Est. 1841 | YORK ST JOHN UNIVERSITY

Sena Abonie, Ulric, Ackah, Martin and Kelly, Michael (2025) Effectiveness of pilates on fatigue in persons with chronic conditions: a systematic review and meta-analysis. Disability and Rehabilitation, 48 (3). pp. 571-580.

Downloaded from: https://ray.yorksj.ac.uk/id/eprint/15991/

The version presented here may differ from the published version or version of record. If you intend to cite from the work you are advised to consult the publisher's version: https://doi.org/10.1080/09638288.2025.2512406

Research at York St John (RaY) is an institutional repository. It supports the principles of open access by making the research outputs of the University available in digital form. Copyright of the items stored in RaY reside with the authors and/or other copyright owners. Users may access full text items free of charge, and may download a copy for private study or non-commercial research. For further reuse terms, see licence terms governing individual outputs. Institutional Repositories Policy Statement

RaY

Research at the University of York St John

For more information please contact RaY at ray@yorksj.ac.uk



Taylor & Francis
Taylor & Francis Group

Disability and Rehabilitation

ISSN: 0963-8288 (Print) 1464-5165 (Online) Journal homepage: www.tandfonline.com/journals/idre20

Effectiveness of pilates on fatigue in persons with chronic conditions: a systematic review and meta-analysis

Ulric Sena Abonie, Martin Ackah & Michael Kelly

To cite this article: Ulric Sena Abonie, Martin Ackah & Michael Kelly (2026) Effectiveness of pilates on fatigue in persons with chronic conditions: a systematic review and meta-analysis, Disability and Rehabilitation, 48:3, 571-580, DOI: 10.1080/09638288.2025.2512406

To link to this article: https://doi.org/10.1080/09638288.2025.2512406

© 2025 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

View supplementary material

Published online: 11 Jun 2025.

Submit your article to this journal

Article views: 2899

View related articles

View Crossmark data

Citing articles: 2 View citing articles

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=idre20

DISABILITY AND REHABILITATION
2026, VOL. 48, NO. 3, 571–580
https://doi.org/10.1080/09638288.2025.2512406

Taylor & Francis
Taylor & Francis Group

REVIEW ARTICLE

OPEN ACCESS Check for updates

Effectiveness of pilates on fatigue in persons with chronic conditions: a systematic review and meta-analysis

Ulric Sena Abonie, Martin Ackah and Michael Kelly

Department of Sport, Exercise & Rehabilitation, Northumbria University, Newcastle upon Tyne, United Kingdom

ABSTRACT

Purpose: To examine the effectiveness of Pilates on fatigue, quality of life and physical function in persons with chronic conditions and explore potential intervention moderators.

Materials and methods: PubMed, SPORTDiscus, AMED and CINAHL were systematically searched from database inception to September 2024, to identify relevant studies. Two independent reviewers screened and selected the articles and evaluated methodological quality. Studies were included if they were randomised controlled trials of Pilates to improve fatigue in persons with chronic conditions.

Results: Eighteen studies involving 812 participants were included. Pilates had a significant effect on fatigue, quality of life and physical function. Meta-analyses showed Pilates had significant effect on physical function [Hedge's $g=0.85$ (95% CI: 0.30; 1.40), $p=0.01$] but the effects on fatigue [Hedge's g $=-0.43$ (95% CI: −0.96; 0.11), $p=0.12$] and quality of life [Hedge's $g=0.49$ (95% CI: −0.40; 1.37), $p=0.28$] were not significant. Interventions with smaller duration (6–8 weeks) influenced Pilates effect on fatigue. The type of chronic condition and control did not influence effect.

Conclusions: Pilates has beneficial effects on physical function and may help reduce fatigue and improve quality of life in persons with chronic conditions. Pilates exercises used in rehabilitation settings can influence health outcomes.

IMPLICATIONS FOR REHABILITATION

- This study shows physical function improved after Pilates exercise interventions and provides a basis to integrate Pilates in function stimulation programs for persons with chronic conditions.
- Pilates is a plausible rehabilitation strategy for persons with chronic conditions and the effects are not influenced by the type of condition.
- Pilates exercises can feasibly be implemented in standard health care of persons with chronic conditions to improve physical function and manage fatigue.

