Virtual reality for physical and psychological improvement during the treatment of patients with breast cancer: Systematic review

Bryan Tito-Llana[1], Nils Riveros-Torre[1], Brian Meneses-Claudio[2,*], Monica Auccacusi-Kañahuire[2]

[1]Facultad de Ingeniería, Universidad Tecnológica del Perú, Lima, Perú
[2]Facultad de Negocios, Universidad Tecnológica del Perú, Lima, Perú

Abstract

During breast cancer treatment, patients face various physical and psychological problems. However, a promising solution has been found in the use of virtual reality as a tool to address these problems. Our goal was to identify the most common problems and symptoms during treatment, as well as investigate the effectiveness of virtual reality in addressing them. We also set out to determine if there are any disadvantages associated with using this system. To this end, we conducted a systematic review using a non-experimental, descriptive, and qualitative-quantitative approach. 20 open access articles were selected in the Scopus database, following established inclusion and exclusion criteria. The results revealed that anxiety and pain are the most common symptoms experienced during breast cancer treatment. Regarding the effectiveness of virtual reality to treat these symptoms, differences were found: a significant impact on anxiety was observed ($p < 0.001$), but no significant impact on pain was found ($p < 0.07$). In addition, only three studies mentioned the possible presence of cyberdisease as an obstacle. In conclusion, anxiety and pain are the most common symptoms during breast cancer treatment. Virtual reality shows high efficacy in managing anxiety, but its effectiveness in pain management is limited. In addition, technological advances appear to have reduced the occurrence of cyberdisease and associated drawbacks, although little information is available in the studies reviewed.

1. Introduction

Breast cancer is a disease that is seen with high frequency throughout the world. It is one of the most common types of cancer globally (1) (2). The incidence rate of breast cancer in developed regions such as Australia, New Zealand and North America is almost three times higher than the rate in developing regions such as Central and South Asia, Central Africa, and East Africa. In 2020, approximately 2.3 million new cases of breast cancer were diagnosed, representing about 11.7% of all cancers diagnosed.

These numbers reflect the high incidence of breast cancer worldwide. In addition, studies have shown that breast cancer is the fifth leading cause of cancer death worldwide, accounting for approximately 685,000 deaths. Many patients who have been diagnosed with this disease prolong their lives through different types of treatment. The types of treatment for this cancer are surgery, radiation therapy, chemotherapy, endocrine therapy, and targeted therapy. Cancer recovery or treatment involves a group of professionals from different disciplines working together

to encourage patient functioning (3) (4) (5). There is also a growing need of inclusion and gender-based studies within healthcare, coping and identity areas (6) (7) (8).

Unfortunately, during or after this process patients suffer physical and psychological symptoms, such as pain, fatigue, depression and anxiety, also functional deficits, such as cognitive impairment and reduced range of motion of the shoulder and complications such as haemorrhage, effusion, or flap necrosis. The limitations that arise due to cancer can further affect a person's ability to participate in everyday activities and have a good quality of life (9). These results are consistent with those shown by previous studies in various health disciplines (10) (11).

The management for pain and the other effects that this cancer brings has pharmacological and non-pharmacological methods. First, the pharmacological method; It involves the use of medications which can cause dry mouth, hallucinations, and myoclonic spasms. And second, the non-pharmacological method; This has two classifications: peripheral therapies; which has a cold and heat treatment, acupuncture, massage, hydrotherapy and exercise, and cognitive-behavioural therapies, such as relaxation, meditation, prayer, yoga, hypnosis, and distraction.

In recent years, a new technology came to support rehabilitation to manage the effects caused by this cancer, a technology known as virtual reality, this system has been widely used in cancer treatments, as it serves as a distraction system and this could relieve symptoms such as pain, stress, distress, worry, and other effects that make the patient uncomfortable. Several studies have approached to the importance of rehabilitation and their results are promising, although the are several question to be answered (12) (13) (14) (15) (16) (17) (18) .

Virtual reality systems now have a device that looks like glasses and are mounted on the head, or also known as HMD, these help the person see what is shown on the screen (19). They now also feature additional devices like sensors for tracking body movements, headsets, and other types of hardware like data gloves and joysticks. These systems have two categories: immersive and non-immersive. The immersive practically refers to a complete immersion, bone that excludes the patient from the light and sound of the outside, making the person only concentrate on the screen they have mounted on the head or rather on the HMD. And the non-immersive, is also characterized by having a head-mounted screen, but the person can communicate with the external world through interventions allowed through the sensors or other additional devices already mentioned.

The use of immersive or non-immersive virtual reality becomes very useful to divert the attention of patients, causing them to concentrate on the screen of the system or intervening in it, in this way, the anguish, anxiety, worry or pain decreases when those are during or after treatment for this disease (20) (21) (22) (23) (24) (25) (26) (27).

Most studies have shown that the implementation of virtual reality during breast cancer treatment can play an important role in the symptoms and side effects that this process

entails. However, the use of this technology has some drawbacks or problems that affect patients, such as cybernetic dizziness that refers to a discomfort that can occur after a few minutes of seeing the system used, causing different levels of discomfort and fear when using this system again. The weight of this technology is also presented as another drawback, causing pressure on the patient's head, causing him not to concentrate on the projected image, and thus not being able to manage the worry and the other effects that the patient entails. It is true that the use of this system helps in the treatment of breast cancer, but it also has some drawbacks (28) (29).

Increasing the level of knowledge about the obstacles currently existing in relation to the use of virtual reality would allow efforts to be directed towards improving aspects such as structure, weight or other characteristics that may impact the patient's experience when using this system, among other applications (30). By having a deeper understanding of the drawbacks that may arise, new opportunities would open to research and develop innovative solutions that effectively address the specific challenges faced by users of this technology. This continuous improvement approach seeks to optimize both the performance and comfort of virtual reality, to maximize its therapeutic potential and ensure a rewarding and safe experience for the patients involved, which is consistent with the data available in the literature (27) (31) (32).

The present study or systematic review was conducted to verify how effective the use of virtual reality is in rehabilitation during the treatment of patients with breast cancer. In addition, we will also study how much it affects the mentioned drawbacks in patients or if they are still present, since the articles studied show that this is not too clear. Therefore, the main objective of this document is to carry out a comprehensive analysis about the effectiveness of virtual reality in addressing the most common problems that arise during the breast cancer treatment process. The aim is to determine whether the application of this technology can provide significant benefits to patients and, at the same time, to identify whether problems related to its use persist in recent studies carried out in this field (27) (33).

In this sense, the content is structured as follows. Section 2, Methodology, describes the approach used to carry out the systematic review (SR), detailing from the research questions posed to the operations performed to select the material discussed in the paper. Section 3, Results, presents, and organizes findings obtained after analyzing primary studies examining the efficacy of virtual reality in breast cancer treatments. Section 4, Discussion, addresses the sources and examines the percentages or probabilities of effectiveness in implementing the virtual reality system to treat the most common symptoms. Finally, section 5, Conclusions, summarizes the main findings and suggests possible directions for future research on the topic.

2. Methodology

2.1. Description of the systematic search strategy

In the present systematic literature review, the PICO methodology was used to exhaustively search scientific articles. The PICO schema is a widely used heuristic for formulating research questions, especially in the field of clinical research. In this context, a specific research question was raised: To what extent does virtual reality improve the medical treatment of breast cancer patients? (34). As a result of the application of this methodology, a formula was developed that had a successful performance when used in the Scopus database. The scientific articles or documents obtained were carefully selected and filtered through different methods such as inclusion and exclusion. We developed the formula based on previous studies with similar purposes (35) (36) (37) (38) (39) (40) .

