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REVIEW

Impact of Exergames in Women with Breast Cancer After Surgery: a Systematic Review

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Abstract

In recent years, exergames have been used in healthcare, and particularly in rehabilitation, with positive results. Exergames in healthcare have a significant potential; however, gaps in some areas remain, including the domain of exergames post-surgery for breast cancer. This study aimed to synthesise the existing studies on exergames following surgery for breast cancer and evaluate their impact through a systematic review. A total of 8 articles published between 2015 and 2022 were selected. The search took place in January 2022 with no time limits. Altogether 209 women participated in these studies. Interventions ranged from 4 to 8 weeks. Most of the interventions took place in the late postoperative period. It was possible to observe their impact on some indicators (range of motion, pain, functionality, depression). Importantly, no negative impact was reported in any of the different studies. The present review concluded that exergames can be a promising intervention for rehabilitation in oncology. However, more robust studies are needed that evaluate the effectiveness of using exergames as a complement to conventional rehabilitation and to assess the degree of satisfaction, motivation, and adherence of participants.

Keywords Games · Exergames · Breast cancer · Rehabilitation

Introduction

Breast cancer is one of the most common cancers globally among women and the second most common cause of cancer mortality in women worldwide[1, 2]. The diagnosis of cancer is considered devastating, but with improved outcomes compared to previously[3]. Despite advances in treatments and surgical strategies, breast cancer and its treatment have a significant negative impact on a woman's quality of life[1, 4]. Mastectomy and other forms of major surgery for breast cancer remain essential, and women expect better quality, evidence-based care to optimise pain relief and improve to function during a successful recovery [4].

Despite the change in surgical options, the risk of complications persists and may vary markedly according to the type of reconstruction, risk profiles, and duration of follow-up [5]. Complications following breast cancer surgery may determine the negative impact on the quality of life, and rehabilitation is essential to prevent or treat such dysfunctions[6].

The implications for the person who receives a breast cancer diagnosis go beyond those arising from surgical procedures. Indeed, many different treatment options may be presented, all dependent on the type of breast cancer, the stage at the time of diagnosis, and the tumour location[7]. Complications may be diverse, including physical-functional, muscle and nerve lesions, haemorrhages, scarring, alterations in sensation, fibrosis, postural alterations, reduced range of shoulder movement, impairment of muscle strength, pain, fatigue, and lymphoedema of the homolateral limb[6]. Surgical treatment may lead to limitations of limb mobility and lead to structural deformities and movement disorders of the trunk and shoulder girdle, as well as asymmetry in the distribution of body weight and displacement of the centre of gravity, causing balance and gait disturbances [2]. The

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negative effects of treatment can also result from adjuvant treatments such as chemotherapy, radiotherapy, hormone therapy, and immunochemotherapy [7]. Due to the variety of disorders resulting from the treatment of breast cancer, rehabilitation is complicated and multidirectional [2].

Therefore, it is very important to develop an evidence-based plan of functional exercises for patients with breast cancer, especially after surgery, and encourage patients to perform gradual functional exercises to recover the function of the upper limb and shoulder joint and reduce the incidence of complications[8, 9]. In rehabilitation, the use of technology is growing progressively, and emerging technologies encourage patients even more to engage in their daily treatment and traditional programs [10]. One of the resources used are exergames, which consists of exercise through videogames, demanding attention and motivation, promoting a sense of accomplishment, and, because it is enjoyable, contributing to treatment adherence [11]. In recent years, there has been a trend towards the use of video games in health applications. Interactive video games—also known as exergames—enable the individual to interact with the game by moving their limbs or the entire body cancer [12, 13].

Exergaming combines exercise with gaming, in which the user must use physical movements to interact with the game [12] and has been used in people with cancer [11, 13]. Exergaming, which is exercising through videogames, can reproduce the practice of light- to moderate-intensity physical activity when used with combined whole-body movements [11]. Despite the growing popularity of these resources, no published report discusses the use of exergames with breast cancer after surgery. This is the first review on the topic and focuses only on its use for this population. Given the potential of these resources and to address the gap in the domain of exergames for patients after breast cancer surgery, this study aimed to provide a systematic review to synthesise the existing studies on the subject, as well as its impact.

