Review Article

The Use of Virtual Reality/Augmented Reality Applications in Breast Cancer Patients: A Nursing Perspective

Pehlivan Melike, RN, PhD
Gediz Vocational School of Health Services, Department of Medical Services and Techniques, Kutahya Health Sciences University, Kutahya, Turkiye

Correspondence: Pehlivan Melike, RN, PhD, Gediz Vocational School of Health Services, Department of Medical Services and Techniques, Kutahya Health Sciences University, Kutahya Turkiye
e-mail: melike.pehlivan@ksbu.edu.tr, pehlivanmelikee2@gmail.com

Abstract
This article explores the use of virtual reality (VR) and augmented reality (AR) technologies in breast cancer patients from a nursing perspective. During the treatment process of breast cancer, these technologies have been found to be effective in managing symptoms such as pain, anxiety, stress, and depression. VR and AR applications are utilized to enhance the quality of life for patients throughout various stages, including surgery, chemotherapy, radiotherapy, and rehabilitation. Nurses play a crucial role in the implementation of these technologies, providing essential support in patient education, motivation, and care. This review aims to demonstrate how VR and AR technologies can be integrated as an integral part of nursing care in breast cancer treatment and highlights the positive impacts of these applications on patients.

Keywords: virtual reality (VR), augmented reality (AR), breast cancer, nursing care, symptom management

Virtual and Augmented Reality Technologies

Virtual Reality (VR) is defined as the interaction between humans and a computer-simulated environment that includes computer graphics and artificial intelligence. The term VR is a combination of the word "virtual," meaning imaginary, and "reality," meaning real, two antonyms fused together (Mittal, 2020).

Essentially, this term refers to the process of simulation and the use of technologically advanced interfaces to create a simulated environment in the real world, allowing control over the senses (sight/hearing/taste/touch/smell, etc.) (Ray, 2020). Since Jaron Lanier first used the term in 1986, VR has often been described as an extension of technological devices. Rubino (2002), McCloy, and Stone (2001) defined VR as “a collection of skills and technologies that enable individuals to efficiently interact with three-dimensional (3D) computerized databases in real-time using their natural senses”.

In Augmented Reality (AR) applications, digital elements such as computer-generated sound, images, animations, and holograms are overlaid in real-time onto the environment through devices like smartphones, tablets, and virtual reality glasses, creating a new perception of reality.

This technology enriches the environment with technological images, allowing objects and phenomena that cannot physically exist under normal conditions to be perceived virtually in the real world (Ha & Hong, 2016; Muthuseshan, 2021; Bingöl, 2018).

These technologies include various hardware components that enable users to immerse themselves in the created virtual world and experience an engaging experience. These include head-mounted displays (HMDs) with stereoscopic features, tracking sensors/reflectors like leap motion or Helsinki designed to provide the most realistic VR/AR experience, headphones used to ensure audio sources in 3D space, data gloves, and game controllers as input devices (Revathi, Swettha & Rajalakshmi, 2020).

The Use of Virtual Reality/Augmented Reality Applications in Breast Cancer Patients

According to the 2022 data from the International Agency for Research on Cancer (IARC, 2022), it is observed that there are approximately 19 million cancer patients worldwide. Analyzing the global situation, breast cancer is identified as the most frequently encountered cancer, with an incidence rate of 11.7%, and this number is expected to increase further in the coming years. The latest technological developments and the application of modern technology in the health sector offer new non-invasive approaches for managing cancer-related symptoms, providing significant new benefits (Chirico et al, 2016; Zeng et al, 2019).

VR/AR technology-based applications can be defined as a distraction intervention capable of alleviating symptoms such as pain, stress, anxiety, depression, fatigue, and nausea (Menekli, Yaprak & Doğan, 2022). Many studies have shown that these technological applications can play an important role in patient education (van der Kruk et al, 2022), empowerment, managing treatment side effects, managing cancer-related symptoms (Chirico et al, 2020; Bani Mohammad & Ahmad, 2019), rehabilitation (Bu et al, 2022), and psychiatric disorders (Cieślik et al, 2020). Based on this information, the preferred VR/AR applications for breast cancer patients have been examined below in terms of diagnosis, screening, treatment, and rehabilitation stages.

