

Examining the Efficacy of Pilates in Women with Breast Cancer Undergoing Hormonal Treatment: A Systematic Review

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ABSTRACT

Introduction: Approximately 70% to 80% of breast cancers are hormone receptor-positive, and hormonal therapy is an important pillar in their treatment. Nevertheless, any cancer itself as well as the treatment with hormonal therapy is frequently related to physical and psychological side-effects that compromise quality of life. Pilates, a mind-body exercise therapy, has emerged as a possible supportive intervention to counteract these complications.

Aim: To assess the efficacy of Pilates in enhancing physical function, symptom control, and psychological well-being in breast cancer patients treated with hormonal therapy.

Materials and Methods: A systematic review was conducted based on the recommendations by Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. Moreover, the protocol was registered on the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42024568245). Scholarly databases and search engine; PubMed, Cochrane library, Physiotherapy evidence database (PEDro) and Google Scholar were extensively searched for

Randomised Controlled/Clinical Trials (RCTs) published between January 2018 and December 2024. Studies that enrolled women (≥ 18 years) with stage 0-III breast cancer receiving hormonal therapy and undergoing a Pilates-based intervention were included. Data extraction and quality assessment were independently done by two reviewers. The PEDro scale and Cochrane Risk of Bias tool (RoB 2) were employed to evaluate methodological quality.

Results: Five RCTs were found to meet the inclusion criteria among the 2,852 articles identified. Pilates interventions differed in format and duration across the included studies. Methodological quality was fair to good, with PEDro scores of 5 to 7. Most of the studies demonstrated a low RoB; however, a few presented some concerns related to outcome measurement and participant adherence.

Conclusion: Pilates seems to be a useful adjunctive intervention for enhancing physical outcomes and managing fatigue in patients with breast cancer receiving hormonal therapy. Its psychological benefits, however, continue to lack conclusive evidence.

Keywords: Cancer patients, Exercise therapy, Female, Hormonal therapy, Oestrogen Receptor Modulators

INTRODUCTION

Breast cancer is a prevalent form of cancer that primarily originates in breast tissue [1], affecting predominantly women, while also occurring in men. It is marked by the uncontrolled growth of cells, which may metastasise to other parts of the body if left untreated. Key contributors influencing the risk of developing breast cancer include age, genetic factors, family history, hormonal influences, and lifestyle choices such as alcohol consumption and obesity [2]. Early detection through screening methods can significantly improve the chances of recovery, as many patients remain asymptomatic in the early stages [3].

Its treatment options are tailored to each individual and vary widely based on determinants such as the cancer's stage and type, along with the patient's health and personal preferences. Standard treatments include surgery to remove the tumour and sometimes nearby tissue; chemotherapy, which uses potent drugs to destroy cancer cells; radiation therapy, which applies high-energy rays to eliminate the cancer cells [4]; hormone therapy, utilised for hormone receptor-positive breast cancers, to block hormones production that fuel cancer growth; targeted therapy, that employs drugs targeting specific molecules involved in the development and survival of cancer cells; and immunotherapy, which helps the immune system fight cancer. The healthcare team determines the optimal treatment plan for a breast cancer patient after careful consideration of these factors [5,6].

Hormonal therapy, by blocking or reducing the production of hormones like oestrogen and progesterone, helps prevent cancer

cells from growing and spreading. Some of the therapeutic agents include Selective Oestrogen Receptor Modulators (SERMs) [7], aromatase inhibitors, and Gonadotropin-Releasing Hormone (GnRH) agonists [8]. Menopausal status, tumour characteristics, and patient-specific factors further influence the optimal choice for hormonal therapy. While offering substantial clinical benefits like reduced risk of cancer recurrence, improved disease-free survival, and better long-term prognosis, hormonal therapies are associated with potential side-effects, necessitating careful patient monitoring [3].

Post-treatment complications following hormonal therapy can significantly impact a patient's quality of life and overall well-being. It can contribute to decreased bone density, thus increasing the risk of fractures and osteoporosis. Weight fluctuations can also occur, impacting body image and self-esteem. Psychological effects such as mood swings, anxiety, and depression are not uncommon due to hormonal fluctuations during treatment [9]. Lastly, some therapies may also elevate cardiovascular risks, including hypertension and elevated cholesterol levels. These complications vary based on the specific condition being treated, the type of hormonal therapy administered, and individual patient factors [10].

Pilates, a physical exercise system emphasising core strength, flexibility, postural alignment, muscle tone, balance, and mental well-being [11] presents a potential avenue for mitigating these challenges. Developed by Joseph Pilates, it employs controlled movements and proper breathing [12]. Key principles include centering, concentration, control, precision, breath, and flow [13]. It can be practiced on a

mat (Mat Pilates) or using specialised equipment (Reformer Pilates). Pilates can enhance physical function, particularly in the upper body, enhancing shoulder mobility, neck mobility, bolstering strength, flexibility, and overall functional capacity, crucial for daily activities, regaining independence, and overall well-being [9,14,15]. Beyond physical benefits, Pilates can improve mental health by reducing stress and anxiety, positively impacting body image, and overall quality of life [16]. Literature supports the effectiveness of Pilates in improving pain management, physical function, and quality of life across various conditions. Studies have shown significant improvements in functional capacities among patients with chronic pain when engaging in Pilates-based rehabilitation programs. Its application in populations with neurological conditions has also demonstrated benefits in balance and coordination [17].

Women undergoing hormonal therapy as a part of cancer treatment frequently experience a decline in physical function, characterised by reduced muscle strength, flexibility, and endurance, which can significantly compromise quality of life. Pilates, emphasising core strength, flexibility, and mind-body integration, presents a promising intervention to address these challenges. However, despite its potential, the role of Pilates in this specific population is fragmented and inconsistent.