PICO question and its components

Table 1. PICO and its components

To what extent does virtual reality improve the medical treatment of breast cancer patients?	
P	Medical Treatment of Breast Cancer
I	Virtual reality
C	Breast cancer patients
O	Improve medical treatment

Relevant specialized keywords

We established 4 keywords that emerged from the research question:

Table 2. Keywords

Keyword (Spanish)	Keyword (English)
Medical Treatment of Breast Cancer	"Breast cancer" OR biopsy OR metastasis OR chemotherapy OR radiotherapy OR mastectomy OR lymphedema OR "mammary cancer" OR "breast carcinoma" OR "medical attention"
Virtual reality	"Virtual reality" OR "walled garden" OR avatar OR "digital twins" OR "augmented reality" OR "3D devices" OR "artificial intelligence" OR "instructional virtual" OR "virtual realities"
Breast cancer patients	Patients OR "sick people" OR affected OR sickly OR "serious health" OR infected OR indisposed OR "worn out person"
Improve medical treatment	Improvement OR empower OR recover OR "effective method" OR thrive OR "quiet therapy" OR "peaceful process"

Search equation used.

The PICO method resulted in the following formula, which was used in Scopus to search scientific documents that contribute to the research.

("breast cancer" OR biopsy OR metastasis OR chemotherapy OR radiotherapy OR mastectomy OR lymphedema OR "mammary cancer" OR "breast carcinoma" OR "medical attention") AND ("virtual reality" OR "walled garden" OR avatar OR "digital twins" OR "augmented reality" OR "3D devices" OR "artificial intelligence" OR "instructional virtual" OR "virtual realities") AND (Patients OR "sick people" OR affected OR sickly OR "serious health" OR infected OR indisposed OR "worn out person") AND (Improvement OR empower OR recover OR "effective method" OR thrive OR "quiet therapy" OR "peaceful process")

2.1.4. Definition of the inclusion and exclusion criteria for scientific articles

After the collection of information from the investigations, a critical evaluation was carried out taking into account the following points.

Inclusion criteria:

CI1. Included studies should address breast cancer treatment.

CI2. Studies should address improvements in virtual reality elements for better comfort for patients.

CI3. Studies should show efficacy of virtual reality for breast cancer treatment.

CI4. Accepted publication types are review articles.

Exclusion criteria:

CE1. Documents published before 2019.

CE2. Documents in languages other than English and Spanish

CE3. Documents such as conference paper, thesis, or non-indexed material

2.2. Description of the selection process

Results obtained from the scientific literature search process.

After carrying out the rigorous keyword search process to obtain the scientific articles that will contribute and support the research being done, we proceeded to use the formula generated from the PICO methodology. As an initial result of this application, a total of 317 documents were obtained that will be analyzed and filtered to use those that are really related to the chosen topic and achieve the objectives set.
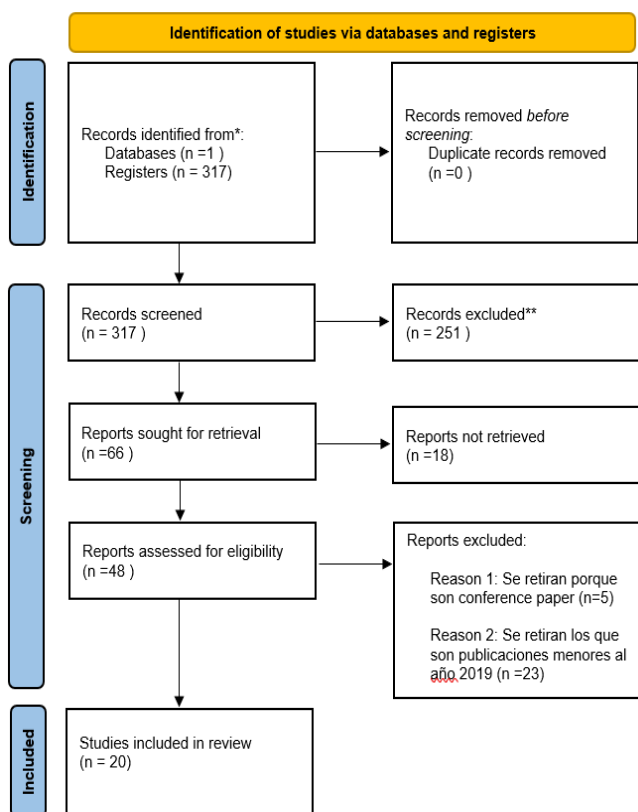
Description of the selection logic considered (PRISMA)

The process of obtaining articles or documents that provide significant value to our systematic literature review has been based on the PRISMA statement logic. The statement Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), published in 2009, was created with the purpose of making it easier for systematic reviewers to transparently report on the reasons behind a review, the procedures carried out by the authors and the results found. According to this logic, once the systematic literature search has been carried out, a series of steps are carried out to ensure the quality and relevance of the selected documents (41).

First, we proceed to remove any duplicates that may have arisen if more than one database was used during the search. Next, a review of the titles and abstracts of the papers is performed to identify those that are of interest to our research. Also, an additional filter is made to ensure that the selected documents are available in their full version, whether in PDF, HTML, or other formats.

Once a complete set of documents has been obtained, a final selection is carried out using previously established inclusion and exclusion criteria. Finally, the entire process is documented in a flowchart following the structure and guidelines provided by PRISMA. In this way, a rigorous and transparent systematic review is guaranteed, supported by a reliable methodology.

Detailed description of the steps of the selection process and their results

First, a total of 317 documents were obtained because of the search carried out exclusively in the Scopus database, without finding duplicate files. Subsequently, a filtering process was carried out in which those documents that did not present a direct relationship with the research topic were discarded, based on the reading of titles and summaries of the documents obtained in the first phase of search, which found 251 documents that had no relation to the chosen topic, and we were left with 66 documents.

Additionally, documents in which the PDF or HTML file could not be extracted because they were not available for free to users or were no longer accessible were discarded, giving a total of 18 documents without full text. As a result of this filtering stage, 48 documents remained. A series of additional exclusion criteria were also applied, such as documents that were not in Spanish or English, that were not systematic literature reviews and that their year of publication was not earlier than 2019. Where it was found that all documents were in English and Spanish, 5 were conference papers and 23 were documents that have been published before the year 2019. In this way, 28 documents were deleted.

Taking into account the aspects mentioned above, 20 documents were selected to support our systematic literature review.

Figure 1. PRISMA flowchart

3. Results

Based on the articles obtained, the precedent of these studies was analyzed, where it was obtained that most of the articles studied are from the United States with a total of 6 investigations. The high incidence of breast cancer in the United States is because it is the most common type of cancer in this country.

There is an estimated 1 in 8 women chance of developing invasive breast cancer in their lifetime. In addition, the chance of dying due to this disease is about 1 in 35 women. China ranks second with 5 investigations, in a study by Wang et al. (42) (43) (44) (45) (46) (47) (48) (49) (50) (51) (52) (53).

A summary of cancer awareness levels is provided with the aim of increasing awareness of this disease among people, as this disease is very common in people. We also have three investigations originating in Italy, along with two studies from New Zealand. In addition, four investigations with respective origins in Poland, Iran, Portugal, and Egypt are included (20) (27) (54) (55) (56) (57) (58) (59) (60) (61).