Methods

This systematic review study was reported on the basis of the statement of preferred reporting items for systematic reviews and meta-analyses (PRISMA—Preferred Reporting Items for Systematic Reviews and Meta-Analyses, 2020). Before we start, we check if the review question we were interested in answering was not already being investigated by another research group.

Search Strategy

We searched the following databases: MEDLINE® (Medical Literature Analysis and Retrieval System Online), CINAHL® (Cumulative Index to Nursing and Allied Health Literature), SPORTDiscus, SCOPUS, SciELO (Scientific Electronic Library Online), Psychology and Behavioral Sciences Collection, Cochrane Central Register of Controlled Trials, and PEDRo (Physiotherapy Evidence Database). The search strategy is included in the supplementary material (**Appendix**). The search was performed using the appropriate syntax and indexing terms for each database. We made a previous exploratory search to identify the respective descriptors using search syntaxes appropriate to each database, like integrating Medical Subject Headings (MeSH) terms, CINAHL Headings, and others. Free terms were used in addition to each database's descriptors to ensure the search was as comprehensive as possible. A search for additional studies was also performed in the reference lists of the included articles by 'Backward citation searching'.

Selection of Studies

The inclusion and exclusion criteria were determined according to the guiding question, considering the participants, the intervention, and the outcomes of interest. The following inclusion criteria were defined: regarding population, studies concerning the surgical treatment of a person with breast cancer were included; for intervention, studies concerning the use of exergames as a rehabilitation intervention and which described and evaluated the exergame used; for outcomes, all the evaluated results were included in the analysis. In the integration of articles, due to the absence of information about coadjuvant treatments, they were not considered as exclusion criteria. Therefore, all studies were included, regardless of the phase of application of the exergame, type of surgery, and adjuvant treatments.

In terms of methodology, only studies with randomised clinical trials or experimental studies with pre- and post-evaluation were considered. Articles that did not include specific results for the use of exergames were not exclusively used for people with breast cancer. Gender was not considered a reason for exclusion, but given that only results with women were found, the article's title assumed this designation. The search took place in January 2022 with no time limits.

Data Extraction

For the first stages of data selection, we used the Rayyan QCRI® platform (the Systematic Reviews web app). The results were assessed and selected for inclusion based on the information provided in the title and abstract. Two authors performed the screening simultaneously (CSF, CB), and disagreements on the inclusion of studies were resolved by discussion with a third researcher (LMF). Next, the selected articles were fully read before being

included in the final sample. **Figure 1** shows the identification and inclusion process of the articles submitted through PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). (Registration https://doi.org/10.17605/OSF.IO/DS8AU).

Data Synthesis

In order to systematise the data extracted from the articles, they were first descriptively compiled in **Table 1**, which had been previously prepared by the researchers, integrating the place where the study was conducted, study objective, study design, participants, intervention, type of game, and results. In order to facilitate the presentation and discussion of the results, the articles were coded as illustrated in **Table 1**. Given the heterogeneous nature of the designs and results of the different studies included in the sample, only a descriptive summary was performed (**Table 3**).

Quality Assessment

The methodological assessment of the studies was performed using the different standardised assessment tools of the Joanna Brigg's Institute (JBI) for each type of study. We used different assessment instruments standardised by the Joanna Briggs Institute, for randomised controlled trials and quasi-experimental studies. Although, based on the outcome of this step, no studies were excluded when considering the methodological quality assessment of the studies, and the respective results are presented in **Table 2.**

Results

Study Selection

The search strategy retrieved 670 records. After removing the duplicates, 582 records were included for the first screening and analysis of the title and abstract. After the different