Research Question

Therefore, the current systematic review explores the critical question, how effective are Pilates interventions at reducing post-treatment complications and enhancing physical function and quality of life among breast cancer survivors who are receiving hormonal therapy?

MATERIALS AND METHODS

Protocol and Registration

The present systematic review was conducted following the guidelines outlined by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) [18]. Adhering to these guidelines enhances the reliability and comprehensiveness of the review process. The review was registered in PROSPERO [19] on 02/08/2024 with the PROSPERO ID CRD42024568245, which can be accessed through PROSPERO (<https://www.crd.york.ac.uk/PROSPERO/>).

Information Sources

The systematic review utilised a comprehensive primary search across electronic databases, including PubMed, Cochrane Library, Google Scholar, and PEDro, to identify relevant peer-reviewed articles, exploring the effectiveness of Pilates in breast cancer patients undergoing hormonal therapy. Additionally, the reference list of the identified literature was hand-searched secondarily for any other pertinent articles. Efforts were made to distinguish any grey literature if deemed feasible and relevant. The search was conducted by the primary author (JKG).

Search Strategy

The extensive search strategy was applied to the databases using a combination of keywords and Boolean operators (AND, OR) to find the most relevant literature. The central search terms included “Pilates” (with variations such as “Mat Pilates” and “Pilates Method”), “breast cancer” (and related terms like “mammary neoplasm”), and “hormonal therapy” (along with “hormonal therapy” and “endocrine therapy”). The “AND” operator joined these fundamental concepts, and “OR” was applied to add synonymous terms within every concept. The phrase “randomised controlled trial” or “RCT” was also incorporated with the application of “AND” in filtering the specified research design. Targeted search strings were modified for every database, taking into account their indexing and search functionalities, and the number of retrieved and included articles was

recorded. A detailed search strategy according to the databases has been illustrated in [Table/Fig-1].

Database/ search engines	Search Terms	Articles extracted	Articles screened
Cochrane library	Pilates, breast cancer, hormonal therapy	15	8
	Mat Pilates, breast cancer, hormonal therapy	8	8
	Pilates, women, breast cancer, hormonal therapy, Randomised Clinical Trial (RCT)	8	7
	Pilates, breast cancer	50	9
PEDro	Pilates, breast cancer, hormonal therapy	1	1
	Mat Pilates, breast cancer, hormonal therapy	1	1
	Pilates, women, breast cancer, hormonal therapy, Randomised Clinical Trial (RCT)	1	1
	Pilates, breast cancer	36	11
Medline/ PubMed	Pilates AND breast cancer AND hormonal therapy	9	8
	Mat Pilates AND breast cancer AND hormonal therapy	7	7
	Pilates AND women AND breast cancer AND hormonal therapy AND Randomised Clinical Trial (RCT)	6	4
Google scholar	Pilates, breast cancer, hormonal therapy	969	4
	Pilates, women, breast cancer, hormonal therapy, Randomised Clinical Trial (RCT)	1510	7
	Wall Pilates, women, breast cancer, hormonal therapy, Randomised Controlled and Clinical Trial (RCT)	231	3
Total		2852	79

[Table/Fig-1]: Search strategy.

Inclusion criteria: Only RCTs that assessed the efficacy of Pilates exercise intervention for women with stage 0-III breast cancer on hormonal therapy were included in the review. Full-text articles in English published between January 2018 and December 2024, peer-reviewed, were considered. Participants in these studies must be women aged ≥18 years.

Exclusion criteria: Studies whose participants were receiving active cancer treatment aside from hormonal therapy, had existing medical conditions that are contraindicative to exercise, or had impairments in cognition that might interfere with participation were not considered for inclusion. Trials that were specifically concentrating only on highly specialised or unavailable types of Pilates, those having a mixture of populations from which data regarding women with breast cancer on hormonal therapy cannot be isolated, and those in which Pilates was a small part of an overall intervention were also excluded. Case studies, observational studies, reviews, protocols, and trials for which the full text is not available or published in any other language were also excluded.

Selection criteria: The selection of the relevant studies adhered to the Population, Intervention, Comparator, Outcomes, Study design (PICOS) framework: comprising (P) women diagnosed with stage 0 to III breast cancer and are under the treatment of hormonal therapy; receiving (I) Pilates exercise intervention programs; compared to (C) control groups with either no treatment or with usual or conventional care or any other active treatments; reporting (O) on outcomes of quality of life, physical fitness, self-esteem, balance, pain scores, flexibility, or depression; and involving a (S) randomised clinical or controlled trial. It has been depicted in [Table/Fig-2].

Screening process: Upon a thorough search, all the retrieved titles and abstracts were uploaded into the Rayyan software, an online application for systematic screening of the retrieved articles. The titles and abstracts were individually screened against the selection criteria by two independent reviewers (JKG and NB). Disagreements between reviewers about whether or not a study

Population (P)	Intervention (I)	Comparators (C)	Outcome measures (O)	Study design (S)
Women diagnosed with stage 0-III breast cancer and under the treatment of hormonal therapy.	Pilates exercises	Absolute control or Noninvasive conventional or any other active treatment option (exercise, stretching, dance, or sham group)	Quality of life, Physical fitness, Self-esteem, Pain, Depression, Flexibility, and Balance.	Randomised clinical or controlled trial

[Table/Fig-2]: PICOS criteria.

is eligible were addressed by discussion and, as required, by referral to a third reviewer (SP) for resolution. Studies considered potentially eligible from the title and abstract screening were then taken forward for full-text review. The full texts were obtained and independently evaluated by the same two independent reviewers (AS and KA) against the set inclusion and exclusion criteria. Again, disagreements were settled by discussion or consultation with another reviewer (SP). Reasons for study exclusion at the full-text stage were recorded, and a PRISMA flow diagram was generated to demonstrate study selection in detail.