ARTICLE HISTORY
Received 2 January 2025
Revised 22 May 2025
Accepted 23 May 2025

KEYWORDS
Pilates; transdiagnostic; fatigue; rehabilitation; quality of life; physical function

Introduction

Chronic conditions are a significant burden on individuals, healthcare and society [1] and leading cause of death and disability worldwide [2]. The prevalence of chronic conditions increases with age, with approximately one-third (29.3%) of individuals in the UK having at least one chronic condition (ranging from 6.6% in those aged 0–19 years to 82.9% in those aged 80 years and above) [1]. Fatigue is commonly reported by individuals with various chronic conditions (e.g., multiple sclerosis, cancer, Parkinson disease, diabetes, and rheumatoid arthritis), with a prevalence cited between 25 and 78% [3–6]. Fatigue is complex, and characterised by persistent and profound bodily weariness [7], which severely debilitates individuals with various chronic conditions ability to perform routine tasks and engage in physical activity, thereby leading to a decrease in their overall quality of life [7–9].

Evidence suggests that exercise has health-enhancing impact such as positive effects on physical functioning, quality of life and fatigue in individuals with chronic conditions [10–15]. However, participation or maintenance within exercise programmes for those with chronic conditions experiencing fatigue is limited [16–18]. Consequently, adherence to structured mainstream exercise regimens remains a significant challenge for individuals with chronic conditions [19,20]. Barriers to participation including, but not limited to, fatigue, lack of time and motivation have been reported in individuals with multiple sclerosis [21], diabetes [22] and Parkinson's disease [23]. Therefore, alternative forms of exercise may be important to meet their specific needs [24].

In this context, Pilates, a mind-body approach to exercise, requiring core stability, strength and flexibility with a focus on muscle control, posture and breathing [25], may be an alternative approach for individuals with chronic conditions and fatigue. Pilates is a low-to-moderate intensity and predominantly floor based [25,26] with adherence rates reported between (80 and 92%) [27,28], and therefore could be suited to individuals with chronic conditions experiencing fatigue, to promote engagement in physical activity and consequently reduce fatigue [29]. Pilates is frequently utilised and advocated for individuals with chronic conditions including diabetes, cardiorespiratory disease, cardiovascular disease, cancer [30], musculoskeletal conditions [31] and stroke [32]. While Pilates has been recognised as a valid

CONTACT Ulric S. Abonie ulric.abonie@northumbria.ac.uk Department of Sport, Exercise & Rehabilitation, Northumbria University, Coach Lane Campus East, Newcastle upon Tyne NE7 7XA, United Kingdom

Supplemental data for this article can be accessed online at https://doi.org/10.1080/09638288.2025.2512406.

© 2025 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group
This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

rehabilitation strategy, offering potential, it remains poorly researched with very little literature on its effect on fatigue [24,28].

Previous reviews [24,26,33–35] and primary studies [36–40] investigating the effects of Pilates on fatigue have been inconsistent and inconclusive and often focus on one specific chronic condition rather than addressing the symptom itself, despite its prevalence in various chronic conditions[19]. While some studies have demonstrated a significant improvement in fatigue [36–38], quality of life [35] and physical function [40], others have shown no improvement in fatigue [39,40], quality of life [40] and physical function [41]. These findings highlight uncertainty and confusion about the effect of Pilates on fatigue, physical functioning, and quality of life in people with chronic conditions associated with fatigue symptoms.

Taking a transdiagnostic approach to examine fatigue across multiple chronic conditions, considering its common occurrence in chronic condition [42,43] could provide valuable insight into the effectiveness of fatigue management strategies [19]. The existing literature lacks comprehensive reviews encompassing a wide range of chronic conditions. Therefore, in this current review, a transdiagnostic approach was adopted, focusing on a diverse range of chronic conditions to comprehensively synthesise the effectiveness of Pilates methods on fatigue, quality of life and physical function in persons with chronic conditions, and explore potential intervention moderators (e.g., session duration, mode of delivery, and length of interventions).

Materials and methods

Protocol development and registration

The protocol was developed and conducted in accordance with the principles outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [44] and was registered with the International Prospective Register of Systematic Reviews (PROSPERO) database (CRD42024588553), ensuring the adherence to best practices [45].

Inclusion and exclusion criteria

The review included studies focusing on people with chronic conditions who experienced symptoms of fatigue and were aged 18 years or older. The study only considered randomised controlled trials published in peer-reviewed journals in English, evaluating the effects of Pilates exercises and their variants (e.g., mat Pilates) on fatigue in persons with chronic conditions, with no restriction on time of publications.

Pilates exercise interventions could be either standalone or in combination with other supplements (provided at least one group received a Pilates exercise only intervention). The comparator groups could be usual or standard care, education, relaxation, other therapies or those on a waitlist. Non-randomised controlled trials, observational studies, and systematic reviews were excluded from the review. The primary outcome of interest was fatigue. The secondary outcomes were quality of life and physical function.