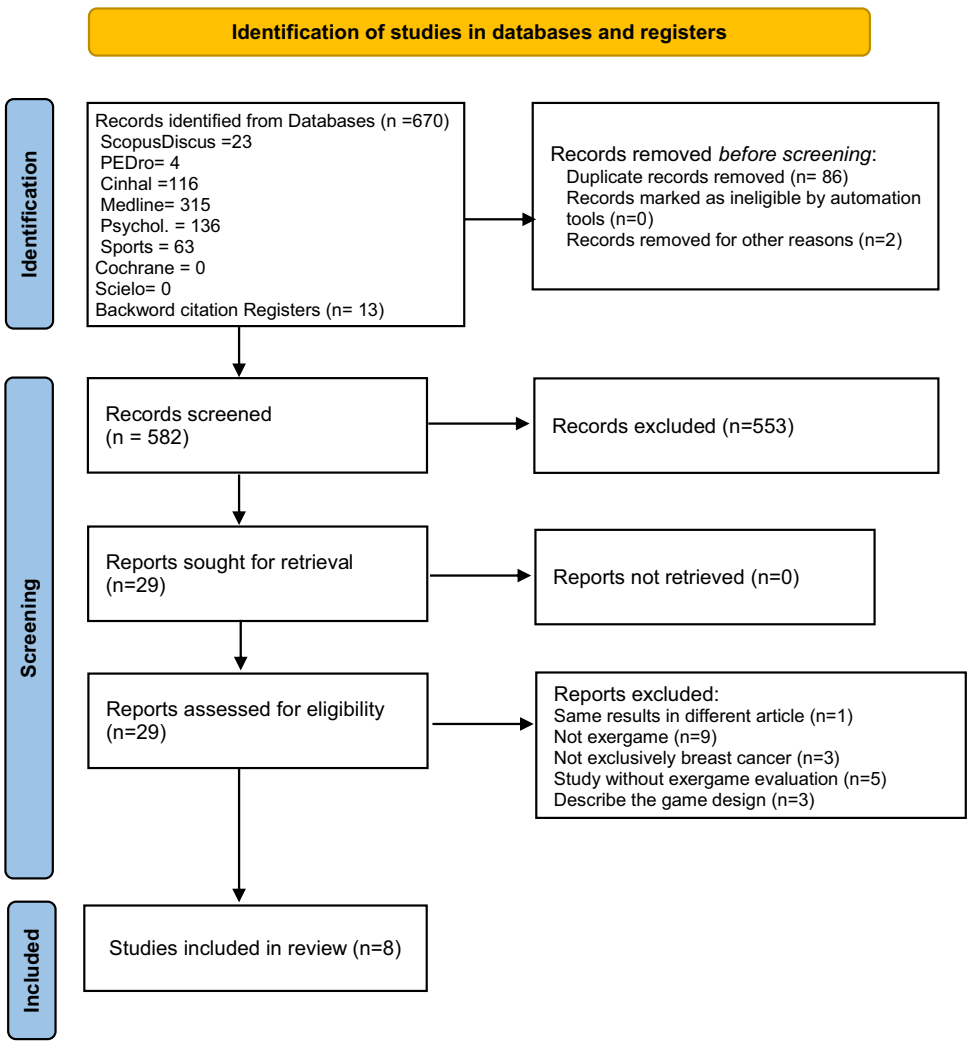

Fig. 1 Article identification and inclusion process—PRISMA *Diagram flow (2020) (PRISMA flowchart according to* https://www.prisma-statement.org//*)*

Table 1 Studies included in the review ($n = 8$)