Table 1. Evaluation of VR/AR Technology Applications and Their Positive Effects in Breast Cancer Patients (Dutucu, Ozdilek & Acar, 2022; Karaman & Tasdemir, 2021; Schneider et al., 2003; Ashley Verzwyvelt et al., 2021; Chirico et al., 2020; Jimenez et al., 2018; Horesh et al., 2022; Reynolds et al., 2022; Zhou et al., 2021; Feyzioglu et al., 2020; Atef et al., 2020)

Stage	Intervention	Expected Positive Effects of VR/AR Technologies
Screening Stage	Watching VR-supported videos during mammography	- Pain, anxiety
Diagnosis Stage	Watching VR-supported videos during biopsy	- Pain, anxiety
Treatment Stage	Tumor localization using AR technology during breast cancer surgery	- Tumor visualization, pain, anxiety, bleeding at the surgical site, quality of life
	Watching VR-supported videos during chemotherapy	- Treatment-related symptoms, anxiety
	Transforming the chemotherapy infusion room into a biophilic area using VR applications	- Pain, stress, heart rate, blood pressure, salivary cortisol levels
	Watching VR-supported videos during chemotherapy	- Anxiety, depression, fatigue
	VR-supported patient education before radiotherapy	- Patient knowledge level, anxiety
Follow-up Stage	AI-based VR mobile psychological intervention using elements of cognitive-behavioral therapy and mindfulness-based stress reduction	- Hot flashes, stress, general psychiatric distress, quality of life, sleep disorders, disease perception, satisfaction level
	Home-based VR intervention for metastatic breast cancer patients	- Physical and psychological well-being, quality of life
Rehabilitation Stage	Upper extremity rehabilitation using VR after breast cancer surgery	- Motivation for movement
	Xbox 360 Kinect-based VR application after breast cancer surgery	- Pain, range of motion (ROM), muscle strength, functionality, fear of movement, motivation

Stage	Intervention	Expected Positive Effects of VR/AR Technologies
	VR-based exercises and proprioceptive neuromuscular facilitation techniques for post-mastectomy lymphedema	- Motivation for movement

Utilization of VR and AR Technologies in Nursing Care for Breast Cancer Screening and Diagnosis

Breast cancer screening and diagnosis involve the use of various screening methods (e.g., ultrasound, MRI), medical history, physical examination, diagnostic radiological methods, and biopsy techniques. These stages can induce stress in women due to the uncertainties associated with the disease, and procedures like biopsies may cause pain and discomfort (Republic of Turkey Ministry of Health, 2020). In nursing care, managing these stages and ensuring patient comfort are of critical importance. The literature highlights that pain from mammography adversely affects women's willingness to participate in subsequent screenings, emphasizing the need for effective pain reduction interventions during mammography (Whelehan et al, 2013). In this context, nurses can utilize VR/AR technologies as distraction methods during the screening and diagnostic process. For instance, virtual reality (VR) applications can be effective tools for reducing pain and anxiety during procedures such as mammography and biopsies (Dutucu, Özdilek & Acar, 2022; Karaman & Taşdemir, 2021). Dutucu et. al. (2022), examined the impact of VR on pain and anxiety during mammography. Patients in the experimental group were given VR headsets before the mammography procedure and watched a nature walk video with accompanying music. This VR application continued throughout the 20-minute mammography session, and the results indicated that VR reduced the perception of pain. Another study evaluated the effects of VR applications on pain and anxiety levels in patients undergoing breast biopsy. In this study, patients in the experimental group were shown a video titled “A Walk on the Beach” with background music, starting 1 minute before the biopsy and continuing throughout the average 4-5 minute procedure. The results showed that the average pain and state anxiety scores in 30 women undergoing fine needle aspiration biopsy were significantly lower compared to the control group (Karaman & Taşdemir, 2021). Additionally, VR/AR technologies can be used in nursing education for biopsy techniques employed during the diagnostic phase. A study testing a VR application designed for breast biopsy intervention highlighted the benefits of such technology. The application offered realistic training by incorporating haptic devices, collision techniques providing feedback when the needle touched, and color and lighting systems to enhance clinical skills. Torres et. al. (2012), reported that advancements in these technologies have led to significant improvements in clinical training.