Data sources and development of search strategies

Articles published prior to September 2024 were identified using the following databases: PubMed, SPORTDiscus, Allied and Complementary Medicine Database (AMED) and the Cumulated Index of Nursing and Allied Health Literature (CINAHL). Medical Subject Headings (MeSH) and free text terms were used in the search process. Keywords included Pilate*, "Pilate exercise*," "Pilate training," "mat Pilate," fatigue, tiredness, lassitude, and their variations. These terms were combined using the Boolean operators "AND" and "OR". The reference lists of some articles were searched in a snowball format to identify potential studies for inclusion [46,47]. Supplementary File S1 is the search strategy.

Data screening, selection, and extraction methods

The screening process was conducted in two stages. First, the titles and abstracts of the studies were independently reviewed by MA and USA. In the second stage, the same authors independently conducted a comprehensive full-text screening. Disagreements were resolved through discussion. A screening guide was employed to ensure that independent reviewers consistently applied the selection criteria. Data extraction was done by MA, with a secondary check by USA. Extracted information included the first author's name and year, type of chronic condition, intervention and control, structure of sessions and assessment, and outcome measured.

Quality and risk of bias assessment

The Cochrane Risk of Bias (ROB-2) [48] tool was used to assess the risk of bias within the included studies. The tool assessed five domains: sequence generation, allocation concealment, blinding, incomplete outcome reporting, and selective outcome reporting. Within each domain, the risk of bias was rated as "low," "high," "some concerns," or "no information." Additionally, an overall risk of bias was assigned a rating of "low," "high," "some concerns," or "no information." The risk of bias was independently assessed by USA and MA, and disagreements were solved by consensus. Additionally, the Physiotherapy Evidence Database (PEDro) scale was employed to evaluate the methodological quality of the included studies [49,50]. We used the assessments and ratings that have been published and made publicly available for each study on the PEDro website (https://search.pedro.org.au/search). Studies achieving a score of at least six points were classified as high quality, whereas those receiving a score of below six were categorised as low quality [49,50]

Data synthesis

Firstly, a systematic review of the outcomes was performed. Secondly, a meta-analysis was carried out if at least two studies reported the outcome data. For studies that reported standard errors instead of standard deviation, the formula [SD = se $\sqrt{n}$] (SD = standard deviation, se = standard error, *n*=sample size) was used to calculate the standard deviation. The Random effects modelling method proposed by DerSimonian and Laird [51] was used to pool effects of Pilates exercise on fatigue, quality of life, and physical function. Pooled effect sizes were estimated using Hedge's *g* [52] with corresponding 95% Confidence Interval (CI). Heterogeneity (I^2) amongst the studies were quantified and interpreted according to Higgins and Thompson classification where 25, 50 and ≥75% were considered as low, moderate and high heterogeneity, respectively [53]. Subgroup analyses were

conducted based on Pilates exercise intervention duration and the number of sessions. Additionally, a meta-regression analysis was conducted to examine how various moderator variables affect the effect estimates. Finally, we assessed potential publication bias using both subjective methods, such as a funnel plot, and objective measures, including Egger's regression test [54]. Microsoft Excel 2013 and Stata (Stata Statistical Tools: Release 16; College Station, TX; Stata Corp LP) software were used for all statistical analyses.

Results

Four databases identified a total of 1,491 articles. Following the removal of 121 duplicate records, 1,370 unique articles underwent the initial screening process. Of these, 47 studies were selected for full-text screening to assess their eligibility based on the pre-established inclusion criteria. Upon further evaluation, 28 studies were excluded for not meeting the eligibility criteria. Consequently, eighteen studies [32,36,38–40,55–67] were included in the final analysis. The study selection process, along with specific reasons for exclusion, is illustrated in Figure 1.

Characteristics of the included studies and interventions

The characteristics of the included study are presented in Table 1. A total of 812 adults with chronic conditions experiencing fatigue (multiple sclerosis, cancer, Parkinson disease, diabetes, and rheumatoid arthritis) were included in the study. The Pilates interventions consisted of supervised, home-based and telerehabilitation Pilates. The session duration and frequency ranged from 30 to 90 min, and once to three times per week respectively. The overall length of the interventions lasted between six weeks to 16 weeks. Fatigue was the outcome measured in eighteen studies and was assessed with the Functional Assessment of Cancer Therapy-Fatigue Subscale [68] in five studies[39,55,62,64,66], the Modified Fatigue Impact Scale [69] in five studies [32,36,58,61,63] and the Fatigue Severity Scale [54] in three studies [58]. Of the remaining studies, one [40] used the Brief Fatigue Inventory [70], another [65] used the Fatigue Impact Scale [71], another [59] the Fibromyalgia Impact Questionnaire [72], another [57] used the Parkinson Fatigue Scale [73], and the other [67] used a Visual Analog Scale [74] to measure fatigue.