Code	Authors, year, country	Study design	Aim of the study	Participants	Game type	Intervention	Control group	Measures	Outcomes
E1	Martínez, Santamaría-Vázquez, Ortiz-Huerta (2021)[9] Spain	Quasi-Experimental design Pre and post-test evaluations in only one group	To improve the scapulohumeral joint limitations and increase the health-related quality of life (HRQOL) in women with lymphedema secondary to breast neoplasms	11 women with lymphedema secondary to breast cancer	Wii Balance Board, together with games such as Wii Sports and Wii Fit Plus Bowling and Golf	1 session of 30 min once a week for 5 weeks, individually	–	------Shoulder Pain and Disability Index (SPADI) ------Oxford Shoulder Score (OSS) ------Health-related quality of life (HRQOL): (Assessment of Cancer Therapy Questionnaire General—FACT-G and FACT-B + 4 ------Muscular strength ------Ranges of motion—ROM	Statistically significant improvements were reported: Pain ($p = 0.011$), Disability ($p > 0.05$), HRQOL associated with lymphedema ($p = 0.016$), Strength ($p < 0.05$), Range of articular motion ($p < 0.05$)
E2	Feyzioğlu, Dinçer, Akan, Algun (2020)[14] Turkey	Randomised control trial	To investigate the potential effects of early postoperative virtual reality (VR) therapy on pain, range of motion (ROM), muscle strength, functionality, and fear of movement	40 women with breast cancer submitted to unilateral mastectomy with axillary lymph node emptying	Xbox Kinect-based games Kinect Sports I (darts, bowling, boxing) for the first 3 weeks of the treatment, and in the last 3 weeks, Kinect Sports I (beach volleyball, table tennis and Fruit Ninja) were played for 30 min Before starting each session, patients did a 5 min warm-up with Dance Central 3: Macarena	($n = 20$) received therapy using Xbox Kinect-based games for 6 weeks	($n = 20$) received standard physiotherapy	------Pain (Visual Analogue Scale) ------Strength (dynamometer), ------DAS Functionality (Disabilities of the Arm, Shoulder, and Hand questionnaire) ------ROM—range of motion ------Fear of movement (Tampa kinesiophobia scale—TKS)	Fear of movement improved significantly in the intervention group, and the control group showed greater improvement in functionality ($p < 0.05$) There were no differences in ROM, muscle strength, and pain between the groups after treatment ($p > 0.05$)

Table 1 (continued)

Code	Authors, year, country	Study design	Aim of the study	Participants	Game type	Intervention	Control group	Measures	Outcomes
E3	Rodrigues, Martins, Nogueira, Rezende, Boas, Costa (2020)[15] Brasil	Randomised control trial	To investigate the potential use of exergame in the dance modality in the fatigue responses	19 women post-operatively of breast cancer for more than 1 year	XBOX© 360 Kinect®, com o jogo Just Dance	($n=9$) 45 min of Exergames with the game Just Dance, twice a week for 4 weeks	($n=10$), Control group maintained 4 weeks without any kind of physical activity	------Health-related quality of life (HRQOL): FACT-B ------Escala de fadiga de PIPER (fadiga muscular)	There was a difference between the groups on the Social/Family dimension of the questionnaire FACT-B questionnaire. $p \leq 0.05$ There was no change in the remaining domains and neither in muscle fatigue
E4	Niewolak, Fielek, Pecyna, Chełminiak, Dariusz, Zieliński, Kobylarz, Cygoń, Stanisławski, Kręcichwiost, Piejko, Polak. (2020)[2] Poland	Quasi-Experimental design Pre and post-test evaluations in only one group	The study was to understand the impact of medical resort treatment extended with modern feedback exercises using virtual reality to improve postural control in breast cancer survivors	49 women undergoing mastectomy and adjuvant treatment completed at least 8 weeks before the start of the study	Rehabilitation software that enables virtual reality-based feedback and collects data on the type of tasks and the accuracy of their performance by patients	Individual exercises with virtual reality-based feedback, 6 days a week (Monday to Saturday), for 45 min 3 weeks	--	------Static and dynamic postural control with Romberg's test with length of the foot pressure centre path on the platform (COP)	In the assessment of dynamic postural control, the length of the trajectory of the foot centre of pressure was statistically significant ($p=0.0083$). In the assessment of static postural control, no statistically significant differences were found between the length of the trajectory of the COP

Table 1 (continued)