Utilization of VR and AR Technologies in Nursing Care for Breast Cancer Treatment and Management

Breast cancer treatment can be categorized into surgical, systemic, and radiotherapy approaches (Republic of Turkey Ministry of Health, 2020). The literature includes various studies on the utilization of VR/AR technologies in nursing care during these three treatment phases. In the surgical phase, VR/AR technologies facilitate 3D modeling to accurately locate the tumor (Gouveia et al, 2021). During the systemic treatment phase, these technologies can be employed in nursing interventions to alleviate the side effects of chemotherapy, including anxiety, pain, fatigue, and depression (Ashley Verzwyvelt et al, 2021; Schneider et al, 2003; Chirico et al, 2020). In the radiotherapy phase, VR/AR is used in nursing education to aid patients in understanding their treatment (Jimenez et al, 2018).

A study conducted in Portugal investigated the role of augmented reality (AR) technology in surgical procedures. For a 57-year-old woman, tumor localization was determined preoperatively using imaging, and during surgery, an AR-synchronized phantom model was projected. The use of this AR application improved tumor localization in conservative surgery and reduced surgical risks such as

pain, anxiety, and bleeding (Gouveia et al., 2021). Another study evaluating the effectiveness of virtual reality (VR) technology in surgical planning for breast cancer patients explored the use of 3D VR technology. The study reported that a VR software platform, reconstructed from magnetic resonance imaging (MRI) data, improved surgical planning by enhancing the visualization of tumors, lymph nodes, blood vessels, and surrounding tissues. The research involved a 36-year-old woman undergoing breast-conserving mastectomy and tissue expander reconstruction, finding that incorporating VR technology into preoperative assessments improved surgical planning and oncoplastic tissue arrangements, thereby increasing surgical accuracy and reducing risks (De la Cruz-Ku et al., 2023). Sommer et al. (2024) assessed the feasibility and effectiveness of VR in reducing preoperative anxiety and distress by simulating the operating room environment and anesthesia induction. Patients in the VR group experienced a VR simulation of the surgery 1-2 weeks prior to the procedure, reported lower levels of distress and anxiety, and found the simulation realistic and beneficial for their preoperative preparation. The simulation also had a calming and soothing effect.

The effects of VR applications during systemic treatment processes have a direct impact on nursing care. For instance, a study examined the effects of VR distraction interventions on chemotherapy symptoms and stress in 16 female patients aged 50 and above. The use of VR during chemotherapy, facilitated by nurses through a video that blocked environmental stimuli, significantly reduced state anxiety and helped improve post-treatment symptoms. Participants expressed a desire to use VR in their subsequent chemotherapy sessions (Schneider et al, 2003). In another study, the impact of creating a biophilic environment with VR on pain and stress during chemotherapy was evaluated. The findings indicated that VR applications are safe and easily integrable into nursing care (Ashley Verzwyvelt et al, 2021). Additionally, a comparative study between VR and music therapy found that both interventions were effective in alleviating anxiety and improving mood, with VR being more effective in reducing anxiety, depression, and fatigue (Chirico et al, 2020).

The role of VR/AR technologies in patient education during the radiotherapy phase is also significant. In a study conducted in Australia, the impact of a VR-based educational tool for patient education prior to radiotherapy was assessed. This tool, used by nurses, provided detailed information about the radiotherapy process, thereby increasing patients' knowledge levels and reducing anxiety (Jimenez et al, 2018).

Utilization of VR and AR Technologies in Nursing Care for Breast Cancer Follow-Up and Rehabilitation

The follow-up and rehabilitation phases of breast cancer focus on patients' quality of life, psychiatric evaluation, and physical therapy and rehabilitation. Nursing care plays a critical role in supporting patients' physical, emotional, and social well-being throughout this process. Post-treatment complications of breast cancer can lead to physical, functional, and emotional changes that hinder individuals' ability to perform daily activities and reintegrate into social life (Republic of Turkey Ministry of Health, 2020). Today, various interventions are being conducted using virtual reality (VR) and augmented reality (AR) to rehabilitate women with breast cancer. These applications, as an integral part of nursing care, are emphasized as particularly important for preventing and treating complications such as lymphedema, which is common after surgery, as well as for improving self-esteem, quality of life, and body image (Camargo et al, 2013).