Below is a table that provides more detailed information on the number of investigations by country of origin.

Table 3. Country of origin

COUNTRY	N° REPETITIONS
Portugal	1
Iran	1
China	5
United States	6
Italy	3
New Zealand	2
Poland	1
Egypt	1

People suffering from breast cancer often mention that they experience debilitating symptoms from both the disease itself and the treatments. These symptoms can manifest both on a physical level, such as pain and fatigue, and on a psychological level, such as depression and anxiety. These symptoms can have a significant impact on quality of life and become a source of suffering and limitations (62) (63) (64) (65).

We have also done a collection of symptoms that some of the studies mention. According to Yazdipour et al, it has been observed that many breast cancer survivors experience symptoms such as pain, fatigue, depression, anxiety, and lymphedema. In a study by Hao et al., it was found that patients also experience pain, fatigue, and anxiety, all of which can limit their participation in daily activities. Reynolds et al. They found that people who undergo rehabilitation for this disease experience stress, pain, and anxiety. Sharifpour and his team reported that people experience a significant level of pain. According to Zhang et al., patients experience great distress during different treatments for this disease. According to Zhao et al., during the radiotherapy process, patients often experience anxiety and stress. Finally, Horesh and his team have highlighted that people often suffer from depression, distress, and anxiety throughout the process. Anxiety is one of the most common symptoms experienced by patients (27) (42) (44) (46) (51) (58).
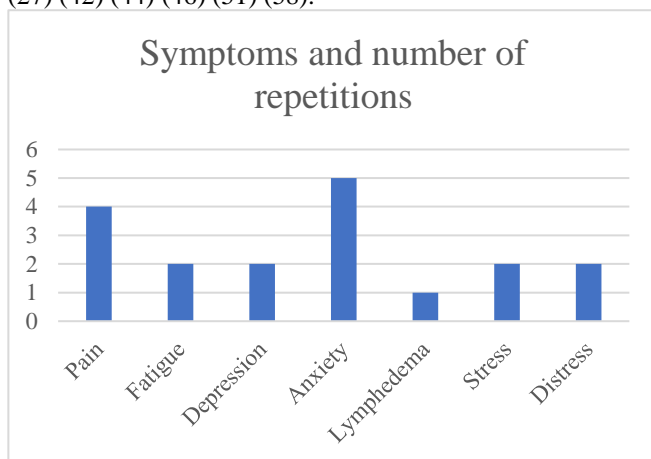

Figure 2. PRISMA flowchart

Breast cancer treatments, such as radiation therapy, chemotherapy, surgery, immunotherapy, targeted therapy, and endocrine therapy, can have adverse health effects. However, they also play a crucial role in controlling the growth and spread of cancer, as well as prolonging patients' lives.

Immunotherapy, which seeks to strengthen the immune system to fight cancer, is used in three studies. For its part, targeted therapy acts on proteins that regulate the multiplication, division and spread of cancer cells, and has also been investigated in three studies. Endocrine therapy, which blocks or removes hormones to prevent cancer growth, has been the subject of analysis in three studies. Chemotherapy, which uses drugs to kill cancer cells, is mentioned in nine studies. Surgery, which involves surgery to treat cancer and its complications, is mentioned in five studies. Radiation therapy also uses high doses of radiation to kill cancer cells and is mentioned in seven studies. In the articles reviewed, chemotherapy is the most frequently mentioned treatment, while immunotherapy, targeted therapy, and endocrine therapy are less addressed. These treatments, although with negative consequences on health, represent important tools in the fight against breast cancer, providing hope and improving the quality of life of patients (24) (27) (42) (43) (44) (46) (47) (49) (50) (52) (59) (60) (66) (67) (68) (69) (70).
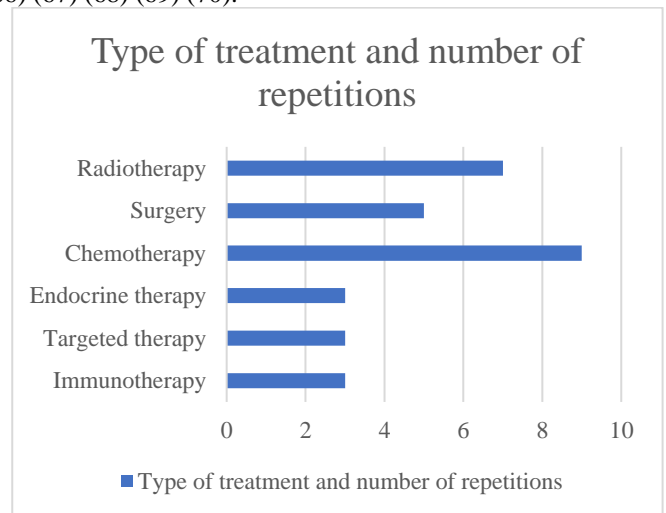

Figure 3. Types of treatment and number of repetitions

Virtual reality is an innovative method of active distraction (71) (72), it is used to cope with stressful or painful medical procedures, and there are two types of virtual reality, immersive and non-immersive. Immersive virtual reality uses accurate, real-time motion tracking devices and powerful graphics processors to generate continuous stereoscopic images on head-mounted displays (HMDs). This type of technology can provide the illusion that users are interacting with 3D objects in a virtual environment as they would in the real world, while non-immersive virtual reality only allows participants to view content based on how the device in use is held and moved. It implements the virtual scene using devices with traditional graphics, such as a large screen or a wall screen (55) (73). We conducted a count of studies that used immersive and non-immersive virtual reality to assess their efficacy in cancer treatments. We noted that 11 studies used immersive virtual reality, while only 1 study employed non-immersive virtual reality.

In addition, we found that 8 studies used both types of virtual reality. Therefore, immersive virtual reality was used in practically 19 studies, suggesting that it is the most recommended option for better results in interventions.
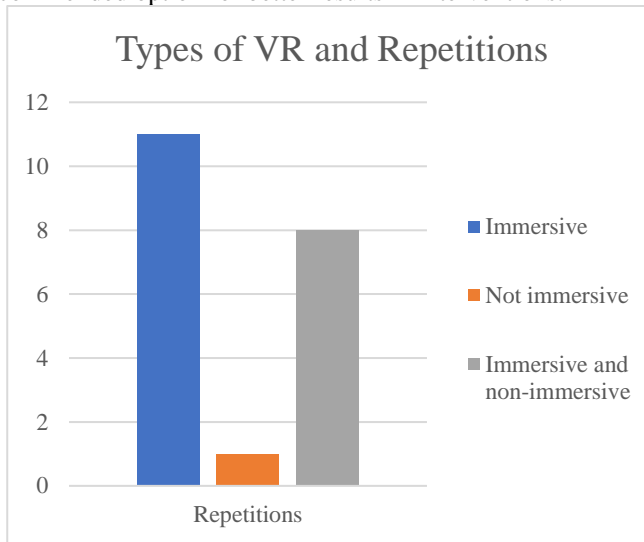

Figure 4. Types of VR and repetitions

Some studies indicate that certain patients who have used virtual reality have experienced certain drawbacks, such as cyberdisease. Cybersickness refers to the unpleasant symptoms and side effects that users experience during or after immersing themselves in virtual reality, including nausea, dizziness, dry mouth, headache, eyestrain, and sweating (74). According to Horesh et al., most of the patients involved in their study did not report any symptoms of cyberdisease (44). Zasadzka et al. presented a study in which these symptoms manifested themselves in less than 20% of cases (20). Yazdiopour also mentions these problems associated with the use of virtual reality, but stresses that it is a minority (27).