Data Extraction: A piloted standardised form for data extraction was created to maintain consistency among reviewers. Two reviewers (JKG and NB) independently used this form to extract data from the included full-text articles. The extracted data consisted of study characteristics (such as author, publication year, study design, sample size, participant demographics, hormonal therapy details, and Pilates intervention), control intervention details, and outcome data for all outcomes of interest (as per PICOS criteria), including measurement tools and time points. Any disagreement in the extracted data was recognised and resolved by means of discussion with the other two reviewers (AS and KA). In the event that a consensus was not achieved, another reviewer (SP) was consulted. The data extracted was then systematically arranged and prepared for a follow-up presentation.

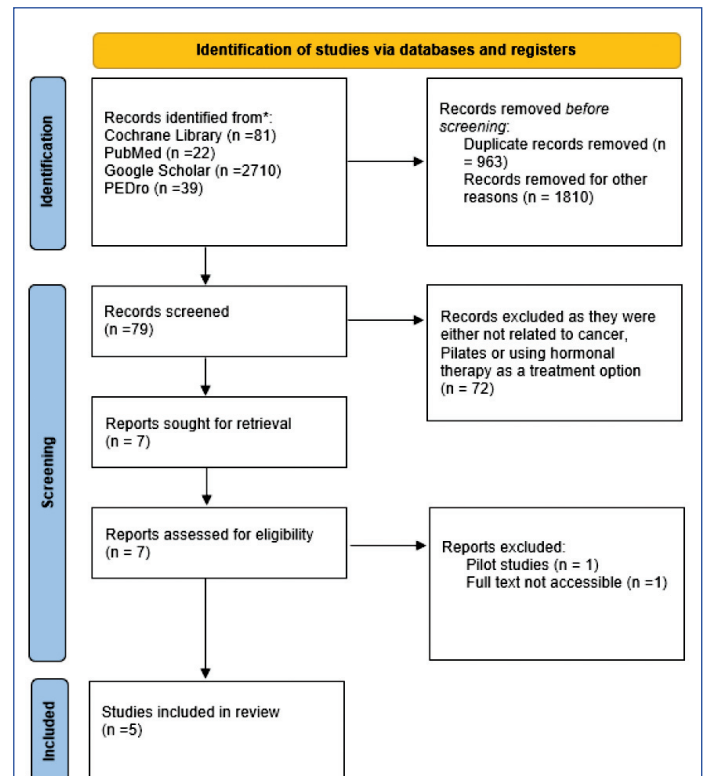
Quality Assessment: AS, KA, and SM individually evaluated the methodological quality of the chosen studies using the PEDro [20-22]. It's important to note that the response to the first question was not included while calculating the PEDro score, even though it was acquired as per the PEDro guidelines. It was excluded because it concerns external validity, while the PEDro score aims to reflect the internal validity and statistical reporting quality of the trial. The PEDro scale provides cut-off points to determine the quality of the studies, with scores of 9-10 indicating excellence, 6-8 indicating good quality, 4-5 indicating fair quality, and scores below 4 indicating poor quality.

Risk of Bias (RoB) Assessment: JKG and SP conducted a RoB evaluation on the included studies to evaluate their internal validity using version 2 of the Cochrane risk-of-bias tool for randomised trials (RoB 2), specifically designed for effective practice and organisation of care reviews. RoB 2 employs a predetermined set of bias domains that target various facets of trial planning, execution, and documentation. Each domain includes a set of 'signaling questions,' designed to extract details about trial features pertinent to bias risk.

RESULTS

Studies selection: Out of 2852 initially searched articles, including 963 duplicates, only 79 were screened based on titles and abstracts. Amongst them, considering the area of interest, a few articles were excluded as 72 were not relevant to breast cancer or Pilates, or didn't include hormonal therapy as a treatment option, one was a pilot study, and one was just the abstract. Therefore, upon scrutiny, only five articles are included in this systematic review [Table/Fig-3].

Studies characteristics: The nature of studies within the systematic review reveals a concentration on specific demographics: women diagnosed with breast cancer who were also undergoing concurrent hormonal treatment. The age range of the participants in these studies was remarkably wide, ranging from 18 to 80 years, which implies an examination of Pilates' impact at different stages of life within this patient population [23].



[Table/Fig-3]: Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow chart.

The interventions under investigation in these studies were focused on different types and uses of Pilates, all targeting the determination of their influence on breast cancer patients undergoing hormonal treatment. These were mostly mat Pilates programmes [9,24-33]. Pilates was compared with circuit-based exercise in some trials, and belly dance or educational programmes were used as comparators in others. Control groups were mostly women continuing with their usual practice or receiving educational classes.

The measures studied across this literature were diverse, covering prime aspects of well-being and physical functioning that are pertinent to survivors of breast cancer. These were subjective outcomes, including quality of life, self-esteem, and depression, in addition to objective or objective assessment measures of physical fitness, pain, flexibility, and balance, along with postural alignment, muscle strength, fatigue, quality of sleep, sexual function, and lymphoedema [25]. This broad range of assessment of outcomes was undertaken to gain a global perspective of the potential benefits of Pilates for this specific patient group. The details of the study characteristics are illustrated in [Table/Fig-4] [9,23-26].

Results of Individual Studies

The studies included in this review produced mixed findings regarding the impact of Pilates on women undergoing hormone therapy for breast cancer. The studies demonstrated no consistent effect of Pilates on depression or self-esteem, with most studies showing no significant difference compared to either control or alternative exercise interventions. For quality of life, Pilates had potential in improving certain domains, particularly fatigue and emotional well-being, while the overall physical activity level changes were modest and influenced by adherence to the study intervention.