Some studies have shown that VR applications also positively affect the objective symptoms of cutaneous vasodilation, such as hot flashes experienced by women who have survived cancer. In a study conducted in the United States, a VR-based mobile psychological intervention that utilizes cognitive-behavioral therapy and mindfulness-based stress reduction elements was tested for treating hot flashes in patients with breast and ovarian cancer. As part of the study, patients in the intervention group were instructed to use the VR application twice daily (morning and evening) and whenever they experienced hot flashes, continuing the

application for 24 days. The results indicated significant reductions in the frequency of daily hot flashes, stress levels, general psychiatric distress, various domains of quality of life, and sleep difficulties, along with improvements in illness perception and high levels of satisfaction (Horesh et al, 2022).

In a study aiming to determine the benefits of home-based VR interventions for women diagnosed with metastatic breast cancer, it was found that VR experiences provided lasting benefits to the women's physical and psychological well-being. The VR interventions were designed as interfaces that patients could easily use in their homes. This sustainable and easy-to-implement VR intervention in the home environment is noted as a new approach to improving the quality of life for a patient population often overlooked after the treatment process (Reynolds et al., 2022).

Another study evaluating the effects of VR applications on patients' psychological states invited 48 women who had undergone breast cancer treatment to read explanations of four internet-based psychotherapy methods (web chat, video conferencing, virtual reality, and avatar therapy) and then answer questions about their perceptions of these methods (e.g., useful, reassuring). The study found that participants had more positive views of technologies offering rich interaction with the therapist (virtual reality and video conferencing) (Durosini et al, 2020).

One of the most common complications in breast cancer treatment is the development of lymphedema in the affected extremity after surgery (Republic of Turkey Ministry of Health, 2020). VR/AR applications can support patients in exercising through specially designed virtual games that increase motivation. Nurses play a significant role in ensuring the applicability of these exercises and motivating patients. In a study conducted in China, the effects and feasibility of VR-based upper extremity rehabilitation exercises for breast cancer patients were tested. The exercises in the VR rehabilitation module were determined by hospital rehabilitation therapists and nurses, consisting of movements such as making a fist, elbow flexion, touching the ear, and climbing a wall. Each set of movements was completed after a certain number of repetitions, and various audio cues were provided during the exercises. In addition to the rehabilitation exercise scene in the VR interface, a puzzle game based on fruit picking in an orchard with relaxing music was also included.

The study concluded that the VR rehabilitation system was feasible and easy to learn for breast cancer patients. Participants reported that the exercises adjusted according to the condition of the affected extremity were encouraging and provided an interesting experience (Zhou et al, 2021).

The study by Wu et al. (2024) indicates that VR technology for rehabilitation after breast cancer surgery provides positive experiences for patients. Qualitative interviews with patients revealed that early interventions to prevent post-surgical lymphedema were complemented similarly to the presence of a physical therapist, and the gamified nature of the VR system was found to be particularly engaging during the early rehabilitation phase. Similar patient feedback was reported in the study by Zhang et al. (2022).

Another study evaluated the potential effects of an Xbox 360 Kinect-based virtual reality application on pain, range of motion (ROM), muscle strength, functionality, and fear of movement in patients after breast cancer surgery. The study found that patients in the virtual reality group showed significant improvement in fear of movement compared to the standard physiotherapy group. It was stated that virtual reality applications could provide more enjoyable, low-cost, and motivating programs after breast cancer surgery. Based on the study results, it was suggested that Kinect-based VR rehabilitation programs could be integrated into standard physiotherapy in the clinic or used instead of traditional physiotherapy for patients with high levels of fear of movement or severe pain after breast cancer surgery (Feyzioğlu et al, 2020).