Code	Authors, year, country	Study design	Aim of the study	Participants	Game type	Intervention	Control group	Measures	Outcomes
E5	Aguirre-Carvajal, Marchant-Pérez (2015)[16] Mexico	Randomised control trial	To describe the effect of early physical therapy on pain and upper limb function in mastectomy patients, using virtual reality exercises	Women with unilateral mastectomy with no shoulder diseases ($n=77$; 41 in the study group, 36 in the control group) Each group was subdivided according to the type of mastectomy	Nintendo Wii Aeroplane, Wakeboard, Sword, Frisbee®, Archery	10 sessions with WiiTM console between days 7 and 30 after surgery. The sessions were performed 3 times a week, each lasting 32 min, distributed in 3 sets of 10 min of effective game time with 1 min of rest 5 weeks	Received standard physiotherapy	------Pain (Visual Analogue Scale) ------Degree of functionality of the ipsilateral upper limb to the QuickDASH mastectomy ------Measurements were taken before surgery (preoperative day 0) and after surgery on days 7 and 30	From the 7th postoperative day onwards, an exercise protocol with exergames favours the recovery of functionality and reduces pain regardless of the type of surgery
E6	Atef, Elkeblawy, El-Sebaie, Abouelnaga (2020)[17] Egypt	Randomised control trial	To identify and compare the therapeutic advantages of virtual reality-based exercises and proprioceptive neuromuscular facilitation for postmastectomy lymphedema	30 women with modified radical mastectomy with axillary lymph node dissection. The postsurgical duration was at least 6 months	Nintendo Wii Tennis, triceps extension, and rhythmic boxing were the games used	15 patients performed virtual reality-based exercises as well as manual lymphatic drainage, pneumatic compression, and home programs, 4 weeks	15 patients performed proprioceptive neuromuscular facilitation as well as manual lymphatic drainage, pneumatic compression, and home programs	------Excess arm volume (EAV) ------Level of functionality of the upper limb ------ipsilateral to the mastectomy QuickDASH scale ------Before treatment and after 4 weeks of treatment for both groups	The excess arm volume significantly decreased in both group ($p=0.001$) and proprioceptive neuromuscular facilitation group ($p=0.005$), and there was no significant difference between the two groups ($p=0.902$) Neither method was found to be superior, except Exergame was found to be superior to proprioceptive neuromuscular facilitation in motivating patients and providing visual feedback

Table 1 (continued)

Code	Authors, year, country	Study design	Aim of the study	Participants	Game type	Intervention	Control group	Measures	Outcomes
E7	House, Burdea, Grampurohit, Polistico, Roll, Damiani, Hundal, Demesmin. (2016)[18] USA	Quasi-Experimental design Pre and post-test evaluations in only one group	The aim of this study was to explore the feasibility of BrightArm Duo therapy for coping with postsurgical chronic pain and associated disability in breast cancer survivors with depression	6 women with chronic pain after breast cancer surgery	BrightArm Duo Rehabilitation System 9 custom games were developed in Unity 3D19 For unimanual and bimanual motor (shoulder, elbow, grasp), emotive and cognitive (executive function, focusing, short-term and delayed memory, working memory and task sequencing) training	They trained in the system 2 times a week for 8 weeks Session (20 to 50 min)	---	------Pain (Visual Analogue Scale) ------Range of motion (ROM) ------Shoulder strength ------Upper Extremity Functional Index 20 (UEFI-20) ------The Beck Depression Inventory (BDI-II) ------Measurements were taken before the intervention and 8 weeks	The results indicate improvement in cognition, shoulder range of motion, strength, function, and depression. Pain intensity showed a downward trend of 20% ($p=0.1$)
E8	Basha, Aboelnour, Alsharidah, Kamel (2022)[10] Egypt	Randomised control trial	To compare the effects of virtual reality (VR) training and resistance exercises training on lymphedema symptom severity as well as physical functioning and QoL in women with breast cancer–related lymphedema VR Kinect ($n=30$) and control group ($n=30$)	60 women with lymphoedema related to breast cancer	Xbox Kinect The 'Macarena' dance typically (5 min) Other Xbox Kinect games (darts, bowling, boxing, table tennis, fruit ninja, and beach volleyball)	5 sessions per week for 8 weeks	Both groups received complex decongestive physiotherapy	------Excess arm volume (EAV) ------Visual Analogue Scale (VAS) ------Disability of the Arm, Shoulder, and Hand (DASH) questionnaire ------Shoulder range of motion (ROM) ------Shoulder muscles strength ------The results were evaluated pre and post-intervention (week 8)	Statistically significant differences were recorded in VAS, pain intensity, DASH, shoulder ROM ($p<0.001$), body pain, ($p=0.002$), general health status ($p<0.001$), and vitality ($p=0.006$) in favour of the Xbox Kinect group. However, there were no statistically significant differences in shoulder strength ($p=0.002$) in favour of the resisted exercise group