Physical function was the outcome measure in seven studies and was evaluated with the six minutes walking tests (6MWT) [75] in seven studies [32,38,40,57,58,60,65], while both the 6MWT and the Time up and Go (TUG) test was used in two studies [32,57].

Quality of life was the outcome measure in ten studies, and was measured using the Multiple Sclerosis Quality of Life scale [76] in four studies [56,60,63,65] and the European Organisation for Research and Treatment of Cancer-Quality of life [77] in two studies [62,64]. Of the remaining studies one [38] used the Rheumatoid Arthritis Quality of Life [78], another [67] used the Short-Form health survey-36 [79], another [59] used the Fibromyalgia Impact Questionnaire [72], and the other [66] used the Functional Assessment of Cancer Therapy-Fatigue Subscale [68].

Risk of bias and quality assessment

Overall, the risk of bias across the included studies was evaluated using ROB-2, with five studies being determined to have a low risk of bias [32,36,38,57,65], and eight studies were rated to have some concerns[39,55,56,60,61,63,64,66]. Additionally, five studies [40,58,59,62,67] were found to present a high risk of bias (see Figure 2 for detailed visualization). A parallel assessment of study quality conducted using the Physiotherapy Evidence Database

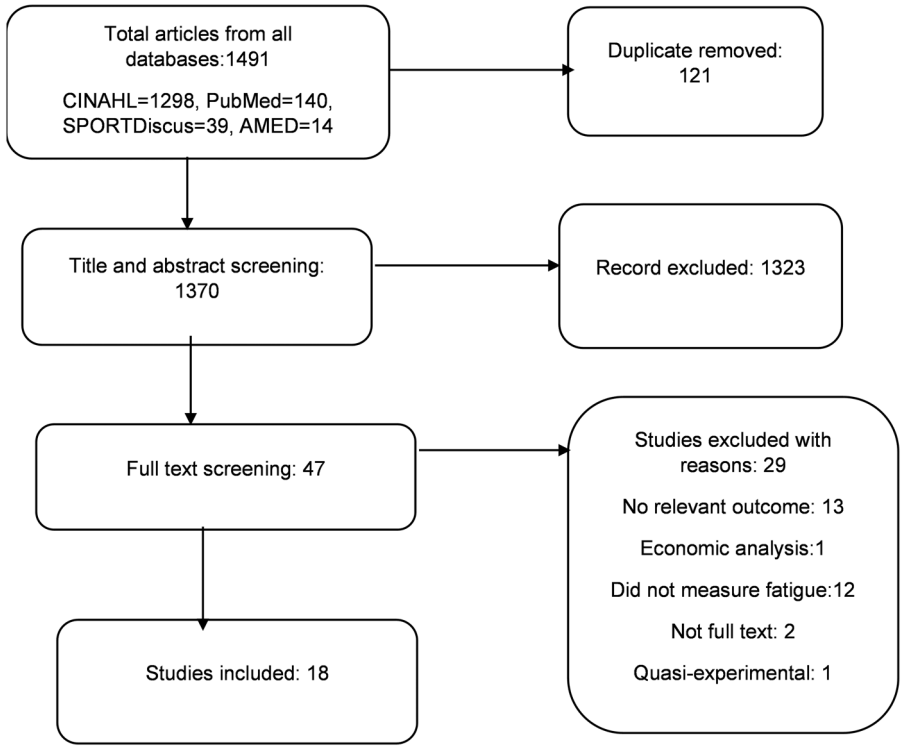


Figure 1. PRISMA flowchart for study screening and selection.

Table 1. Characteristics of the included studies and interventions.