Study	Place	Objective	Population	Intervention	Comparator	Outcome measures
Boing L et al., (2023) [23]	Florianopolis, Brazil	To assess the effects of Pilates and belly dance interventions on the quality of life of women with breast cancer undergoing clinical treatment, and to evaluate the impact of these interventions on physical and psychological aspects related to breast cancer treatment.	Women aged ≥ 18 years, stages 0-III breast cancer, receiving adjuvant hormone therapy	Pilates (3 $\times$ /week, 60 min/session, 16 weeks; long-term follow-up planned (6, 12, 24 months))	Belly dance (3 $\times$ /week, 60 min/session, 16 weeks; long-term follow-up planned (6, 12, 24 months))	EORTC QLQ-C30, 6MWT, Cycle Ergometer, Arm Circumference, IPAQ-short version, DASH, Goniometer test, Dynamometer test, Sit & Reach, BDI, BIBCQ, Rosenberg, FACT-F, VAS, FSFI, PSQI
Leite B et al., (2021) [24]	Brazil	To analyse the effect of belly dance or mat Pilates on upper limb range of motion, self-esteem, and depressive symptoms in women with breast cancer receiving hormone therapy.	Women with breast cancer undergoing adjuvant hormone therapy	Mat Pilates (3 $\times$ /week, 60 min/session, 16 weeks)	Belly dance (3 $\times$ /week, 60 min/session, 16 weeks) Educational lectures and routine activities (3 $\times$ /week, 60 min/session, 16 weeks)	BDI, EAR
Barbosa KP et al., (2021) [9]	Brazil	To investigate the effect of Pilates compared with circuit-based exercise in reducing arthralgia and its consequences on upper limb function and quality of life in women during hormone therapy.	Women aged ≥ 18 years, stages 0-III breast cancer, with hormone therapy-induced arthralgia.	Mat Pilates (2 $\times$ /week, 75 min/session, 8 weeks)	Circuit-based training (2 $\times$ /week, 75 min/session, 8 weeks)	NPRS, BPI, DASH, Sit & Reach, PSQI
Fretta TB et al., (2021) [25]	Florianopolis, Brazil	To evaluate the effects of the mat Pilates method on postural adjustment and balance in breast cancer patients undergoing hormone therapy.	Women aged ≥ 18 years, stages 0-III breast cancer, on hormone therapy	Mat Pilates (3 $\times$ /week, 60 min/session, 16 weeks)	Routine activities with stretching, self-esteem, and lymphedema prevention (3 $\times$ /week, 60 min/session, 16 weeks)	SAPO, Mini-BESTest Balance Assessment
Bertoli J et al., (2022) [26]	Brazil	To determine the effects of adherence to a Pilates program on muscle strength and flexibility in women with breast cancer undergoing hormone therapy.	Women aged ≥ 40 years, stages 0-III breast cancer, receiving hormone therapy	Mat Pilates (3 $\times$ /week, 60 min/session, 24 weeks)	No intervention	Shoulder abductor strength, Trunk extensor strength by isokinetic dynamometer, Handgrip by hand-held dynamometer, Physical activity by accelerometer, Flexibility by Sit & Reach

[Table/Fig-4]: Study characteristic [9,23-26].

EORTC QLQ-C30: European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire – Core 30; 6MWT: Six-Minute Walk Test; IPAQ-short version – International Physical Activity Questionnaire (short version); DASH: Disabilities of the Arm, Shoulder and Hand questionnaire; BDI – Beck Depression Inventory; BIBCQ: Body Image after Breast Cancer Questionnaire; FACT-F: Functional Assessment of Cancer Therapy – Fatigue; VAS: Visual Analogue Scale; FSFI – Female Sexual Function Index; PSQI: Pittsburgh Sleep Quality Index; EAR: Rosenberg Self-Esteem Scale (Escala de Autoestima de Rosenberg – Brazilian version); NPRS – Numeric Pain Rating Scale; BPI: Brief Pain Inventory; SAPO: Software for Postural Assessment; Mini-BESTest: Mini Balance Evaluation Systems Test

There was variability around pain-related outcomes. One study showed there was no significant change in general pain, while another showed improved joint pain resulting from hormone therapy. Balance outcomes were also varied, where one of the studies indicated a benefit in postural control and alignment, and the other study had no significant effect. Flexibility showed the most robust improvement, with participants with higher adherence demonstrating more improvement.

In summary, Pilates may offer targeted benefits in select areas such as fatigue, pain management, balance, and flexibility following breast cancer treatment, but there may be limited and variable benefits with respect to depression, self-esteem, and physical fitness in general. A summary of the findings for each study is represented in [Table/Fig-5] [9, 23-26].

Quality Assessment

The PEDro scores for all the studies included in the analysis fall within the range of 5 to 7, indicating that the quality of the studies varied from fair to good. It is important to note that only one study by Leite B et al., implemented blinding for assessors [24]; studies by Barbosa KP et al., and Bertoli J et al., were the only studies with concealed allocation [9,26]. Regarding the allocation of subjects, all the studies used random allocation methods. Three studies by Boing L et al., Barbosa KP et al., and Bertoli J et al., included measures of at least one key outcome obtained from more than 85% of the subjects initially allocated to groups [9,23,26]. The summary of the quality assessment for each study is presented in [Table/Fig-6].

Risk of Bias (RoB) Assessment

[Table/Fig-7,8] [9,23-26] provide a summary of the RoB in the included studies. Overall, four studies demonstrate a low RoB.

Specifically, studies by Boing L et al., (2020) [23], Leite B et al., (2021) [24], Barbosa KP et al., (2021) [9], and Bertoli J et al., (2022) [26] exhibit low overall bias. Barbosa KP et al.'s studies raise some concerns regarding outcome measurement, and Bertoli J et al., raise some concerns about missing data [26]. A study by Fretta TB et al., has some concerns about bias due to deviation from the intended intervention and related to the measurement of outcome measures [25].

DISCUSSION

The current systematic review of five RCTs examined the effects of Pilates on women with breast cancer undergoing hormone therapy. There was fair to good methodological quality of the studies included in the review, as demonstrated by a PEDro score of 5-7, and the majority of interventions involved mat-based Pilates treatment, administered for 2 to 3 times per week for 8-24 weeks.