Symptoms of cyberdisease were only mentioned in three studies on the use of virtual reality in the treatment of breast cancer patients, while other studies do not refer to them, which could indicate that technology has advanced enough to reduce the occurrence of such symptoms.
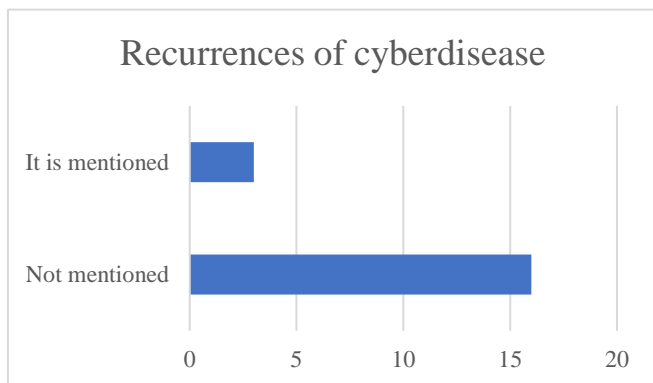

Figure 5. Mention of cyberdisease in studies

The studies examined also shed light on the number of patients who were evaluated for the effectiveness of using virtual reality in breast cancer treatments. In this connection, Grilo et al., they indicate that a total of 376 patients with various oncological diseases participated in their studies, of which approximately 300 people were identified as breast cancer patients (60). On the other hand, Zhao et al., to evaluate the effectiveness, carried out tests with a group of 120 patients undergoing radiotherapy. These patients were divided into two groups: one control and one intervention (49). In another study, Hao et al. They identified a total of 799 patients with different types of cancer, and through a pooled analysis, we sought to determine whether the use of virtual reality showed significant improvements in treatment (42).

Regarding the methodology used, Ioannou et al. conducted a randomized crossover trial with 50 patients receiving active chemotherapy treatment, using linear mixed-effects models for statistical analysis (43). Reynolds et al., meanwhile, invited women with cancer to participate in their study through mailing lists of the New Zealand Breast Cancer Foundation and Sweet Louise (58). To assess the acceptability of the system in their research, they selected 30 adult participants (58).

In another study, Horesh et al. They recruited 42 women with cancer aged between 18 and 60. These participants were recruited by sending emails or direct contact with their personal physician (44). Chin et al. They included 38 women with cancer in their study and carried out interventions using virtual reality (59).

In another context, Zhang et al, they recruited ninety-eight breast cancer patients for their study, and all these patients were evaluated through a functional assessment (51). Also, Sharifpour et al., they investigated the effect of virtual reality therapy on pain variables among 30 adolescents in the chemotherapy stage, randomly assigning them to experimental and control groups (46). Finally, Ying Chun et al. They included 165 patients in their study, with the average age of these participants being 47.14 years. The cancers included in their sample included lung, liver, breast and colorectal (53).

In summary, when considering the number of patients collected from the studies analyzed, a total of 1748 patients is obtained. This figure is considered sufficiently representative to be able to evaluate whether the use of virtual reality can contribute to counteract the negative aspects associated with cancer treatment.
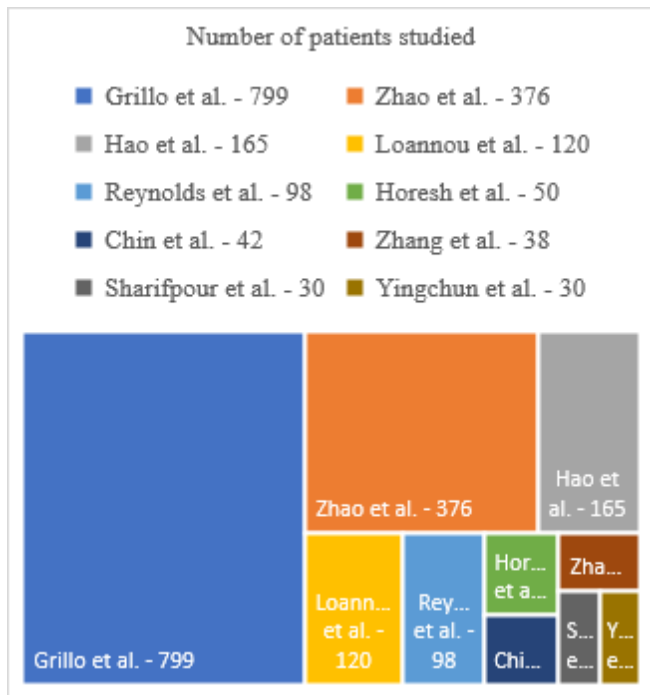
Figure 6. Number of patients evaluated per study.

Anxiety and pain are common symptoms among patients undergoing breast cancer treatments. Therefore, a comprehensive analysis has been conducted on the effectiveness of virtual reality in alleviating these common symptoms.

First, emphasis has been placed on anxiety, where Yazdipour et al. They have conclusively shown that the use of virtual reality systems has a significant impact on reducing anxiety (27). Grilo et al. They have also backed up this claim in their study, evidencing a decrease in anxiety levels. Their results highlight the specific advantages of using virtual reality as a complement to educational methods in preparing patients to undergo radiotherapy (60) (75) (76).

In addition, the joint analysis conducted by Hao and his team has revealed that patients experienced improvement in both fatigue and anxiety after using virtual reality (42). Similarly, Zhao has pointed out in his findings that virtual reality can significantly reduce anxiety. On the other hand, Reynolds et al., in their study, have indicated that virtual reality offers some benefits in managing anxiety, albeit in a more limited way (58).

Zhang's study found that virtual reality intervention significantly reduced psychological distress and improved quality of life for women who had survived breast cancer in their daily lives. In addition, during an 8-month follow-up, patients who participated in such a study reported a decrease in levels of distress and anxiety. Ying Chun also supports the idea of the positive impact that the implementation of virtual reality has on the management of anxiety in treatments. Another study has conclusively shown that VR-based interventions achieved significant improvement in anxiety.

Five studies show that virtual reality is very effective against anxiety during treatments and two studies still wanted to do more evaluations to reach a conclusion. Therefore, it can be concluded that virtual reality intervention has a significant impact on the symptom of anxiety.
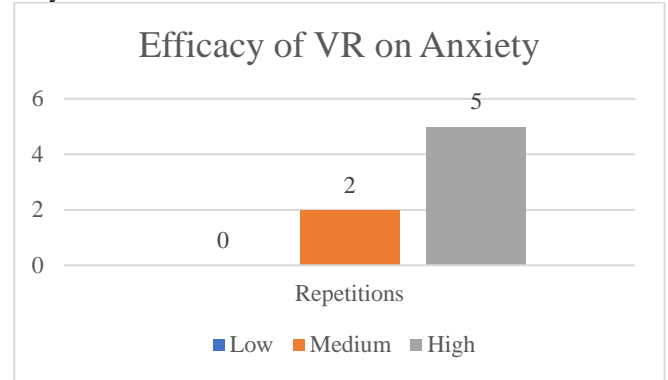

Figure 7. Effectiveness of VR on anxiety

Pain is the second most common symptom among patients undergoing breast cancer treatments. Research has been conducted to evaluate the effectiveness of virtual reality in managing this symptom.