Study ID and setting	Participants	Characteristics of Pilates intervention	Control description	Outcomes	PEDros score
Boing et al. [55] Brazil	74 Adults with breast cancer	60 Minutes supervised mat Pilates thrice a week for 16 weeks	Usual care	Fatigue	5
Bulguroglu et al. [56] Turkey	38 Adults with multiple sclerosis	90 Minutes supervised mat Pilates thrice a week for 8 weeks	Relaxation	Fatigue and quality of life	5
Çağlar et al. [57] Turkey	34 Adults with Parkinson's Disease	60 Minutes supervised Pilates thrice a week for 8 weeks	Standard care	Fatigue and physical function	7
Eftekhari et al. [58] Iran	30 Adults with multiple sclerosis	60 Minutes mat Pilates thrice a week for 8 weeks	Standard care	Fatigue and physical function	5
Ekici et al. [59] Turkey	43 Adults with fibromyalgia	60 Minutes supervised Pilates thrice a week for 4 weeks	Connective tissue massage	Fatigue and quality of life	4
Eldemir et al. [60] Turkey	40 Adults with multiple sclerosis	60 Minutes supervised tele-mat Pilates thrice a week for 6 weeks	Waitlist	Fatigue, quality of life, and physical function	5
Eyigor et al. [40] Turkey	42 Adults with breast cancer	60 Minutes supervised Pilates thrice a week for 8 weeks	Usual care	Fatigue and physical function	4
Fleming et al. [36] Ireland	80 Adults with multiple sclerosis	60 Minutes home-based mat Pilates twice a week for 8 weeks	Waitlist	Fatigue	5
Fleming et al. [61] Ireland	17 Adults with multiple sclerosis	60 Minutes home-based mat Pilates twice a week for 8 weeks	Waitlist	Fatigue	7
Kalron et al. [32] Israel	45 Adults with multiple sclerosis	30 Minutes Pilates once a week for 12 weeks	Standard care	Fatigue and physical function	7
Kavya et al. [62] India	12 Adults with breast cancer	Pilates thrice a week for 8 weeks	Aerobic training	Fatigue and quality of life	5
Küçük et al. [63] Turkey	20 Adults with multiple sclerosis	60 Minutes supervised mat Pilates twice a week for 8 weeks	Standard care	Fatigue and quality of life	5
Leite et al. [64], Brazil	34 Adults with breast cancer	60 Minutes supervised mat Pilates thrice a week for 16 weeks	Usual care	Fatigue and quality of life	5
Ozkul et al. [65] Turkey	34 Adults with multiple sclerosis	60 Minutes supervised Pilates thrice a week for 8 weeks	Relaxation	Fatigue, quality of life, and physical function	8
Saraiva et al. [66] Brazil	30 Adults with cancers	60 Minutes mat Pilates twice a week for 12 weeks	Standard care	Fatigue and quality of life	5
Torres et al. [39] United States of America	164 Adults with breast cancer	60 Minutes mat supervised mat Pilates twice a week for 6 weeks	Standard care	Fatigue	6
Yentür et al. [38] Turkey	30 Adults with rheumatoid arthritis	45 Minutes supervised Pilates thrice a week for 8 weeks	Aerobic training	Fatigue, quality of life, and physical function	6
Yucel et al. [67] Turkey	45 Adults with diabetes mellitus	45 Minutes (increased to 70 minutes) supervised mat Pilates thrice a week for 12 weeks	Standard care	Fatigue and quality of life	4

(PEDro) scale found that six studies [32,36,38,39,57,65] were moderate-to-high quality (Table 1).

Fatigue

Eighteen studies [32,36,38–40,55–67] reported Pilates effects on fatigue. Among these, fourteen studies demonstrated positive effects of Pilates exercise in reducing fatigue. In contrast, four studies [38,40,62,64] found no significant improvement in fatigue perception among adults with chronic conditions.

The pooled meta-analysis of twelve studies [32,36,40,55,57,58,60,63–67] that presented data on fatigue outcomes revealed the effect was not statistically significant when compared to the control group [g= −0.43, 95% CI: −0.96; 0.11, I^2=87.0%, p = 0.12], and the results were heterogeneous (Table 2). The exclusion of three studies [38,39,56] from the pooled analysis was due to methodological variations: two studies utilised aerobic exercise as the control group [38,39], and one study did not report standard deviation data [56].

Sub-group analysis revealed that interventions lasting 6–8 weeks had a significant effect on fatigue (g= −1.00, 95% CI: −1.57 to −0.44, p = 0.01). No effect was found for interventions that were 12–16 weeks (g = 0.29, 95% CI: −0.05 to 0.63, p = 0.09). Number of sessions did not show a significant effect on fatigue (Table 2).

The meta-regression analysis conducted to investigate the influence of moderator variables on the fatigue effect indicated that neither the type of chronic condition (z = −0.32, p = 0.75) nor the type of control (z = −1.35, p = 0.18) had a significant influence on the results. Additionally, the type of fatigue measure had no significant influence on the effect estimates (z = −0.90, p = 0.37).

Quality of life

Ten studies [38,56,59,60,62–67] investigated the effects of Pilate on quality of life for adults with chronic conditions and fatigue. The studies showed positive improvement in quality-of-life measures [38,56,59,60,62–67].

The pooled meta-analysis of six RCTs [60,63–67] revealed Pilates was did not have a greater impact on participants' quality of life [g = 0.49 (95% CI: −0.40 to 1.37, p = 0.28)]. However, substantial heterogeneity was observed in the results [I^2 = 88.3%] (Table 3). Subgroup analysis revealed no significant effects for interventions lasting 6–8 weeks (g = 0.47, 95% CI: −1.12 to 2.05) and those lasting 12–16 weeks (g = 0.50, 95% CI: −0.72 to 1.71).