Physical Outcomes

Pilates produced significant positive effects on flexibility and other areas of physical fitness. Bertoli J et al., (2022) found improved shoulder abductor strength and trunk extensor strength, and flexibility in the participants with adherence, who had greater flexibility improvements [26]. Barbosa KP et al., (2021) also used the Sit & Reach Test and found improved flexibility after an 8-week program [9]. The findings of the current review is in accordance with the prior literature, that suggest an improvement in flexibility and trunk and shoulder strength could be attributed to the fact that, Pilates emphasises low impact, controlled movements to exercise within the body's range of motion and has been shown to increase overall joint mobility and endurance of the muscles used when moving with control; these factors could reduce the likelihood of stiffness related

Depression			
Study	Outcome Measures	Result	Conclusion
Boing L et al., (2023) [23]	BDI	Both Pilates and belly dance groups showed reduced depressive symptoms post-intervention, but no statistically significant difference between groups ($p>0.05$).	Pilates did not show a superior effect over belly dance in reducing depressive symptoms.
Leite B et al., (2021) [24]	BDI	Depressive symptoms decreased in both groups after 16 weeks, but the change was not statistically significant between groups ($p=0.214$).	Mat Pilates was not more effective than belly dance in reducing depressive symptoms.
Quality of Life			
Study	Outcome Measures	Result	Conclusion
Boing L et al., (2023) [23]	EORTC QLQ-C30	Pilates group showed significant improvement in fatigue and emotional function compared to control ($p<0.05$); effects sustained during 6- and 12-month follow-up.	Pilates positively influenced fatigue and emotional domains of quality of life.
Physical Fitness			
Study	Outcome Measures	Result	Conclusion
Boing L et al., (2023) [23]	IPAQ short form	Physical activity levels showed a modest increase in both groups, with no significant between-group difference ($p=0.64$).	Pilates did not significantly outperform belly dance in improving overall physical activity levels.
Bertoli J et al., (2022) [26]	Physical activity by accelerometer	High training adherence significantly improved flexibility and left shoulder abductor strength, while low adherence surprisingly improved a broader range of strength parameters (trunk, both shoulders, handgrip, peak torque), with no difference in physical activity level between the groups.	High adherence to Pilates positively influenced physical activity levels in women undergoing hormone therapy.
Self-Esteem			
Study	Outcome Measures	Result	Conclusion
Leite B et al., (2021) [24]	EAR	Self-esteem scores changed minimally, with no significant difference between groups ($p=0.276$).	Mat Pilates did not improve self-esteem compared to belly dance.
Pain			
Study	Outcome Measures	Result	Conclusion
Boing L et al., (2023) [23]	VAS	Pain scores decreased slightly, with no significant difference ($p = 0.41$)	Pilates was not superior to belly dance in reducing pain.
Barbosa KP et al., (2021) [9]	NPRS	Arthralgia reduced significantly in the Pilates group compared to circuit exercise; between-group difference -1.3; ($p=0.020$)	Pilates effectively reduced hormone therapy-induced joint pain.
Balance			
Study	Outcome Measures	Result	Conclusion
Barbosa KP et al., (2021) [9]	Bioimpedance balance	Balance scores showed negligible change with no significant difference ($p = 0.62$).	Pilates did not improve balance compared to circuit training.
Fretta TB et al., (2021) [25]	MINI-BESTest Balance Assessment	Balance improved significantly in the Pilates group (+2.4 points; $p=0.034$), along with better postural alignment (iliac spine: $p=0.039$; acromion: $p=0.016$).	Pilates enhances balance and postural control.
Flexibility			
Study	Outcome Measures	Result	Conclusion
Boing L et al., (2023) [23]	Sit & Reach Test	Flexibility increased slightly in the Pilates group and belly dance group, with no significant difference ($p=0.12$).	Pilates did not significantly outperform belly dance for flexibility.
Barbosa KP et al., (2021) [9]	Sit & Reach Test	Flexibility improved significantly in the Pilates group ($p<0.05$).	Pilates improved flexibility in women with hormone therapy-induced arthralgia.
Bertoli J et al., (2022) [26]	Sit & Reach Test	High training adherence significantly improved flexibility and left shoulder abductor strength, while low adherence surprisingly improved a broader range of strength parameters (trunk, both shoulders, handgrip, peak torque), with no difference in physical activity level between the groups.	Higher adherence to Pilates resulted in greater flexibility improvement.

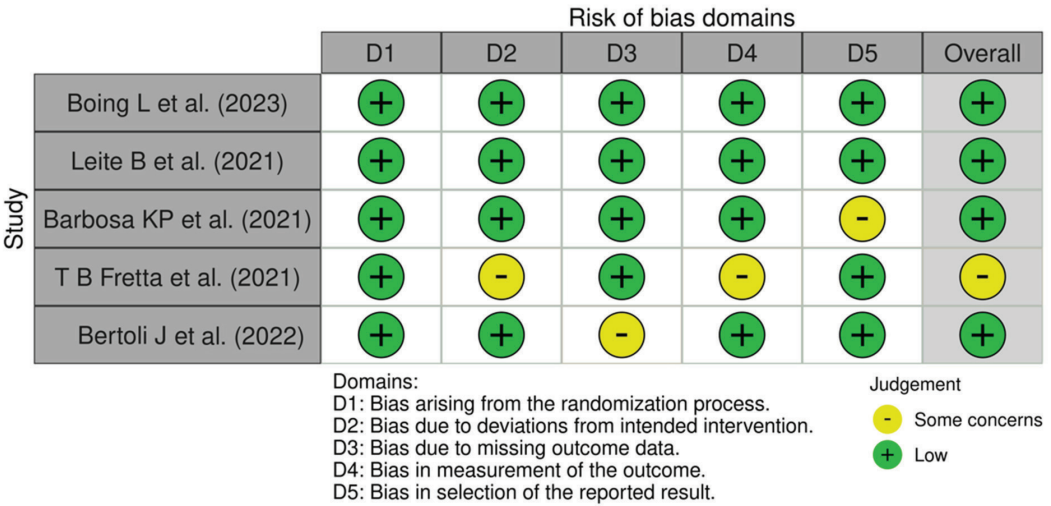
[Table/Fig-5]: Results of individual studies [9, 23-26].

