



The Use of Virtual Reality as an Education Tool for Pregnant Women: A Systematic Review

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Abstract. Objective: To know the benefits of using Virtual Reality as an education tool for pregnant women. **Methods:** Using four search tools with inclusion and exclusion criteria in electronic databases of PubMed, Scopus, Google Scholar, and SINTA. All the collected full texts were screened systematically using a PRISMA flowchart. **Results:** Based on the research results from 12 of the 19.148 articles selected, it was found that VR has been used in various fields, especially for education. **Conclusion:** The use of VR is beneficial for mothers, as training and simulations increase understanding in helping to reduce risks, pain, and anxiety during childbirth and adverse events.

Keywords: Virtual reality, Education, Maternal

1 Introduction

Mother's preparation during pregnancy is essential until the mother gives birth. Human health depends on the mother's condition, especially nutrition during pregnancy [1]. Variations in embryonic development, which are neurobehavioral, can lead to variations in pregnancy outcomes and differences in the health of the newborn or later in life [2]. The number of births in Indonesia is estimated to reach 47,125,000 in 2021. This number is decreasing compared to the number of births in 2020 [3].

In addition, the global community adopted a set of 17 Sustainable Development Goals (SDGs) on September 25, 2015, which aims to provide benchmarks as global development targets between 2015 and 2030. These targets are intended to build momentum and enthusiasm for the Millennium Development Goals (MDGs) and reframe the environmental and social challenges within the goal of achieving further global sustainable development. We are undertaking the global strategy for women, children, and youth health 2016-2030, which further aims to discuss maternal mortality in a series of programs to improve women's and children's health globally [4],[5].

The secondary target of MDG 5, taken in 2005, calls for universal access to reproductive health care with sub-targets aimed at contraceptive prevalence, teenage pregnancy, antenatal care coverage, and family planning services, but not prioritizing other reproductive health services for trained midwives, delivery in a facility, or social care services. Due to the delay in developing access to reproductive health in the MDGs'

agenda, the related data collection system requires time to mature, so this problem has not been specifically related to the maternal aspect. For this reason, SDG 3.7 continues to aim for universal access to sexual and reproductive health services by 2030 [4].

Human health depends on the mother's condition and nutrition during pregnancy [1]. In neurobehavior, variations in embryonic development can lead to variations in pregnancy outcomes and differences in the newborn's health or health later in life [2]. The development of applications that provide three-dimensional (3D) further enhances ultrasound imaging in the first trimester by enhancing the visualization of fetal structures [6].

Enhanced visualization can be achieved using virtual reality (VR) displays [6]. VR is one of the new technologies that can bring someone into the virtual world. VR has helped significantly in recent years in terms of cost, quality, and accessibility of devices, as well as providing new applications in the medical field [7]. Users can engage in immersive technology experiences through a combination of technologies in which head-mounted displays, headphones, joysticks, or other devices are manipulated into a virtual environment [8]. VR provides potential results through increased knowledge and self-efficacy and can be used in person or online [9],[10]. Therefore, the authors want to know the benefits of using virtual reality to educate pregnant women.

2 Methods

Presenting study finding the preferred reporting items for systematic reviews by PRISMA checklist was used and handled by a discussion with two authors.

2.1 Data sources and search strategy

A systematic search was conducted utilizing electronic databases such as PubMed, Scopus, Google Scholar, and SINTA to find relevant published articles on virtual reality as education for pregnant women. It is regarded as preparation education for pregnant women regarding maternal and birth preparation.

The most recent article search was conducted in December 2021. The population, Intervention, Comparison, and Outcomes (PICO) setting paradigm was used to establish article eligibility. The Participant (P) refers to pregnant women, the Intervention (I) was virtual reality, the Comparison (C) was n/a, and the Outcome (O) was pregnancy preparation education.

The keywords used during the search for relevant articles in combination or separately were: "maternal" and "ibu hamil." The keyword used for the exploration of Intervention was "virtual reality." The keywords used for outcome were "hasil" and "outcome".

2.2 Eligibility criteria

All articles on the preparation education for pregnant women as prepared for their maternal and birth were included, as well as those reporting on the impact of using virtual

reality for their maternal and birth. Studies were included irrespective of study design or setting. There were restrictions on the year of publication and language. The inclusion and exclusion criteria for papers are presented in Table 1.

Table 1. Inclusion and exclusion criteria for papers

Inclusion criteria	Exclusion criteria
- Population: Pregnant women	- Publication before 2011
- Intervention: virtual reality	- Besides Bahasa and English
- Primary outcome measure: preparation education for pregnant women	- Mothers who use virtual reality are not pregnant or not giving birth
- Publication years: 2011-2021	- Outcomes other than the description of use, purpose of use, and results of utilization
- Location: Any	
- Language: Bahasa and English	
- Study design: Any	

2.3 Exclusion criteria

Articles were excluded if they were reported on publication before 2011. Besides Bahasa and English, mothers who use virtual reality are not pregnant or not giving birth, and outcomes are other than the description of use, purpose, and utilization results.