Meta-regression analysis revealed the type of chronic condition (z = −0.03 p = 0.97), the type of control (z = 0.18, p = 0.85) and the outcome measure (z = −0.94, p = 0.35) did not influence effect estimates

Physical function

Seven trials [32,38,40,57,58,60,65] examined the effects of Pilates on physical function. The findings across these studies consistently demonstrated a positive impact upon physical function.

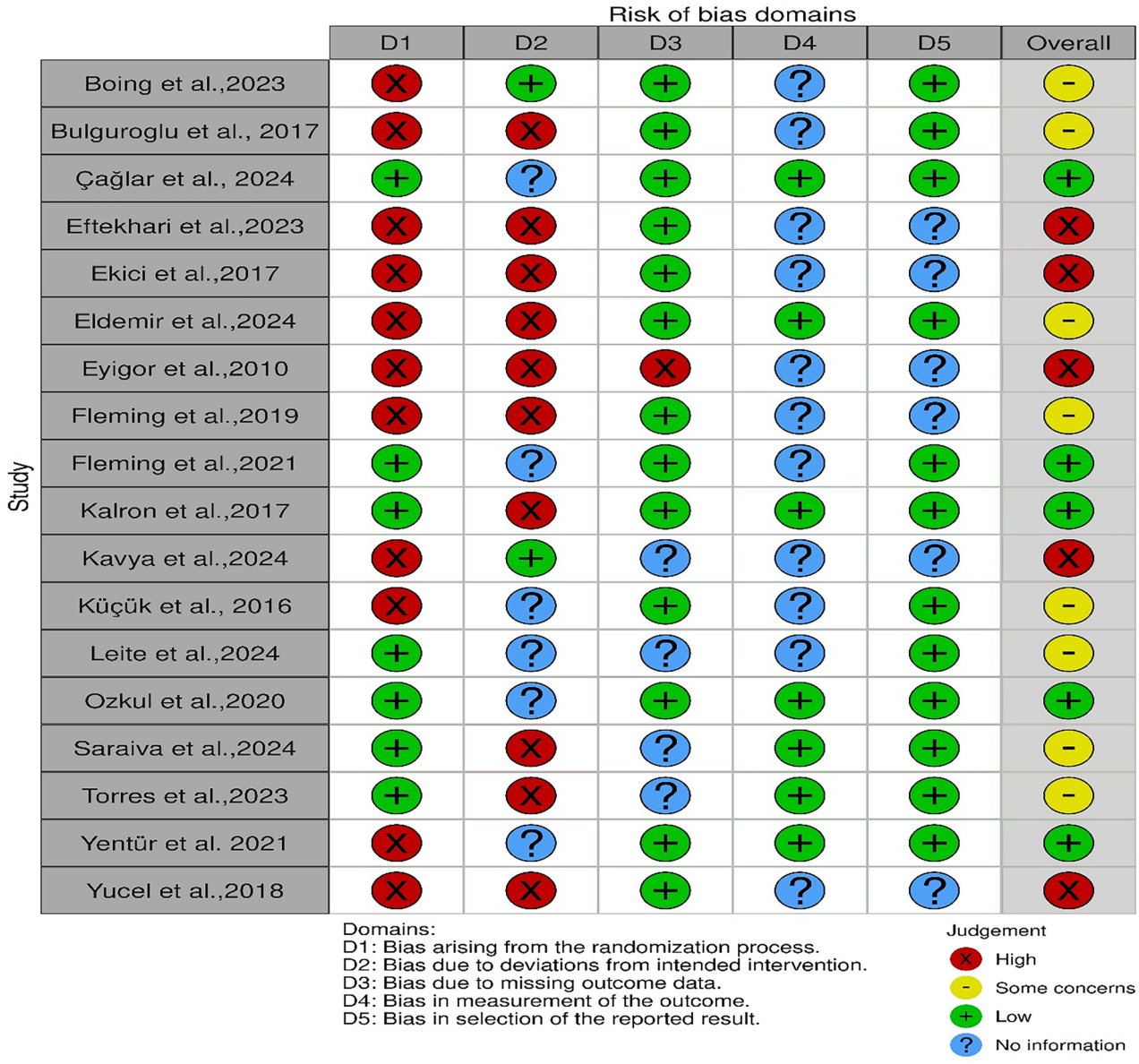


Figure 2. Risk of bias assessment of the included studies.

Table 2. Overall and sub-group analyses of Pilates effect on fatigue at post-treatment.