Similarly, a study conducted in Egypt reported that VR-based exercises and proprioceptive neuromuscular facilitation provided therapeutic advantages and superior benefits in motivating patients for lymphedema after mastectomy. Nurses play a crucial role in implementing these

interventions by guiding and motivating patients, thus contributing to the treatment process (Atef et al, 2020).

Conclusion: The increasing accessibility and advantages of VR/AR technologies—such as their engaging, portable nature and non-invasive approach—make them frequently utilized in nursing practices. Nurses play a crucial role in the diagnosis, screening, treatment, follow-up, and rehabilitation processes of breast cancer. They can benefit from VR/AR technologies in patient education, pain management, anxiety reduction, quality of life enhancement, and rehabilitation processes. Given the rise of virtual reality technologies and fictional universes like the "Metaverse," it is anticipated that VR technologies will become increasingly prevalent in healthcare and nursing applications. Literature review indicates that studies focusing on VR/AR use in nursing care primarily center around systemic treatment and rehabilitation processes. However, there is a notable gap in research related to the use of VR/AR technologies in patient education, a fundamental nursing responsibility throughout all stages of breast cancer care. New studies utilizing VR/AR technologies for 3D visualization and enhancing patient understanding of educational content are expected to make significant contributions to the field.

References

Ashley Verzwyvelt, L., McNamara, A., Xu, X., & Stubbins, R. (2021). Effects of virtual reality v. biophilic environments on pain and distress in oncology patients: a case-crossover pilot study. Sci Rep 11, 20196. https://doi.org/10.1038/s41598-021-99763-2.

Atef, D., Elkeblawy, M. M., El-Sebaie, A., & Abouelnaga, W. A. I. (2020). A quasi-randomized clinical trial: virtual reality versus proprioceptive neuromuscular facilitation for postmastectomy lymphedema. Journal of the Egyptian National Cancer Institute, 32(1), 29. https://doi.org/10.1186/s43046-020-00041-5.

Bani Mohammad, E., & Ahmad, M. (2019). Virtual reality as a distraction technique for pain and anxiety among patients with breast cancer: a randomized control trial. Palliat Supp Care, 17(1), 29–34.

Bingöl, B. (2018). Yeni Bir Yaşam Biçimi: Artırılmış Gerçeklik (AG). Etkileşim, (1), 44-55. https://doi.org/10.32739/etkilesim.2018.1.8.

Bu, X., Ng, P. H., Xu, W., Cheng, Q., Chen, P. Q., Cheng, A. S., & Liu, X. (2022). The Effectiveness of Virtual Reality-Based Interventions in Rehabilitation Management of Breast Cancer Survivors: Systematic Review and Meta-analysis. JMIR Serious Games, 10(1), e31395. https://doi.org/10.2196/31395.

Camargo, C., Cavalheiro, G., Cardoso, A., Lamounier, E., Andrade, A. O., Mendes, I., Lima, F., & Lima, M. (2013). Virtual rehabilitation in women with post breast cancer — A case study. In 2013 International Conference on Virtual Rehabilitation (ICVR), Philadelphia, PA, USA, pp. 188-189. https://doi.org/10.1109/ICVR.2013.6662120.

Chirico, A., Lucidi, F., De Laurentiis, M., Milanese, C., Napoli, A., & Giordano, A. (2016). Virtual reality in health system: beyond entertainment. A mini-review on the efficacy of VR during cancer treatment. J Cell Physiol, 231(2), 275–287.

Chirico, A., Maiorano, P., Indovina, P., Milanese, C., Giordano, G. G., Alivernini, F., Iodice, G., Gallo, L., De Pietro, G., Lucidi, F., Botti, G., De Laurentiis, M., & Giordano, A. (2020). Virtual reality and music therapy as distraction interventions to alleviate anxiety and improve mood states in breast cancer patients during chemotherapy. Journal of Cellular Physiology, 235(6), 5353–5362. https://doi.org/10.1002/jcp.29422.

Cieślik, B., Mazurek, J., Rutkowski, S., Kiper, P., Turolla, A., & Szczepańska-Gieracha, J. (2020). Virtual reality in psychiatric disorders: a systematic review of reviews. Complement Ther Med, 52, 102480.