2.4 Screening of articles

The original search results were saved in the Mendeley reference management. Duplicates were deleted, and the remaining articles were separately screened using the title and abstract criteria. The screening of articles was done independently, and the research that was agreed upon was included in the full-text review. Disagreement was resolved through discussion. Independent full-text reviews of eligible publications were conducted collaboratively, followed by analysis of the complete texts of all relevant articles that matched the inclusion criteria.

2.5 Data extraction

Data extraction consisted of the author, year, literature type, important conclusion, and database resources, as shown in Table 2.

Table 2. Data Extraction for Included Studies

Authors	Year	Method	Important Conclusion	Database Resources
Ebrahimian <i>et al.</i> [11]	2020	Randomized controlled trial	The effects of watching VR videos and chewing gum help a satisfying delivery experience.	Google Scholar
Riska <i>et al.</i> [8]	2019	Quasi-experimental	VR showed a decrease in anxiety from the results of the pregnancy-related anxiety questionnaire (PRA-Q) anxiety score.	SINTA

Setiawan <i>et al.</i> [12]	2019	Prospective cohort	Pregnancy training helps by using virtual reality.	Google Scholar
Wu <i>et al.</i> [13]	2020	Randomized controlled trial	The use of VR helps reduce anxiety and pain in epidural analgesics.	Google Scholar
Noben <i>et al.</i> [14]	2019	Randomized controlled trial	The PCQ questionnaire showed a significant improvement in the VR group without a history of emergency cesarean section.	PubMed
Hajesmaeel-Gohari, <i>et al.</i> [15]	2021	Scoping review	Various studies show that using VR has many benefits, such as reducing anxiety and childbirth pain.	Scopus
Pietersma, <i>et al.</i> [6]	2020	Randomized controlled trial	Pregnant women in the early trimester who assisted in interpretation with 3D VR ultrasound are found to help improve their quality of life.	Scopus
Parisi, <i>et al.</i> [1]	2017	Rotterdam periconception cohort	Evaluation of embryo development was assisted using 3D US with VR visualization to provide accurate first-trimester results.	PubMed
Melcer, <i>et al.</i> [16]	2019	Randomized controlled trial	VR as a distraction tool during amniocentesis in pregnant women reduces the use of drugs.	PubMed
Koning <i>et al.</i> [17]	2016	Rotterdam periconception cohort	Measurement of head volume growth compared to head circumference using VR gives more accurate results over time.	PubMed
Oostingh <i>et al.</i> [18]	2018	Rotterdam periconception cohort	VR is used as a measurement of embryo growth and development.	PubMed
Dijk <i>et al.</i> [19]	2018	Prospective cohort	This research uses VR to see embryo development.	PubMed

3 Results

An initial database search yielded 19,148 articles, PubMed (18), Scopus (2), Google Scholar (19,126), and SINTA (2), as viewed in Fig. 3, a. Following initial screening by title and abstract, a full-text review was performed on thirteen articles for the final analysis, which met the inclusion criteria as shown in the PRISMA flow chart Fig. 1. Of the twelve studies, one was from China and Israel, two from Iran, two from Indonesia, and six from the Netherlands, as seen in Fig. 2, b. There are five cohorts [1], [12], [17], [18], [19], five randomized controlled trials (RCT) [6], [11], [13], [14], [16], one scoping review [15], and one quasi-experimental [8], as viewed in Fig. 3, b. The studies had a follow-up period ranging from up to 10 years, with 8% of studies published in 2016 and the most published in 2019, as viewed in Fig. 2, a. One study assessed helping the delivery of mother [11], one assessed the exercise for pregnant woman [12], four assessed decreasing pain and anxiety [8], [13], [14], [15], and six assessed the development of embryo [1], [6], [16], [17], [18], [19].