Table 2 Quality appraisal of the studies

Study	Study code				
Randomised controlled trials	E2	E3	E5	E6	E8
Appraisal item					
(1) Was true randomisation used to assign participants to treatment groups?	X	?	-	X	X
(2) Was allocation to treatment groups concealed?	X	?	-	-	X
(3) Were treatment groups similar at the baseline?	?	X	X	X	X
(4) Were participants blind to treatment assignment?	?	-	-	-	X
(5) Were those delivering treatment blind to treatment assignment?	?	-	-	-	?
(6) Were outcomes assessors blind to treatment assignment?	X	-	-	-	X
(7) Were treatment groups treated identically other than the intervention of interest?	X	?	?	X	X
(8) Was follow-up complete, and if not, were differences between groups in terms of their follow-up adequately described and analysed?	X	X	X	X	X
(9) Were participants analysed in the groups to which they were randomised?	X	X	X	X	X
(10) Were outcomes measured in the same way for treatment groups?	X	X	X	X	X
(11) Were outcomes measured in a reliable way?	X	X	X	X	X
(12) Was appropriate statistical analysis used?	X	X	X	X	X
(13) Was the trial design appropriate, and were any deviations from the standard RCT design (individual randomisation, parallel groups) accounted for in the conduct and analysis of the trial?	-	-	-	-	-
Quasi-experimental studies			Study code		
Appraisal item			E1	E4	E7
(1) Is it clear in the study what is the 'cause' and what is the 'effect' (no confusion about which variable comes first)?			X	X	X
(2)Were the participants included in any comparisons similar?			?	-	-
(3)Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?			-	-	-
(4) Was there a control group?			-	-	-
(5) Were there multiple measurements of the outcome both pre and post intervention/exposure?			X	X	X
(6) Was follow-up complete, and if not, was follow-up adequately reported, and strategies to deal with loss to follow-up employed?			?	?	?
(7) Were the outcomes of participants included in any comparisons measured in the same way?			X	X	X
(8) Were outcomes measured in a reliable way?			X	X	X
(9) Was appropriate statistical analysis used?			X	X	X
Legend Yes X No - Unclear ? Not applicable NA					

steps illustrated in Fig. 1, 8 publications met the eligibility criteria and were included for analysis.

Study Characteristics

Table 1 summarises the characteristics of the 8 studies integrated in this review, including authors, year, country, and study design, objectives, and participants, type of game, intervention, measurement instruments, and study results.

A total of 8 articles published between 2015 and 2022 were selected for this review[2,9,10,14–18.]. The studies were conducted in quite different locations: Turkey, Brazil, Mexico, Egypt, Poland, USA, and Spain. A total 209 women participated altogether in the studies. The exergames used in the intervention programmes were Nintendo Wii® [9, 16, 17], Xbox® [10, 14, 15], or proprietary software[2, 18]. The interventions ranged from 4 to 8 weeks. Most of the interventions took place in the late postoperative period [2, 9, 10, 15, 17, 18].

Quality Assessment

With regard to study design, the studies included 5 randomised clinical trials and 3 quasi-experimental studies (before and after studies). Using the methodological assessment of the studies carried out using the different standardised assessment tools of the Joanna Brigg's Institute (JBI) [19], it can be observed **(Table 2)** that the lower quality of