De la Cruz-Ku, G., Mallouh, M. P., Torres Roman, J. S., & Linshaw, D. (2023). Three-dimensional virtual reality in surgical planning for breast cancer with reconstruction. SAGE Open Medical Case Reports, 11. https://doi.org/10.1177/2050313X231179299.

Durosini, I., Triberti, S., & Pravettoni, G. (2020). Breast Cancer Survivors' Attitudes Towards Internet-Based Psychotherapy. Annual Review of Cybertherapy and Telemedicine, 201-205.

Dutucu, N., Özdilek, R., & Acar Bektaş, H. (2022). Sanal gerçekliğin mamografi sırasındaki ağrı ve anksiyeteye etkisi: Randomize kontrollü bir çalışma. Anatolian Journal of Health Research, 3(1), 1-7. http://dx.doi.org/10.29228/anatoljhr.53937.

Feyzioğlu, H., Kaya, D., & Demir, S. (2020). Is Xbox 360 Kinect-based virtual reality training as effective as standard physiotherapy in patients undergoing breast cancer surgery? Supportive Care in Cancer: Official Journal of the Multinational Association of Supportive

Care in Cancer, 28(9), 4295–4303. https://doi.org/10.1007/s00520-019-05287-x

Gouveia, P. F., Costa, J., Morgado, P., Kates, R., Pinto, D., Mavioso, C., Anacleto, J., Martinho, M., Lopes, D. S., Ferreira, A. R., Vavourakis, V., Hadjicharalambous, M., Silva, M. A., Papanikolaou, N., Alves, C., Cardoso, F., & Cardoso, M. J. (2021). Breast cancer surgery with augmented reality. Breast (Edinburgh, Scotland), 56, 14–17. https://doi.org/10.1016/j.breast.2021.01.004.

Ha, H., & Hong, J. (2016). Hanyang Med Rev, 36, 242-247. https://doi.org/10.7599/hmr.2016.36.4.242.

Horesh, D., Kohavi, S., Shilony-Nalaboff, L., Rudich, N., Greenman, D., Feuerstein, J. S., & Abbasi, M. R. (2022). Virtual Reality Combined with Artificial Intelligence (VR-AI) Reduces Hot Flashes and Improves Psychological Well-Being in Women with Breast and Ovarian Cancer: A Pilot Study. Healthcare (Basel, Switzerland), 10(11), 2261. https://doi.org/10.3390/healthcare10112261.

International Agency for Research on Cancer. (2022). Global Cancer Observatory. (Erişim tarihi: 10.06.2024), https://gco.iarc.fr/.

Jimenez, Y. A., Cumming, S., Wang, W., Stuart, K., Thwaites, D. I., & Lewis, S. J. (2018). Patient education using virtual reality increases knowledge and positive experience for breast cancer patients undergoing radiation therapy. Supp Care Cancer, 26(8), 2879–2888.

Karaman, D., & Taşdemir, N. (2021). The Effect of Using Virtual Reality During Breast Biopsy on Pain and Anxiety: A Randomized Controlled Trial. J Perianesth Nurs, 36(6), 702-705. https://doi.org/10.1016/j.jopan.2021.04.007.

Lanier, J., Zimmerman, T. G., Blanchard, C., Bryson, S., & Harvill, Y. (1987). A hand gesture interface device. Proceedings of the SIGCHI/GI conference on Human factors in computing systems and graphics interface, 189-192.

McCloy, R., & Stone, R. (2001). Science, medicine, and the future. Virtual reality in surgery. British Medical Journal, 323(7318), 912-5.

Menekli, T., Yaprak, B., & Doğan, R. (2022). Effectiveness of Virtual Reality Therapy in the Rehabilitation of Patients with Stroke: A Systematic Review and Meta-analysis. Journal of Stroke and Cerebrovascular Diseases, 31(4), 1063-1075. https://doi.org/10.1016/j.jstrokecerebrovasdis.2021.1063.

Mittal, H. (2020). Virtual Reality: An Overview. CSI Communications, 44(4), 9-10. https://www.researchgate.net/publication/343095838.