Fatigue	*k*	Hedge's g [95%CI]	*p*-Value	Test of group difference	I^2 (%)
Overall	12	−0.43 [−0.96; 0.11]	0.12		87.0
Duration of intervention					
6–8 Weeks	7	−1.00[−1.57; −0.44]	0.01	$Q = 14.7$, $p = 0.01$	77.4
12–16 Weeks	5	0.29[−0.05; 0.63]	0.09		32.6
Number of sessions					
≤24	9	−0.61 [−1.31; 0.09]	0.09	$Q = 3.11$, $p = 0.08$	88.7
>24	3	0.09 [−0.25; 0.43]	0.62		0.00

Legend: *k* = number of studies; I^2 = heterogeneity.

Table 3. Overall and sub-group analyses of Pilates effect on quality of life at post-treatment.

Quality of life	*k*	Hedge's g [95%CI]	*p*-Value	Test of group difference	I^2 (%)
Overall	6	0.49 [−0.40; 1.37]	0.28		88.3
Format of Pilate					
Mat Pilate	4	0.62 [−2.8; 1.52]	0.18	$Q = 0.11$, $p = 0.74$	85.3
Standard clinical Pilate	2	0.15 [−2.42;2.73]	0.91		94.8
Duration of intervention					
6–8 Weeks	3	0.47 [−1.12; 2.05]	0.56	$Q = 0.00$, $p = 0.98$	91.6
12–16 Weeks	3	0.50 [−0.72; 1.71]	0.42		88.6

k: number of studies; I^2: heterogeneity.

Similarly, the pooled analysis of six trials [32,40,57,58,60,65] indicated significant positive effects on participants' physical functioning ($g = 0.85$, 95% CI: 0.30; 1.40, $p < 0.001$) (Figure 3). However, the results exhibited considerable heterogeneity (I^2 = 73.9%). The small number of studies included in the analysis limited the ability to perform further subgroup analyses on this outcome.

Meta-regression analysis showed no significant influences of the type of chronic condition ($z = 1.41$, $p = 0.16$) and the type of control ($z = 0.22$, $p = 0.83$).

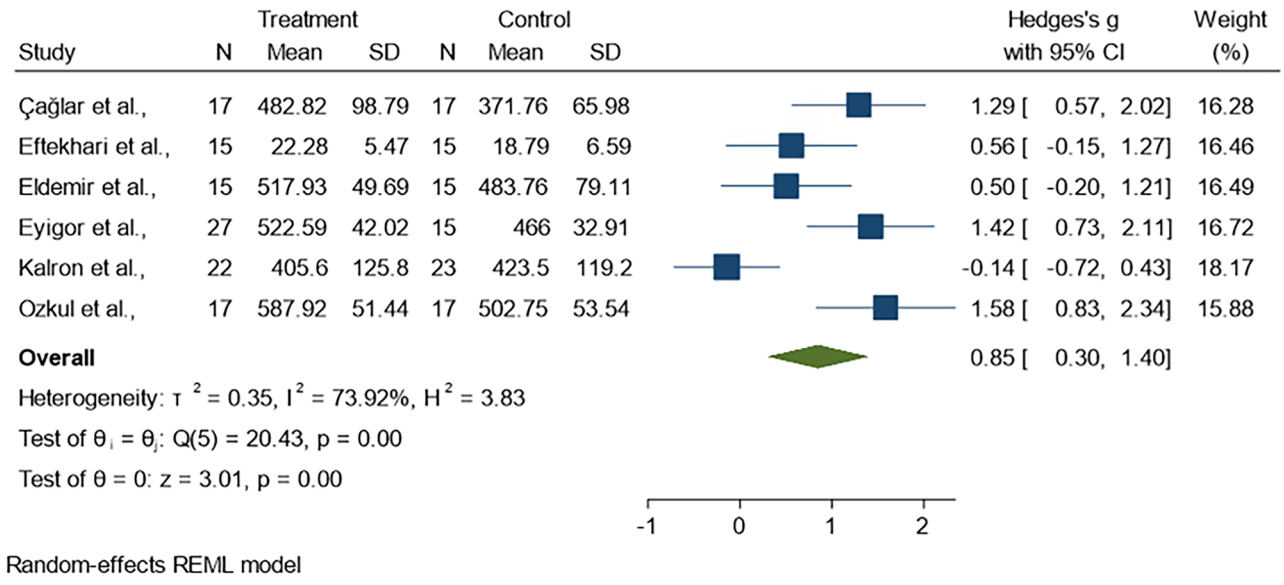


Figure 3. Pooled analysis of Pilates effect on physical function at post treatment.