Table 3 Intervention outcomes

Outcome	Code study	Intervention weeks	Design study	Sample	Effect	*Obs*
ROM	E2	6	RCT	40	?	Flexion abduction, external rotation
	E1	5	QE	11	+	Flexion and abduction
	E7	5	QE	11	+	Abduction, external rotation, internal rotation
	E8	8	RCT	60	+	Flexion, abduction
Pain-VAS	E2	6	RCT	40	?	
	E5	5	RCT	77	+	
	E7	8	QE	6	+	
	E8	8	RCT	60	+	
Strenght	E2	6	RCT	40	?	
	E8	8	RCT	60	?	
	E1	5	QE	11	+	
SPADI scale	E1	5	QE	11	+	Sub-scale disabilty and pain
OSS scale	E1	5	QE	11	?	
HRQQL scale	E1	5	QE	11	?	Fact-G
	E1	5	QE	11	+	FACT_B + 4
	E3	4	RCT	19	+	FACT_b social/family
DAS scale	E2	6	RCT	40	?	
DAS scale	E8	8	RCT	60	+	
Fear of Movement	E2	6	RCT	40	+	
PIPER scale	E3	4	QE	19	?	FACT_b social/family
COP scale	E4	3	QE	49	?	**Static**
	E4	3	QE	49	+	**Dynamic**
QuickDASH scale	E6	4	RCT	40	?	
	E5	5	RCT	77	+	
EAV scale	E6	4	RCT	40	?	
	E8	8	RCT	60	+	
BDI-II scale	E7	8	QE	6	+	
UEFI-20 scale	E7	8	QE	6	+	

RCT randomised control trial, *QE* quasi-experimental design, *S* sample, *W* interventions week.

+ Positive effect.

− Negative Effect.

? No effect.

some studies is related to the lack of information regarding the measures used for blinding of participants, professionals involved, assessors, and homogenisation of samples.

Outcomes

Table 1 shows the great diversity of instruments used to assess the impact of exergames, namely pain, functionality, range of motion, quality of life, among others *(Shoulder Pain and Disability Index-SPADI, Oxford Shoulder Score-OSS, Health-related quality of life- HRQOL: Assessment of Cancer Therapy Questionnaire General -FACT-G, FACT-B, and FACT-B + 4, Muscular strength, Ranges of motion—ROM, Pain-Visual Analogue Scale, DAS Functionality-Disabilities of the Arm, Shoulder and Hand questionnaire, Fear of movement-Tampa kinesiophobia scale—TKS, PIPER fatigue scale—muscular fatigue, static and dynamic postural control, degree to function of the upper limb ipsilateral to the mastectomy QuickDASH, Excess arm volume—EAV, Upper Extremity Functional Index 20—UEFI-20, Beck Depression Inventory—BDI-II).* Given the heterogeneity of the instruments and study designs, a meta-analysis was unable to be performed. The data are illustrated descriptively in **Table 3.**

Four of the included studies (E1, E2, E7, and E8) measured shoulder range of motion. In three of the studies, the results favour the intervention with exergames (E1, E7, E8) in some of the movements (E1: flexion and abduction, E7:abduction, external rotation, and internal rotation, E8 flexion and abduction); however, the results were not statistically significant in study E2.

With regard to pain assessment, the results of studies E5, E7, and E8 support the use of exergames, although study E2 did not obtain the same results. The strength of the affected upper limb was assessed in 3 of the studies (E2, E8, and E1), but only study E1 obtained positive results for the exergame.

Regarding SPADI (E1), TKS (E2), Beck Depression Inventory—BDI-II (E7), UEFI-20 (E7), the intervention favoured the use of the exergame. No statistically significant results were obtained for the OSS (E1) and PIPER (E3) instruments. Regarding the evaluation of functionality—Deficits of the arm shoulder and hand (DAS) (E8), static and dynamic postural control (E4), degree of functionality of the upper limb ipsilateral to the mastectomy (QuickDASH) (E5), and the excess of arm volume—EAV (E8), results are obtained in only one of the two studies.

Finally, in the assessment of quality of life with the Assessment of Cancer Therapy Questionnaire General—FACT, in study E1, no significant results were obtained using the 27-item scale (FACT-G). On the other hand, in studies E1 and E3, results favoured the use of exergames with the FACT-B + 4 scale (E1), for evaluation regarding lymphedema, and the FACT-B (E3) scale with 37 items.