Muthuseshan, G. (2021). Augmented Reality (AR) in Healthcare. Journal of Interdisciplinary Cycle Research, 12(11), 343-359.

Ray, J. (2020). VR-not a reality but neither a hallucination nor dreaming imaginings. CSI Communications, 44(4), 10-14. https://www.researchgate.net/publication/343095838.

Revathi, A. R., Swettha, M., & Rajalakshmi, P. (2020). Virtual Reality Role in the World. CSI Communications, 44(4), 24-28. https://www.researchgate.net/publication/343095838.

Reynolds, L.M., Cavadino, A., Chin, S., Little, Z., Akroyd, A., Tennant, G., Dobson, R., Broom, R., & Gautier, A. (2022). The benefits and acceptability of virtual reality interventions for women with metastatic breast cancer in their homes; a pilot randomised trial. BMC cancer, 22(1), 360. https://doi.org/10.1186/s12885-021-09081-z.

Rubino, F., Soler, L., Marescaux, J., & Maisonneuve, H. (2002). Advances in virtual reality are wide ranging. British Medical Journal, 324(7337), 612.

Schneider, S.M., Ellis, M., Coombs, W.T., Shonkwiler, E.L., & Folsom, L.C. (2003). Virtual reality intervention for older women with breast cancer. Cyberpsychology & behavior: the impact of the Internet, multimedia and virtual reality on behavior and society, 6(3), 301–307. https://doi.org/10.1089/109493103322011605

Sommer, J.L., Reynolds, K., Hebbard, P., Smith, M.S.D., Mota, N., Mutch, W.A.C., Maples-Keller, J., Roos, L., & El-Gabalawy, R. (2024). Preoperative Virtual Reality to Expose Patients With Breast Cancer to the Operating Room Environment: Feasibility and Pilot Case Series Study. JMIR Form Res. 17;8:e46367.

Torres, R.S., Biscaro, H.H., de Araujo, V., & Nunes, F.L.S. (2012). ViMeTGame: A serious game for virtual medical training of breast biopsy. SBC Journal on 3D Interactive Systems, 3(3), 12-22.

Turkish Ministry of Health, General Directorate of Health Services, Research, Development, and Health Technology Assessment Department. (2020). Clinical Guidelines for Breast Cancer Prevention, Screening, Diagnosis, Treatment, and Follow-up. (Accessed: June 2, 2024). http://www.tmhdf.org.tr/Uploads/Editor/tc_sb_meme_kanseri_klinik_rehber.pdf

van der Kruk, S.R., Zielinski, R., MacDougall, H., Hughes-Barton, D., & Gunn, K.M. (2022). Virtual reality as a patient education tool in healthcare: A scoping review. Patient Educ Couns. 105(7):1928-1942.

Zhang, H., Xu, H., Zhang, Z., & Zhang, Q. (2022). Efficacy of virtual realitybased interventions

for patients with breast cancer symptom and rehabilitation management: a systematic review and meta-analysis. BMJ Open. 12:e051808.

Zhou, Z., Li, J., Wang, H., Luan, Z., Li, Y., & Peng, X. (2021). Upper limb rehabilitation system based on virtual reality for breast cancer patients: Development and usability study. PloS one, 16(12), e0261220. https://doi.org/10.1371/journal.pone.0261220.

Zeng, Y., Zhang, J.E., Cheng, A.S.K., Cheng, H., & Wefel, J.S. (2019). Meta-Analysis of the Efficacy of Virtual Reality-Based Interventions in Cancer-Related Symptom Management. Integrative cancer therapies, 18, 1534735419871108. https://doi.org/10.1177/1534735419871108.

Whelehan, P., Evans, A., Wells, M., & MacGillivray, S. (2013). The effect of mammography pain on repeat participation in breast cancer screening: A systematic review. Breast, 22(4), 389–394. https://doi.org/10.1016/j.breast.2013.03.003.

Wu, S.C., Chuang, C.W., Liao, W.C., Li, C.F., & Shih, H.H. (2024). Using Virtual Reality in a Rehabilitation Program for Patients With Breast Cancer: Phenomenological Study. JMIR Serious Games.16;12:e44025.