Hao and his team conducted a pooled analysis that showed significant improvement in pain experienced by patients (42). However, summarizing the findings of several experimental and quasi-experimental studies, Comparcini and his team found inconclusive evidence about the beneficial effects of virtual reality on pain reduction in patients receiving chemotherapy (55).

One study by Lee Wong et al. used an exploratory randomized control trial along with qualitative interviews in Chinese pediatric patients receiving their first intravenous chemotherapy. While the study suggested positive results regarding the use of virtual reality for pain management, the researchers concluded that large-scale randomized controlled trials were required to validate these effects (50).

Moreover, Ioannou and his team conducted a randomized crossover trial and found that virtual reality did not show efficacy in relieving symptoms of nausea, pain, and discomfort, although an improvement in patients' mood was observed (43). Two studies did not demonstrate effectiveness, another study did not reach a definitive conclusion, while another study did find a positive result (43).

Overall, the studies analyzed have mixed results regarding the efficacy of virtual reality in pain management in breast cancer patients. Although some studies suggest benefits, others find no strong evidence of its effectiveness. Therefore, further research and well-designed clinical trials are required to determine with certainty the impact of virtual reality on pain relief, and practical solutions for the identified limitations and the adequate integration of ICT (77) (78) (79) (80) (81) (82) (83).
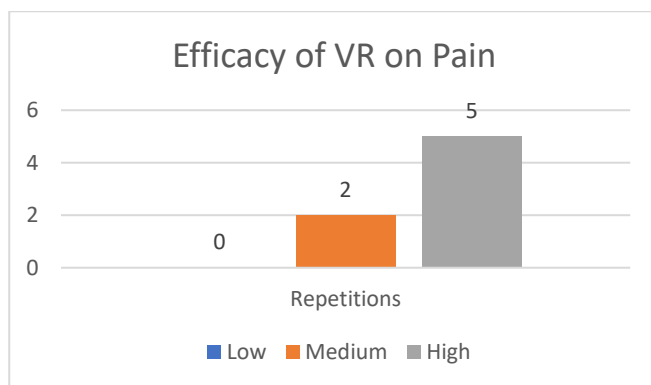
Figure 8. Efficacy of VR in pain

4. Discussion

In this systematic review, we examined the effectiveness of virtual reality in pain management, revealing results indicating a relatively low impact ($p < 0.07$) when comparing an intervention group using virtual reality with a control group. However, a significant difference in pain reduction was observed only in patients aged between 12 and 17 years. On the other hand, the findings of Ioannou et al. did not support the efficacy of virtual reality in relieving pain symptoms, presenting a p-value lower than 0.05 (43). In contrast to the results mentioned above, the study by Hao et al. suggests that virtual reality can significantly reduce the pain experienced by patients. In that study, pain intensity was assessed using both a visual analogue scale and the McGill pain questionnaire (42). The results of a pooled analysis showed that the level of pain decreased significantly after the virtual reality intervention, with a p-value of less than 0.001. Despite these promising results, it is important to mention that there are two studies that did not find such significant efficacy of virtual reality in pain relief. These findings suggest that there may be variations in outcomes depending on participant characteristics, the type of pain assessed, and other contextual factors (55).

The effectiveness of virtual reality in managing anxiety was also investigated, and the results of several studies, such as those conducted by Grilo et al. and Hao et al., consistently indicated that virtual reality had a significant impact on reducing anxiety. Grilo reported on a study in which scores of three measures of anxiety (STAI-S, systolic blood pressure, and heart rate) were examined in the experimental group and found that these scores were significantly lower compared to the intervention control group (60). These differences reached statistical significance, suggesting that virtual reality had a positive effect on decreasing anxiety in that specific study. On the other hand, Hao conducted a study in which a pooled analysis was performed within the experimental group, revealing that the virtual reality intervention significantly reduced the level of anxiety ($p < 0.001$) (42). In addition, when performing a comparative analysis between groups, it was found that the group that used virtual reality showed significantly lower anxiety levels compared to the control group ($p < 0.001$). These results support the efficacy of

virtual reality as an effective tool in reducing anxiety. However, it is important to mention that, in contrast to previous findings, Reynolds et al., in their study, indicated that reductions in anxiety did not reach the threshold to be considered clinically important (58). They raised the possibility that this was because the sample initially had relatively low levels of anxiety, which could have limited the scope for a clinically meaningful reduction. Although these results may suggest some variability in the effects of virtual reality on anxiety, most of the studies reviewed generally point to virtual reality as an effective tool to decrease anxiety levels in treatments (42) (58) (60) (84). Still, challenges regarding ICT integration, teaching and learning of these tools and similar, remain as main target for future studies (85).

5. Conclusions

In conclusion, this study has carried out an exhaustive investigation that has identified, through various studies, that anxiety is the most frequently mentioned problem during breast cancer treatment, followed closely by pain. Given this problem, the feasibility and effectiveness of the implementation of virtual reality as a potential solution to address these challenges has been investigated.

The results obtained indicate that, about anxiety, the application of virtual reality has yielded significant results in the reduction of this worrying emotion. Patients who have experienced virtual reality sessions as part of their treatment have shown a considerable reduction in their anxiety levels, which represents a promising advance in the field. As for pain, while some studies have shown some effectiveness of virtual reality in its management, most have not found solid evidence to support its effectiveness in this regard. Although it is important to note that there is research that supports its benefit, it is necessary to delve into this topic and carry out more studies to obtain more conclusive conclusions.

Regarding the symptoms associated with cyberdisease, it was observed that only three studies specifically addressed this aspect in the context of the use of virtual reality in patients with breast cancer. In contrast, other studies did not make explicit references to these symptoms, which could indicate that technological advances have made it possible to reduce their occurrence and, therefore, the disadvantages related to them.

In terms of future research, it is recommended to explore other databases and additional information sources, with the aim of obtaining a broader and more complete view on the effectiveness of virtual reality in pain management. Likewise, it is crucial to identify if the symptoms associated with the use of the virtual reality system continue to be a relevant concern, since so far there is no definitive clarity in this regard. These aspects will be key to advancing the implementation of virtual reality as an effective and safe therapeutic tool in the treatment of breast cancer.

References

[1] Reyes DJP, Ferrer RL, Castellanos MSR. Contribution of genetic factors in the occurrence of breast cancer in cuban women. Data and Metadata 2022;1:37-37.

[2] Lema Guaraca CA, Illares Guncay LX, Rodríguez Balarezo AS. Supervivencia en pacientes con Cáncer de Mama Subtipo Triple Negativo: Experiencia Institucional. Salud, Ciencia y Tecnología 2023;3:423. https://doi.org/10.56294/saludcyt2023423.

[3] Cañaveral Estrella NL, López Pérez GP. Atención de enfermería en pacientes oncológicos con cuidados paliativos. Salud, Ciencia y Tecnología 2023;3:488. https://doi.org/10.56294/saludcyt2023488.

[4] Quenorán Almeida VS, López Pérez GP, Espín López VI. Educación al cuidador informal del paciente oncológico en fase agónica. Salud, Ciencia y Tecnología 2023;3:426. https://doi.org/10.56294/saludcyt2023426.