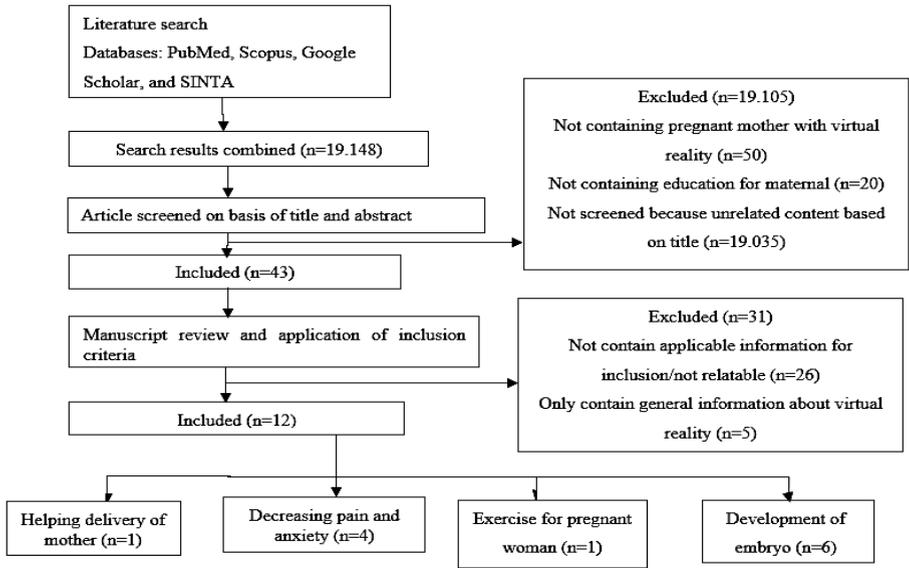


Fig. 1. PRISMA Flowchart Showing Study Selection

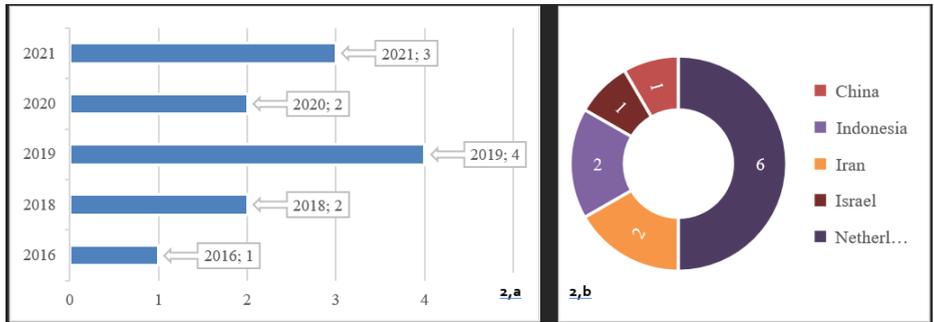


Fig. 2.a. Publication Year, and 2. b. Country's Research

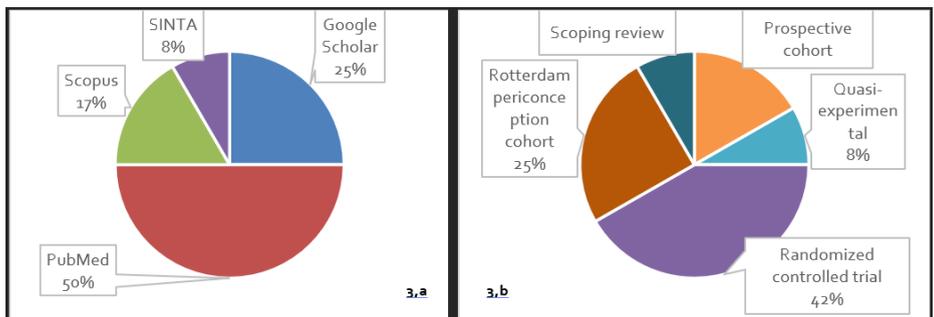


Fig. 3.a. Database Source, and 3. b. Study Type

4 DISCUSSION

4.1 Pregnancy

Pregnancy is a process that affects many aspects of physiological and psychological changes in a mother. Pregnancy is a complex event with significant psychological and social changes, especially for mothers who are pregnant for the first time [8].

The study results showed a normal average weight gain from 22.0 to 36.8 pounds during pregnancy. Blood volume during pregnancy and plasma increases around the sixth week. Some women have symptoms during pregnancy. From 10 to 25 percent of women continue to experience symptoms by 20 to 22 weeks of gestation. Increased sleep disturbances may occur and are followed by significant changes in sleep patterns up to the postnatal period. Nausea and vomiting are complications during pregnancy in up to 70% of cases [20].

During the pregnancy process, anxiety often occurs due to thoughts about the state of the baby's condition, the health and normality of the baby, the appearance of the mother, and things that might happen after giving birth [8].

4.2 Labor

Labor is a physiological mechanism by which the fetus leaves the uterus, defined by regular uterine contractions accompanied by thinning of the cervix and dilatation [21]. Normal delivery is the mechanism of spontaneous expulsion of the fetus at term (37 to 42 weeks) with a presentation behind the head within 18 hours, without complications to the mother or fetus [21].

