, through a clinical trial, that combining VR with mindfulness and yoga significantly reduces post-COVID depression and anxiety, providing scientific evidence of its therapeutic efficacy. In contrast, the present research focused on developing a world within the metaverse to promote postnatal psychoprophylaxis, highlighting its technological innovation and educational potential.

As for limitations, this study consisted of developing a virtual environment to promote and disseminate postnatal psychoprophylaxis, so only internal testing was performed in order to verify that the environment functioned. The resultant functional environment was not tested with external participants. In addition, virtual reality headsets are needed to enhance the immersive and engaging experience of the virtual environment. As the authors [27] state, virtual reality headsets as well as immersive environments increase the user's feeling of presence and control over the environment, thus increasing user (client) involvement, emotional connection, and level of engagement with the content.

In summary, the methodology used was instrumental in facilitating access to the environments of postnatal psychoprophylaxis. It enabled testing of compatibility on multiple devices, in addition to accommodating postnatal conditions and adaptation activities, to prepare mothers for their postnatal experiences. The VR environment offers a range of activities beyond those provided within the first weeks to help mothers engage with their babies. It enables mothers to take role-playing first-person simulations and other relaxing activities.

In conclusion, notwithstanding the current limitations, it is hopeful that future research can gather exhaustive tests with participants in controlled conditions in order to assess the impact and satisfaction of the virtual environment; similarly, to complement what has already been considered in previous modules or activities.

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