EORTC QLQ-C30: European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire – Core 30; BDI: Beck Depression Inventory; IPAQ: short version – International Physical Activity Questionnaire (short version); EAR: Rosenberg Self-Esteem Scale (Escala de Autoestima de Rosenberg – Brazilian version); NPRS: Numeric Pain Rating Scale; VAS: Visual Analogue Scale; Mini-BESTest: Mini Balance Evaluation Systems Test

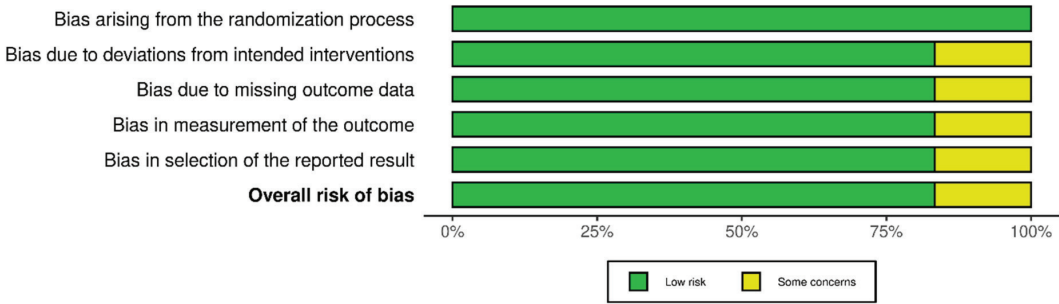
Author/Year	1	2	3	4	5	6	7	8	9	10	11	Total	Quality
Boing L et al., (2023) [23]	1	1	0	1	0	0	0	1	1	1	1	6/10	Good
Leite B et al., (2021) [24]	1	1	0	1	0	0	1	0	1	1	1	6/10	Good
Barbosa KP et al., (2021) [9]	1	1	1	1	0	0	0	1	1	1	1	7/10	Good
Fretta TB et al., (2021) [25]	1	1	0	1	0	0	0	0	1	1	1	5/10	Fair
Bertoli J et al., (2022) [26]	1	1	1	1	0	0	0	1	1	1	1	7/10	Good

[Table/Fig-6]: Quality assessment of the included studies using PEDro [9,23-26].

1. Eligibility criteria were specified; 2. subjects were randomly allocated to groups; 3. allocation was concealed; 4. the groups were similar at baseline; 5. There was blinding of all subjects; 6. There was blinding of all therapists who administered the therapy; 7. There was blinding of all assessors who measured at least one key outcome; 8. Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups; 9. intention to treat analysis; 10. Comparison between the groups; 11. The study provides measures of variability. Each positive point in studies is given a score of 1 on 0 to 10 scale. Interpretation of PEDro scores: 0-3 are considered 'poor', 4-5 'fair', 6-8 'good', and 9-10 'excellent'.



[Table/Fig-7]: Traffic light plot [9, 23-26].



[Table/Fig-8]: Summary plot [9, 23-26].

to hormone therapy [3]. Moreover, hormonal therapies, especially aromatase inhibitors, are known to contribute to musculoskeletal degeneration and promote weakness, fatigue, and stiffness. Pilates, in its controlled and low-level exercise movements, can potentially overcome these negative effects through improved neuromuscular function and maintenance of mobility [27].

Quality of Life

Considering the generalised quality of life, Boing L et al., (2020) discovered important improvements in the fatigue and emotional function domains of the EORTC QLQ-C30 within the Pilates group, maintained for up to 12 months [23]. This is consistent with previous evidence that mind-body exercises, such as Pilates, may reduce cancer-related fatigue through better circulation, neuromuscular activation, and greater regulation of stress [28]. Additionally, this could be due to the mind-body relationship created by Pilates, encouraging controlled breathing, concentration, and relaxation, all of which can have beneficial effects on treatment-related fatigue and daily functioning. The organised, rhythmical aspects of Pilates can also improve mood and sleeping quality indirectly, thus leading to a general improvement in quality of life [29,30].

Pain Management

Likely, findings related to pain varied. Boing L et al., (2023) did not find meaningful reductions in general pain scores, [23] whereas Barbosa KP et al., (2021) reported a meaningful decrease in hormone therapy-related arthralgia in the Pilates group compared to the circuit training group [9]. Variance may be due to the nature and specificity of pain being targeted. Arthralgia, which is more inflammatory joint pain, can be more responsive to the joint mobilisation and low-impact quality of Pilates than more generalised or neuropathic types of pain [31]. Also, variation in duration and intensity of intervention among studies could account for the discrepancy. Maybe Pilates must be supplemented by other modalities like pharmacologic management

or cognitive-behavioural therapy for more optimal pain relief. Such a conclusion is consistent with prior research on exercise for arthralgia related to aromatase inhibitors [32].

Balance

Fretta TB et al., (2021) determined improvement of balance, using the Mini-BESTest [25], while Barbosa KP et al., (2021), using bioimpedance, determined no difference [9]. The contrast found between studies likely reflects differences in the capacities to measure change and program design.