[5] Valdés Izquierdo L, Quintana Morejón W, Borroto Bravo D, Herrera Wainshtok AC, Hernández Cuetara L. Cáncer de mama, correlación clínico-emocional identificada a través de AELI® KINETEST. Sal Cienc Tec 2022;2:104. https://doi.org/10.56294/saludcyt2022104.

[6] Ortiz Ruiz F, Gonzálvez H, Espinosa-Rada A. Gender, care and kinships networks: Family forms in Santiago, Chile. AWARI 2022;3. https://doi.org/10.47909/awari.148.

[7] Arévalo Zurita M, Expósito García E, Apez Arévalo I. Business management and gender equity and equality practices: the case of the company Agroforestal Cafetalera Tercer Frente. Reg Cient 2023:202375. https://doi.org/10.58763/rc202375.

[8] Castillo Ospina J, Losada Medina MR. Narrative display of the 'I' through the visualization of narrative graphs: the case of four women who lost their spouse due to unexpected death. AWARI 2021;2:e028. https://doi.org/10.47909/awari.119.

[9] Crespo A, Jiménez F, Cueva P. Methods in breast reconstruction for patients with a history of breast cancer after total or partial mastectomy care. Salud Cienc Tecnol 2023:306. https://doi.org/10.56294/saludcyt2023306.

[10] Diaz-de La Rosa C, Jiménez-Franco LE, Toledo Del Llano R, Vega-Cardulis E, Cardulis-Cárdenas O. Trends, collaboration and impact of Latin American scientific production in anesthesiology and pain medicine in Scopus and Web of Science. Data Metadata 2022;1:13. https://doi.org/10.56294/dm202213.

[11] Gil Oloriz MA, Roche Beltrán C, Campos Sánchez CM. Trends in health telematics and telemedicine services. Data Metadata 2022;1:16. https://doi.org/10.56294/dm202216.

[12] Veloz Montano MDLN, González Martínez MDLC, Pérez Lemus L. Rehabilitation of occupational stress from the perspective of Health Education. Community and Interculturality in Dialogue 2023;3:71. https://doi.org/10.56294/cid202371.

[13] Mendoza Rivas L, Armenta Alcocer IL. Efectos del ejercicio de rehabilitación sobre la calidad de vida en pacientes con fibromialgia. Revisión de ensayos clínicos. Interdisciplinary Rehabilitation / Rehabilitacion Interdisciplinaria 2022;2:23. https://doi.org/10.56294/ri202223.

[14] Cardeño Portela N, Cardeño Portela EJ, Bonilla Blanchar E. ICT and academic transformation in universities. Reg Cient 2023:202370. https://doi.org/10.58763/rc202370.

[15] Gonzalez-Argote J. Uso de la realidad virtual en la rehabilitación. Interdisciplinary Rehabilitation / Rehabilitacion Interdisciplinaria 2022;2:24. https://doi.org/10.56294/ri202224.

[16] Mendoza Rivas L, Martínez Cruz L. Revisión de ensayos clínicos sobre la eficacia de la rehabilitación cognitiva en pacientes con lesión cerebral traumática. Interdisciplinary Rehabilitation / Rehabilitacion Interdisciplinaria 2022;2:25. https://doi.org/10.56294/ri202225.

[17] Veliz Moreno Z, Núñez Ravelo E, Arencibia Llanes L, Suarez Castillo I, Contreras Tamargo Y. Anxiety, depression and coping strategies in convalescent Covid-19 patients. Interdisciplinary Rehabilitation. Rehabilitación Interdisciplinaria 2022;2:10.

[18] Da Silva Justino T, Morato Do Amaral R, Lopes De Faria LI, Cardoso De Brito AG. Scientific collaboration analysis of Brazilian postgraduate programs in information science. AWARI 2021;2:e024. https://doi.org/10.47909/awari.85.

[19] Gonzales Tito YM, Quintanilla López LN, Pérez Gamboa AJ. Metaverse and education: a complex space for the next educational revolution. Metaverse Basic and Applied Research 2023;2:56. https://doi.org/10.56294/mr202356.

[20] Zasadzka E, Pieczyńska A, Trzmiel T, Hojan K. Virtual Reality as a Promising Tool Supporting Oncological Treatment in Breast Cancer. IJERPH 2021;18:8768. https://doi.org/10.3390/ijerph18168768.

[21] Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA A Cancer J Clinicians 2021;71:209-49. https://doi.org/10.3322/caac.21660.

[22] Bu X, Ng PH, Xu W, Cheng Q, Chen PQ, Cheng AS, et al. The Effectiveness of Virtual Reality–Based Interventions in Rehabilitation Management of Breast Cancer Survivors: Systematic Review and Meta-analysis. JMIR Serious Games 2022;10:e31395. https://doi.org/10.2196/31395.

[23] Silver JK, Raj VS, Fu JB, Wisotzky EM, Smith SR, Kirch RA. Cancer rehabilitation and palliative care: critical components in the delivery of high-quality oncology services. Support Care Cancer 2015;23:3633-43. https://doi.org/10.1007/s00520-015-2916-1.

[24] Pergolotti M, Deal AM, Lavery J, Reeve BB, Muss HB. The prevalence of potentially modifiable functional deficits and the subsequent use of occupational and physical therapy by older adults with cancer. Journal of Geriatric Oncology 2015;6:194-201. https://doi.org/10.1016/j.jgo.2015.01.004.

[25] Bani Mohammad E, Ahmad M. Virtual reality as a distraction technique for pain and anxiety among patients with breast cancer: A randomized control trial. Pall Supp Care 2019;17:29-34. https://doi.org/10.1017/S1478951518000639.

[26] Chirico A, Maiorano P, Indovina P, Milanese C, Giordano GG, Alivernini F, et al. Virtual reality and music therapy as distraction interventions to alleviate anxiety and improve mood states in breast cancer patients during chemotherapy. Journal Cellular Physiology 2020;235:5353-62. https://doi.org/10.1002/jcp.29422.

[27] Yazdipour AB, Saeedi S, Bostan H, Masoorian H, Sajjadi H, Ghazisaeedi M. Opportunities and challenges of virtual reality-based interventions for patients with breast cancer: a

systematic review. BMC Med Inform Decis Mak 2023;23:17. https://doi.org/10.1186/s12911-023-02108-4.

[28] Tian N, Lopes P, Boulic R. A review of cybersickness in head-mounted displays: raising attention to individual susceptibility. Virtual Reality 2022;26:1409-41. https://doi.org/10.1007/s10055-022-00638-2.

[29] Yan Y, Chen K, Xie Y, Song Y, Liu Y. The Effects of Weight on Comfort of Virtual Reality Devices. En: Rebelo F, Soares MM, editores. Advances in Ergonomics in Design, vol. 777, Cham: Springer International Publishing; 2019, p. 239-48. https://doi.org/10.1007/978-3-319-94706-8_27.

[30] Vitón-Castillo AA, Fajardo Quesada AJ, Romero Valdes YDLC, Batista Rivero L. Metaverse: an emerging research area. Metaverse Bas App Res 2022;3. https://doi.org/10.56294/mr20223.

[31] Campos Sánchez CM, Guillén León LA, Acosta Yanes RC, Gil Oloriz MA. Metaverso: el futuro de la medicina en un mundo virtual. Metaverse Bas App Res 2022;1:4. https://doi.org/10.56294/mr20224.

[32] Díaz-Chieng LY, Auza-Santiváñez JC, Robaina Castillo JI. El futuro de la salud en el metaverso. Metaverse Bas App Res 2022;1:1. https://doi.org/10.56294/mr20221.