4.3 Virtual reality

Virtual reality is a new technology widely used in the health sector recently and applied in various diseases [22] incredible VR capability to visualize its visual representations in detail. Users from VR visual representations 10 obtain the results of observing material objects or events. Participants can change the display to understand more deeply [23].

VR provides the user experience of being in an artificial environment from the results of the visual display and sound output through the intermediary of sensors connected to a computer or smart device. VR can provide situational awareness, clarity, interactivity, and kinesthetics of a centralized experience. VR training can also be used to increase the physical activity of the elderly. VR can visualize extraordinarily detailed visual representations [12].

Simulation techniques and tools may include, for example, high-tech VR simulators, full-scale mannequins, plastic models, instructed or standardized patients, animal or animal products, human cadavers, or screen-based simulators. This simulation modality can be applied in all types of simulation settings. SBME can be applied in various settings targeting individuals, teams, or both, but it also aims for organizational learning, such as practical changes in equipment, guidelines, or physical clinical environments

[24]. In the long term, this project aims to create a patient-specific VR delivery simulator capable of assessing the likelihood of normal and, more importantly, abnormal outcomes for individual cases before the actual event [5],[25].

4.4 The advantages of using virtual reality

Conventional educational methods currently use learning aids in learning, such as textbooks, lecture notes, simulations, and discussions. However, nowadays, teachers can use regular computer software with the help of additional instructions. VR in education and training is a methodology that can be used. VR has the advantage of visualizing clearly. VR can be used for training that requires simulations, models, and information visualization [12].

The results show increased spatial awareness (observation, color, direction) of content, curiosity, and user interest. Overall, the VR training platform is well-received by students, resulting in faster learning outcomes, better retention, increased engagement, and more informed decision-making. Cost-effectively, VR-based potential must be applied and studied for communities that do not yet have access to areas with limited resources [26].

High enthusiasm for developing VR applications can be used for training-based education in the health sector and medical training to transfer information more accurately to the users through simulation. VR application simulation, also known as PhysEx (Physical Exercise with Exergames), reduces the risk of lack of physical activity and improves cognitive function. Many studies have been conducted to measure user experience in immersive virtual environments (IVE). The IVE questionnaire consists of several components: presence, involvement, immersion, flow, usefulness, expertise, emotion, consequences of experience, assessment, and technology adoption. User experience indicators after being in cyberspace can be measured using the Simulator Sickness Questionnaire (SSQ), and technology adoption is measured using a questionnaire [12].

In Kim's research [27], from the treatment of 35 women with a family history of diabetes after routine training using mobile virtual reality, there was a significant decrease in body weight, body fat, fasting glucose, and hemoglobin A1c. Diet patterns and the promotion of a healthy lifestyle profile significantly increased.

Meanwhile, from the result of Ebrahimian research, watching videos using VR and chewing gum from three groups, it was found that the average length of the second stage was significantly smaller in the intervention group and efficacy in reducing the active postpartum period and the second phase [11].

In a trial by Wu et al., [13] 99 mothers with a VR intervention had no significant effect on maternal delivery, blood loss, and neonatal outcomes. After the administration of epidural analgesia, maternal pain and anxiety in both groups were significantly reduced by 30 minutes and with significant VR relief. However, there was no difference in side effects [13].

For the results of the study [14], there was an increase in VAS-A scores in both VR groups significant improvement in the PCQ questionnaire in the VR group without a history of emergency cesarean section. From the questionnaire, 22 women responded positively, and 19 partners.

From the research resources, the age of the research sample is at least 18 years. In the early to mid-pregnancy age as the research sample, the aim of using VR is to see the development and nutrition of pregnant women and their babies, while at the end of pregnancy until the time of preparation for delivery, virtual reality is much more effective as a diversion of anxiety and pain in facing childbirth.

4.5 Strengths and limitations

This study attempted to collate the evidence on the advantages and utilization of virtual reality for pregnant women as education. This research is the first systematic review evaluating the benefits and how to use virtual reality on pregnant women as education. Independent authors performed article screening, and authors agreed on exclusion and inclusion.

5 Conclusions

Based on a review of research data that has been carried out, the use of VR can help provide a new understanding of how VR functions can work to assist education and simulation. Settings are made as closely as possible so users feel entered into the virtual world. Then, the results of this VR simulation can provide knowledge through training to mothers with additional assistance with other tools. For now, the use of VR has been found in early to mid-pregnancy to have been widely used in the preparation of pregnant women to give birth, whereas a tool to assist in observing the development of the embryo and fetus, improve the quality of life of the mother through training. From the end of pregnancy until the time of preparation for delivery, reduce anxiety and pain during childbirth. This literature review has limited recent references related to the development of VR simulations on the direct benefits of large-scale daily use, so it has the potential to be continued at the clinical research level.

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