Psychological Outcomes

The findings of the effect of Pilates on depression and self-esteem were limited. Boing L et al., (2023) and Leite B et al., (2021) reported minor and non-significant improvements in depressive experiences and no meaningful differences in self-esteem [23,24]. This finding aligns with previous review studies, which concluded that exercise interventions may improve mood and reduce depression, but finding measurable changes in psychological burdens will rarely be feasible from exercising programs having complexity and depth of contributors to the cancer survivorship [33]. There may be various reasons for such findings. One is that the length of the majority of Pilates interventions would have been too short to effect measurable psychological change. Emotional healing from breast cancer and its treatments is a multifaceted, complex process frequently involving long-term psychosocial intervention. Second, the modest number of participants in a number of the studies might have resulted in inadequate statistical power. Furthermore, Pilates alone might not possess the cognitive and affective processing elements required to help the more profound psychological burdens of cancer survivors, including fear of recurrence, body image issues, and anxiety [34].

Notably, adherence to Pilates interventions seemed to play a major role in influencing outcomes. Boing L et al., (2023) found that

participants who had a previous exercise pattern were more likely to comply with the Pilates program [23]. This implies that individual motivation and initial level of physical fitness are important mediators of treatment efficacy. Low adherence can dilute the benefits seen in some trials, and this emphasises the importance of individualised, motivating, and accessible exercise programs in this group.

Some methodological variables across the studies reviewed might have contributed to the heterogeneity in outcomes. Variability in Pilates protocols, intervention duration, frequency, and intensity complicates the singling out of specific intervention effects. In addition, comparator groups were highly variable, from belly dancing to usual care, thus adding variability in control conditions. The studies also employed varying measures of outcomes, from objective measures of fitness to subjective self-reported questionnaires, making the synthesis of results even more challenging.

Limitation(s)

The strength of the evidence base is limited by small sample sizes, heterogeneous protocols, and different comparator interventions, which may explain decreased between-group effects. Additionally, most trials did not stratify participants based on type or length of hormone therapy, to which musculoskeletal and psychological symptoms are related. Lastly, all the trials were geographically limited to Brazil, thus further limiting its generalisability. In their clinical application, Pilates appears to be a safe and accessible adjunct for women undergoing hormone therapy, particularly in terms of flexibility, specific strength training for the affected regions, and addressing the arthralgia related to hormone therapy. Its place in the treatment of persons with depression, self-esteem, or general physical activity levels remains unclear; differences may require the integration of broader rehabilitation or psychosocial programs.

Future Recommendations

Further research is required with larger-scale studies with longer follow-up periods are necessary to provide more robust evidence for the effectiveness of Pilates in this population. Additionally, it is important to explore the optimal Pilates regimen for breast cancer patients, including the ideal frequency, duration, and intensity of sessions.

CONCLUSION(S)

Pilates could be an effective adjunct intervention to improve physical function, flexibility, fatigue, and balance in breast cancer patients receiving hormonal therapy, however, its effects on psychological outcomes and general pain are inconsistent and need further elucidation. The physiological effects that were found in the studies are likely related to greater muscular control, joint mobility, and mind-body associated capabilities, while the lack of psychological improvements may be attributed to the multifactorial nature of emotional rehabilitation, and variations in study design. Directly related to further clarification of the benefits of a Pilates program, future studies should highlight stronger methodological quality, standardised Pilates protocols, larger sample sizes, and greater length of follow-up, so the long-term effectiveness and delivery of Pilates can be established.