Discussion

This study aimed to synthesise the existing studies on the use of exergames after surgery in people with breast cancer, and to evaluate their impact. Although other previous reviews have summarised the effects of exergames in populations with cancer patients, the present study specifically focused on the benefits in breast cancer patients[12, 13]. This systematic review is the first to consider the overall effect of exergaming interventions on the person with breast cancer after surgery.

In this review, only 8 studies were identified, including 209 women, which is considered relatively low given the large investment made in recent years on the potential of games through digital resources[20–22]. These results highlight the need for more effective use of information and communication technologies, resulting in better outcomes and a better patient experience, namely in their rehabilitation.

In this population, rehabilitation has enormous potential to positively impact functional recovery and prevent complications, allowing an early return to daily activities and reintegration into society [7, 23, 24]. The use of exergames can lead to functional improvement of the upper limbs and offer the improved of ability to perform tasks of daily living[10]. Exergames are widely available and can be done at home, reducing the environmental barriers aggravated by the pandemic and increasing the person's engagement through gaming in rehabilitation. Importantly, we should consider that rehabilitation needs a change in the current paradigm towards hybrid care, developing and implementing new resources for remote intervention, namely the exergames triggered by the difficulties imposed by the pandemic[25].

The results favour the intervention with exergames in some of the movements[9,10,18] (flexion and abduction, abduction, external rotation, and internal rotation, flexion and abduction).

With regard to pain assessment, the results of some studies[10,16,18] support the use of exergames. The strength of the affected upper limb only one study obtained positive results for the exergame[9]. Regarding SPADI[9], TKS[14], Beck Depression Inventory- BDI-II[18], UEFI-20[18], the intervention favoured the use of the exergame.

Although our findings did not provide evidence for a positive impact of exergames in all the outcomes analysed, it was possible to observe their effectiveness in some of the indicators (ROM, Pain, Functionality, Depression). Despite the incomplete evidence of positive improvements related to the use of exergames, it is remarkable that no adverse event or negative impact was reported in the different studies. Despite the numerous instruments used in the different studies, none assessed the degree of satisfaction and motivation to exercise, an aspect that may favour the advantage of using exergames. A key problem in physical rehabilitation treatment is patient motivation as these treatments involve slow, repetitive, and often painful movements[26]. In this context, the motivation to play exergames is largely due to their immersive digital experiences with a multitude of stimuli and behavioural contingencies[27].

It is emphasised that the main conclusions of this study should be interpreted with caution due to the small size and variability of some sample sizes, type of surgery and adjuvant treatment, the difference in intervention time, and differences in the type of exergames used and the different study designs. Some of this information was not available in the articles under review. The small number of studies on this population highlights the need for more research in this area.

The quality of this review was enhanced by the comprehensive search strategy, precisely defined criteria for assessing research findings, and the use of two reviewers in decision-making on eligibility and assessments and methods of analysis. Despite these strengths, the review had some limitations that are worth noting for the generalizability of the results. These include the limited number of studies identified, diverse study conditions, and the notable variability of the assessment instruments, which did not allow for a meta-analysis. The results of this review should be confirmed in new high-quality studies, including randomised control groups with larger samples[14].

Conclusion

Rehabilitation is fundamental after surgery for patients with breast cancer, and the use of exergames may be an important resource for postoperative recovery. This study is the first systematic review on the topic. The studies reviewed present exergaming interventions with sizeable heterogeneity, differing in duration, frequency, and type of exergame. The postoperative phase, study design, and measurement instruments also varied widely, making it difficult to reach firm conclusions regarding their impact. However, it was possible to observe its effectiveness for some indicators (range of movement, pain, functionality, depression, and other instruments). Importantly, no negative impact was reported in any of the different studies.

Moreover, the potential of these technologies could help to motivate and challenge, so the results of our journey also allow the authors to think that it is worth enriching the rehabilitation of breast cancer patients with exergames. This will be an important challenge to congregate, thinking about new distance intervention resources for a paradigm shift to hybrid care exacerbated by the pandemic. Finally, this review suggests opportunities to strengthen the current body of knowledge with more prospective controlled studies with higher sample proportions and consider evaluation of satisfaction and motivation for the intervention.

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Consent for publication Not applicable.

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