[33] Dávila Gómez HL, Lorié Sierra LE, Díaz-Perera Fernández G, Bacallao Gallestey J, Regalado Rodríguez E. Analysis of patient-dependent predictors of residual lesion after cervical conization. Data & Metadata 2023:48. https://doi.org/10.56294/dm202348.

[34] Nishikawa-Pacher A. Research Questions with PICO: A Universal Mnemonic. Publications 2022;10:21. https://doi.org/10.3390/publications10030021.

[35] Gontijo MCA, Hamanaka RY, De Araujo RF. Research data management: a bibliometric and altmetric study based on Dimensions. Iberoamerican Journal of Science Measurement and Communication 2021;1:1-19. https://doi.org/10.47909/ijsmc.120.

[36] Luiz Pinto A, De Carvalho Segundo WLR, Dias TMR, Vivian Santos Silva, Gomes JC, Quoniam L. Brazil Developing Current Research Information Systems (BrCRIS) as data sources for studies of research. Iberoamerican Journal of Science Measurement and Communication 2022;2. https://doi.org/10.47909/ijsmc.135.

[37] Ledesma F, Malave González BE. Patterns of scientific communication on E-commerce: a bibliometric study in the Scopus database. Reg Cient 2022:202214. https://doi.org/10.58763/rc202214.

[38] Dayal D, Gupta BM, Bansal J, Singh Y. COVID-19 associated mucormycosis: A bibliometric analysis of Indian research based on Scopus. Iberoamerican Journal of Science Measurement and Communication 2023;3. https://doi.org/10.47909/ijsmc.54.

[39] Dias PM, Dias TMR, Moita GF. Collection and integration of scientific data for production analysis Brazilian scientific in open access journals. En: Rodrigues Dias TM, editor. Advanced Notes in Information Science, vol. 2, ColNes Publishing; 2022. https://doi.org/10.47909/anis.978-9916-9760-3-6.105.

[40] Coimbra FS, Dias TMR. A process for the identification and analysis of scientific articles in conference proceedings. En: Rodrigues Dias TM, editor. Advanced Notes in Information Science, vol. 2, ColNes Publishing; 2022. https://doi.org/10.47909/anis.978-9916-9760-3-6.93.

[41] Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. International Journal of Surgery 2021;88:105906. https://doi.org/10.1016/j.ijsu.2021.105906.

[42] Hao J, Li Y, Swanson R, Chen Z, Siu K-C. Effects of virtual reality on physical, cognitive, and psychological outcomes in cancer rehabilitation: a systematic review and meta-analysis. Support Care Cancer 2023;31:112. https://doi.org/10.1007/s00520-022-07568-4.

[43] Ioannou A, Paikousis L, Papastavrou E, Avraamides MN, Astras G, Charalambous A. Effectiveness of Virtual Reality Vs Guided Imagery on mood changes in cancer patients receiving chemotherapy treatment: A crossover trial. European Journal of Oncology Nursing 2022;61:102188. https://doi.org/10.1016/j.ejon.2022.102188.

[44] Horesh D, Kohavi S, Shilony-Nalaboff L, Rudich N, Greenman D, Feuerstein JS, et al. 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 2022;10:2261. https://doi.org/10.3390/healthcare10112261.

[45] King AL, Acquaye-Mallory AA, Vera E, Mendoza T, Reyes J, Stockdill ML, et al. Feasibility and preliminary efficacy of a virtual reality intervention targeting distress and anxiety in primary brain tumor patients at the time of clinical evaluation: Study protocol for a phase 2 clinical trial. BMC Cancer 2023;23:262. https://doi.org/10.1186/s12885-023-10671-2.

[46] Sharifpour S, Manshaee GR, Sajjadian I. Effects of virtual reality therapy on perceived pain intensity, anxiety, catastrophising and self-efficacy among adolescents with cancer. Couns and Psychother Res 2021;21:218-26. https://doi.org/10.1002/capr.12311.

[47] Leggiero NM, Armstrong TS, Gilbert MR, King AL. Use of virtual reality for symptom management in solid-tumor patients with implications for primary brain tumor research: a systematic review. Neuro-Oncology Practice 2020;7:477-89. https://doi.org/10.1093/nop/npaa012.

[48] Toloza REV, León SMP. Significado de las vivencias de las pacientes con diagnóstico de cáncer de mama. Revista ciencia y cuidado 2012;9:65-78.

[49] Zhao Q, Liu B, Sun Q, Jin Y. Development and validation of a cost-effective virtual reality educational tool to reduce anxiety and improve set-up accuracy in radiotherapy patients. Cancer Medicine 2023;12:6161-9. https://doi.org/10.1002/cam4.5348.

[50] Lee Wong C, Li CK, Choi KC, Wei So WK, Yan Kwok JY, Cheung YT, et al. Effects of immersive virtual reality for managing anxiety, nausea and vomiting among paediatric cancer patients receiving their first chemotherapy: An exploratory randomised controlled trial. European Journal of Oncology Nursing 2022;61:102233. https://doi.org/10.1016/j.ejon.2022.102233.

[51] Zhang X, Yao S, Wang M, Yin X, Bi Z, Jing Y, et al. The Impact of VR-CALM Intervention Based on VR on Psychological Distress and Symptom Management in Breast Cancer Survivors. Journal of Oncology 2022;2022:1-10. https://doi.org/10.1155/2022/1012813.

[52] Zhang H, Xu H, Zhang Z, Zhang Q. Efficacy of virtual reality-based interventions for patients with breast cancer symptom and rehabilitation management: a systematic review and meta-analysis. BMJ Open 2022;12:e051808. https://doi.org/10.1136/bmjopen-2021-051808.

[53] Zeng Y, Guan Q, Su Y, Huang Q, Zhao J, Wu M, et al. A self-administered immersive virtual reality tool for assessing cognitive impairment in patients with cancer. Asia-Pacific Journal of Oncology Nursing 2023;10:100205. https://doi.org/10.1016/j.apjon.2023.100205.

[54] Wang Y-J, Wang F, Yu L-X, Xiang Y-J, Zhou F, Huang S-Y, et al. Worldwide review with meta-analysis of women's awareness about breast cancer. Patient Education and Counseling 2022;105:1818-27. https://doi.org/10.1016/j.pec.2021.12.012.

[55] Comparcini D, Simonetti V, Galli F, Saltarella I, Altamura C, Tomietto M, et al. Immersive and Non-Immersive Virtual Reality for Pain and Anxiety Management in Pediatric Patients with Hematological or Solid Cancer: A Systematic Review. Cancers 2023;15:985. https://doi.org/10.3390/cancers15030985.

[56] Melillo A, Chirico A, De Pietro G, Gallo L, Caggianese G, Barone D, et al. Virtual Reality Rehabilitation Systems for Cancer Survivors: A Narrative Review of the Literature. Cancers 2022;14:3163. https://doi.org/10.3390/cancers14133163.

[57] Fabi A, Fotia L, Giuseppini F, Gaeta A, Falcicchio C, Giuliani G, et al. The immersive experience of virtual reality during chemotherapy in patients with early breast and ovarian cancers: The patient's dream study. Front Oncol 2022;12:960387. https://doi.org/10.3389/fonc.2022.960387.