REFERENCES

- [1] Barzaman K, Karami J, Zarei Z, Hosseinzadeh A, Kazemi MH, Moradi-Kalbolandi S, et al. Breast cancer: Biology, biomarkers, and treatments. *Int Immunopharmacol*. 2020;84:106535.
- [2] Burstein HJ, Curigliano G, Thürlimann B, Weber WP, Poortmans P, Regan MM, et al. Customizing local and systemic therapies for women with early breast cancer: The St. Gallen International Consensus Guidelines for treatment of early breast cancer 2021. *Ann Oncol*. 2021;32(10):1216-35.
- [3] Eyigor S, Karapolat H, Yesil H, Uslu R, Durmaz B. Effects of pilates exercises on functional capacity, flexibility, fatigue, depression and quality of life in female breast cancer patients: A randomized controlled study. *Eur J Phys Rehabil Med*. 2010;46(4):481-87.
- [4] Lovelace DL, McDaniel LR, Golden D. Long-term effects of breast cancer surgery, treatment, and survivor care. *J Midwifery Womens Health*. 2019;64(6):713-24.
- [5] Wang J, Wu SG. Breast cancer: An overview of current therapeutic strategies, challenge, and perspectives. *Breast Cancer (Dove Med Press)*. 2023;15:721-30.
- [6] Barchiesi G, Mazzotta M, Krasniqi E, Pizzuti L, Marinelli D, Capomolla E, et al. Neoadjuvant endocrine therapy in breast cancer: Current knowledge and future perspectives. *Int J Mol Sci*. 2020;21(10):3528.
- [7] Das A, Lavanya KJ, Nandini, Kaur K, Jaitak V. Effectiveness of selective estrogen receptor modulators in breast cancer therapy: An update. *Curr Med Chem*. 2023;30(29):3287-314.
- [8] Martínez-Moreno CG, Calderón-Vallejo D, Harvey S, Arámburo C, Quintanar JL. Growth Hormone (GH) and Gonadotropin-Releasing Hormone (GnRH) in the central nervous system: A potential neurological combinatory therapy? *Int J Mol Sci*. 2018;19(2):375.
- [9] Barbosa KP, da Silva LGT, Garcia PA, Freitas CA, da Silva ECF, Pereira TV, et al. Effectiveness of Pilates and circuit-based exercise in reducing arthralgia in women during hormone therapy for breast cancer: A randomized, controlled trial. *Support Care Cancer*. 2021;29(10):6051-59.
- [10] de Araujo Cazotti L, Jones A, Roger-Silva D, Ribeiro LHC, Natour J. Effectiveness of the pilates method in the treatment of chronic mechanical neck pain: A randomized controlled trial. *Arch Phys Med Rehabil*. 2018;99(9):1740-46.
- [11] Wells C, Kolt GS, Bialocerkowski A. Defining Pilates exercise: A systematic review. *Complement Ther Med*. 2012;20(4):253-62.
- [12] Panhan AC, Gonçalves M, Eltz GD, Villalba MM, Cardozo AC, Bérzin F. Core muscle activation during Pilates exercises on the Wunda chair. *J Bodyw Mov Ther*. 2021;25:165-69.
- [13] Fretta TB, Boing L, Stein F, Santos L, Guimarães ACA. Improved self-esteem after mat Pilates method intervention in breast cancer women undergoing hormone therapy: Randomized clinical trial pilot study. *Rev Bras Cineantropom Desempenho Hum*. 2021;23:e76311.
- [14] Bertoli J, Bezerra ES, Winters-Stone KM, Alberto Gobbo L, Freitas IF Júnior. Mat Pilates improves lower and upper body strength and flexibility in breast cancer survivors undergoing hormone therapy: A randomized controlled trial (HAPIMat study). *Disabil Rehabil*. 2023;45(3):494-503.
- [15] Leite B, Andreatta Denig L, Boing L, de Bem Fretta T, Coutinho de Azevedo Guimarães A. Effects of Pilates method on quality of life, fatigue and sleep quality among breast cancer women receiving hormone therapy - Two-arm randomized clinical trial. *J Bodyw Mov Ther*. 2024;37:18-24.
- [16] Jacinta A, Staffurth J. Hormonal therapy for cancer. *Medicine*. 2016;44(1):30-33.
- [17] Rodríguez-Fuentes G, Silveira-Pereira L, Ferradáns-Rodríguez P, Campo-Prieto P. Therapeutic effects of the pilates method in patients with multiple sclerosis: A systematic review. *J Clin Med*. 2022;11(3):683.
- [18] 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. *BMJ*. 2021;372:n71.
- [19] Schiavo JH. PROSPERO: An international register of systematic review protocols. *Med Ref Serv Q*. 2019;38(2):171-80.
- [20] Maher CG, Sherrington C, Herbert RD. Reliability of the PEDro scale for rating quality of randomized controlled trials. *Phys Ther*. 2003;83(8):713-21.
- [21] Moseley AM, Herbert RD, Sherrington C, Maher CG. Evidence for physiotherapy practice: A survey of the physiotherapy evidence database (PEDro). *Aust J Physiother*. 2002;48(1):43-49.
- [22] de Morton NA. The PEDro scale is a valid measure of the methodological quality of clinical trials: A demographic study. *Aust J Physiother*. 2009;55(2):129-33.
- [23] Boing L, de Bem Fretta T, Lynch BM, Dias M, da Rosa LM, Baptista F, et al. Mat Pilates and belly dance: Effects on patient-reported outcomes among breast cancer survivors receiving hormone therapy and adherence to exercise. *Complementary Therapies in Clinical Practice*. 2023;50:101683.
- [24] Leite B, de Bem Fretta T, Boing L, Coutinho de Azevedo Guimarães A. Can belly dance and mat Pilates be effective for range of motion, self-esteem, and depressive symptoms of breast cancer women? *Complement Ther Clin Pract*. 2021;45:101483.
- [25] Fretta TB, Boing L, Baffa ADP, Borgatto AF, Coutinho de Azevedo Guimarães A. Mat pilates method improve postural alignment women undergoing hormone therapy adjunct to breast cancer treatment. *Clinical trial. Complement Ther Clin Pract*. 2021;44:101424.
- [26] Bertoli J, de Souza Bezerra E, Dos Santos SFDS, Gobbo LA, Júnior IFF. The influence of mat Pilates training adherence on strength and flexibility parameters in breast cancer survivors undergoing hormone therapy. *J Exerc Rehabil*. 2022;18(4):272-83.
- [27] da Silva LD, Shiel A, Sheahan J, McIntosh C. Six weeks of Pilates improved functional mobility, postural balance and spatiotemporal parameters of gait to decrease the risk of falls in healthy older adults. *Journal of bodywork and movement therapies*. 2022;29:01-09.
- [28] Mustian KM, Alfano CM, Heckler C, Kleckner AS, Kleckner IR, Leach CR, et al. Comparison of pharmaceutical, psychological, and exercise treatments for cancer-related fatigue: A meta-analysis. *JAMA Oncol*. 2017;3(7):961-68.
- [29] Ju M, Zhang Z, Tao X, Lin Y, Gao L, Yu W. The impact of Pilates exercise for depression symptoms in female patients: A systematic review and meta-analysis. *Medicine*. 2023;102(41):e35419.
- [30] Amzajerdí A, Keshavarz M, Ezati M, Sarvi F. The effect of Pilates exercises on sleep quality and fatigue among female students dormitory residents. *BMC Sports Science, Medicine and Rehabilitation*. 2023;15(1):67.

- [31] Barnet-Hepples T, Amorim AB, de Azevedo Nogueira C, de Melo MC, Dario AB, Latey P, et al. Pilates lessens pain and disability and improves quality of life in people with musculoskeletal conditions in the extremities: A systematic review. *Annals of Physical and Rehabilitation Medicine*. 2025;68(6):101973.
- [32] Irwin ML, Cartmel B, Gross CP, Ercolano E, Li F, Yao X, et al. Randomized exercise trial of aromatase inhibitor-induced arthralgia in breast cancer survivors. *J Clin Oncol*. 2015;33(10):1104-11.
- [33] Furmaniak AC, Menig M, Markes MH. Exercise for women receiving adjuvant therapy for breast cancer. *Cochrane Database Syst Rev*. 2016;9(9):CD005001.
- [34] Mohamed DM, Hussien AM, Kamel HE, Awad DM. Effect of Pilates exercises on fatigue in post-menopausal women. *Bulletin of Faculty of Physical Therapy*. 2023;28(1):31.

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