[58] Reynolds LM, Cavadino A, Chin S, Little Z, Akroyd A, Tennant G, et al. The benefits and acceptability of virtual reality interventions for women with metastatic breast cancer in their homes; a pilot randomised trial. BMC Cancer 2022;22:360. https://doi.org/10.1186/s12885-021-09081-z.

[59] Chin S, Cavadino A, Akroyd A, Tennant G, Dobson R, Gautier A, et al. An Investigation of Virtual Reality Nature Experiences in Patients With Metastatic Breast Cancer: Secondary Analysis of a Randomized Controlled Trial. JMIR Cancer 2022;8:e38300. https://doi.org/10.2196/38300.

[60] Grilo AM, Almeida B, Rodrigues C, Isabel Gomes A, Caetano M. Using virtual reality to prepare patients for radiotherapy: A systematic review of interventional studies with educational sessions. Technical Innovations & Patient Support in Radiation Oncology 2023;25:100203. https://doi.org/10.1016/j.tipsro.2023.100203.

[61] Atef D, Elkeblawy MM, El-Sebaie A, Abouelnaga WAI. A quasi-randomized clinical trial: virtual reality versus proprioceptive neuromuscular facilitation for postmastectomy lymphedema. J Egypt Natl Canc Inst 2020;32:29. https://doi.org/10.1186/s43046-020-00041-5.

[62] Niklasson A, Paty J, Rydén A. Talking About Breast Cancer: Which Symptoms and Treatment Side Effects are Important to Patients with Advanced Disease? Patient 2017. https://doi.org/10.1007/s40271-017-0242-z.

[63] Park EM, Gelber S, Rosenberg SM, Seah DSE, Schapira L, Come SE, et al. Anxiety and Depression in Young Women With Metastatic Breast Cancer: A Cross-Sectional Study. Psychosomatics 2018;59:251-8. https://doi.org/10.1016/j.psym.2018.01.007.

[64] Cleeland C, Von Moos R, Walker MS, Wang Y, Gao J, Chavez-MacGregor M, et al. Burden of symptoms associated with development of metastatic bone disease in patients with breast cancer. Support Care Cancer 2016;24:3557-65. https://doi.org/10.1007/s00520-016-3154-x.

[65] Toconas LDC. Empathy in nursing professionals for care subjects with depression. Community and Interculturality in Dialogue 2023;3:67. https://doi.org/10.56294/cid202367.

[66] Indovina P, Barone D, Gallo L, Chirico A, De Pietro G, Giordano A. Virtual Reality as a Distraction Intervention to Relieve Pain and Distress During Medical Procedures: A Comprehensive Literature Review. The Clinical Journal of Pain 2018;34:858-77. https://doi.org/10.1097/AJP.0000000000000599.

[67] Cardona-Villa R, Sánchez A, Larenas-Linnemann D, Járes E, Sánchez J. Extractos alergénicos para inmunoterapia en Latinoamérica. RAM 2018;65:25-40. https://doi.org/10.29262/ram.v65i1.287.

[68] Huang A, Yang X-R, Chung W-Y, Dennison AR, Zhou J. Targeted therapy for hepatocellular carcinoma. Sig Transduct Target Ther 2020;5:146. https://doi.org/10.1038/s41392-020-00264-x.

[69] Rasha F, Sharma M, Pruitt K. Mechanisms of endocrine therapy resistance in breast cancer. Molecular and Cellular Endocrinology 2021;532:111322. https://doi.org/10.1016/j.mce.2021.111322.

[70] Fabbro M, Jacot W, Jarlier M, Guiu S, D'Hondt V, Pouderoux S, et al. Hypnosis on patients treated with adjuvant chemotherapy for breast cancer: A feasibility study. Cancer Reports 2023;6:e1732. https://doi.org/10.1002/cnr2.1732.

[71] Gonzalez-Argote D. Immersive environments, Metaverse and the key challenges in programming. Metaverse Bas App Res 2022;1:6. https://doi.org/10.56294/mr20226.

[72] Picalho AC, Bisset Álvarez E, Fadel LM. Virtual reality and augmented reality in tourism: Indicative of use by government agencies in Brazilian states. En: Huisa Veria E, editor. Advanced Notes in Information Science, vol. 1, ColNes Publishing; 2022. https://doi.org/10.47909/anis.978-9916-9760-0-5.96.

[73] Won M, Ungu DAK, Matovu H, Treagust DF, Tsai C-C, Park J, et al. Diverse approaches to learning with immersive Virtual Reality identified from a systematic review. Computers & Education 2023;195:104701. https://doi.org/10.1016/j.compedu.2022.104701.

[74] Weech S, Kenny S, Barnett-Cowan M. Presence and Cybersickness in Virtual Reality Are Negatively Related: A Review. Front Psychol 2019;10:158. https://doi.org/10.3389/fpsyg.2019.00158.

[75] Lepez CO, Simeoni IA. Pedagogical experience with Public Health campaigns from the design of socio-educational projects with insertion in the local territory. Community and Interculturality in Dialogue 2023;3:74. https://doi.org/10.56294/cid202374.

[76] Veloz Montano MDLN, Keeling Álvarez M. The educational and pedagogical intervention in scientific research. Community and Interculturality in Dialogue 2023;3:70. https://doi.org/10.56294/cid202370.

[77] Zhang W. Blockchain-based solutions for clinical trial data management: a systematic review. Metaverse Bas App Res 2023:17. https://doi.org/10.56294/mr202217.

[78] González Vallejo R. Metaverse and translation studies: analysis of machine translation. Metaverse Bas App Res 2023:38. https://doi.org/10.56294/mr202338.

[79] Jiménez-Pitre I, Molina-Bolívar G, Gámez Pitre R. Systemic vision of the technological educational context in Latin America. Reg Cient 2023:202358. https://doi.org/10.58763/rc202358.

[80] Ron M, Pérez A, Hernández-Runque E. Nivel de riesgo para la salud y predicción del dolor musculo-esqueletico en trabajadores en condiciones de teletrabajo: Un enfoque matricial. Interdisciplinary Rehabilitation / Rehabilitacion Interdisciplinaria 2023;3:40. https://doi.org/10.56294/ri202340.

[81] Duarte Mascarenhas HA, Rodrigues Dias TM, Mascarenhas Dias P. Adoption of Network Analysis Techniques to

Understand the Training Process in Brazil. AWARI 2020;1:e004. https://doi.org/10.47909/awari.63.

[82] Araujo-Inastrilla CR, Vitón-Castillo AA. Blockchain in health sciences: Research trends in Scopus. Iberoamerican Journal of Science Measurement and Communication 2023;3. https://doi.org/10.47909/ijsmc.56.

[83] De Sousa RPM, Shintaku M. Data privacy policy: relevant observations for its implementation. En: Rodrigues Dias TM, editor. Advanced Notes in Information Science, vol. 2, ColNes Publishing; 2022. https://doi.org/10.47909/anis.978-9916-9760-3-6.112.

[84] Veloz Montano MDLN, González Martínez MDLC, Pérez Lemus L. Interdisciplinary Exploration of the Impact of Job Stress on Teachers' Lives. Interdisciplinary Rehabilitation / Rehabilitacion Interdisciplinaria 2023;3:57. https://doi.org/10.56294/ri202357.

[85] Álvarez Campos H. Pedagogical strategies based on inverted classroom - Integration of ICT in naval technologies at the Escuela Naval de Suboficiales A.R.C. Barranquilla. Reg Cient 2023:202397. https://doi.org/10.58763/rc202397.