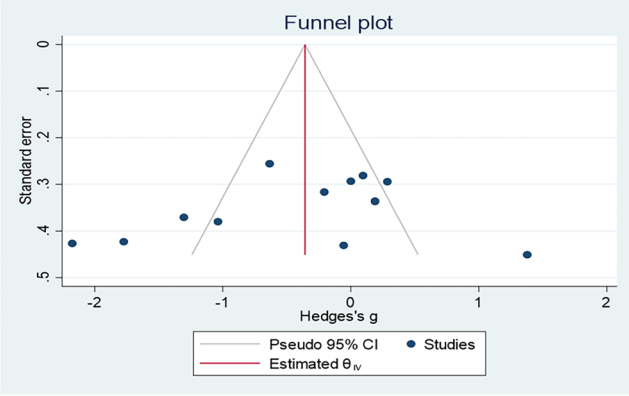


Figure 4. Assessing publication bias by funnel plot inspection.

Publication bias

Publication bias was assessed using the meta-analysed fatigue outcome. The results indicated no evidence of publication bias, as demonstrated by both the subjective visual inspection of the funnel plot [Figure 4] and the objective Egger's regression test ($z = -0.73$, $p = 0.46$).

Discussion

In this systematic review and meta-analysis, data from eighteen studies were synthesised to examine the effectiveness of Pilates interventions as a rehabilitation strategy to reduce fatigue and improve quality of life and physical function among adults with chronic conditions. To the best of our knowledge, this is the first study to comprehensively evaluate the impact of Pilates interventions on fatigue, quality of life and physical function across a range of chronic conditions. Evidence indicates that fatigue increases the risk for developing negative health outcomes, including physical decline occurs, diseases and mortality, suggesting the need for interventions [9].

The findings of the studies analysed in the review indicated, Pilates has beneficial effect on fatigue, quality of life and physical function. The results of the meta-analysis indicated that Pilates resulted in statistically significant improvements in physical function, but its effects on fatigue and quality of life was not statistically significant. A non-significant effect of Pilate interventions was found for fatigue, with the exception of fatigue when measured after 6–8 weeks. Intervention effects varied widely between studies and subsequent subgroup comparisons revealed that number of sessions was not a significant moderator of the effect of the interventions on fatigue at post-treatment. Furthermore, meta-regression analysis revealed that the type of chronic condition was not a source of heterogeneity of Pilates effect on fatigue, indicating that the type of condition did not influence the responsiveness to Pilates interventions

These findings are similar to that of previous systematic reviews and meta-analyses on the effects of Pilates interventions that pointed to non-significant influence of Pilates interventions in comparison with the control groups [28,35]. Pinto-Carral et al. [28] and Sanchez-Lastra at al. [35] in their meta-analyses on the effect of Pilates for women with breast cancer and patients with multiple sclerosis respectively, reported that Pilates interventions were not statistically more effective than the control groups. These findings are however contrary to the metanalysis by Fleming et al. [26] that found Pilates resulted in a statistically significant large reduction in feelings in persons with fibromyalgia, diabetes and postpartum fatigue. One possible explanation for the non-significant effect of Pilates for fatigue found in this current study could be the varied measures used to assess the fatigue in the included studies, as evident in the meta-regression that revealed the type of fatigue measure had a significant influence on the effect estimates.

The analysis revealed that the condition investigated within the studies, did not have a significant influence on the outcome measures. This finding is important, providing justification for the transdiagnostic approach adopted in this current review and also provides valuable insights for need the need to adopt a transdiagnostic approach to fatigue management. Regarding the intervention length, this meta-analysis revealed that trials lasting from six to eight weeks demonstrated statistically significant effect on fatigue among adults with chronic conditions. The finding is somewhat similar to that of a recent meta-analysis on the effects of physical activity interventions that pointed at the beneficial effects of minimal contact interventions on fatigue [19]. This makes a

case for Pilates as a plausible rehabilitation intervention that is less resource intensive in the context of fatigue management. The beneficial effect found for minimal duration intervention coupled with the lack of significant effect for longer duration (lasting twelve to sixteen weeks) suggest that Pilates is effective in reducing fatigue, but its effects are not expected to be superior to those resulting from other therapies beyond 6–8 weeks [28]. Thus, alternate therapies may be appropriate for greater benefits in the long-term particularly for fatigue.

Regarding quality of life, Pilates was not significantly better than control groups. However, considerable variation in effects was observed across studies, impacting the analysis. Subsequent subgroup comparisons revealed that intervention duration and number of sessions were not significant moderators of the effect of the interventions on quality of life at post-treatment. The finding is similar to that of previous meta-analyses of Pinto-Carral et al. [28] Fleming et al. [26] and Sanchez-Lastra at al. [35] that showed a large but not statistically significant effect of Pilates for quality of life in persons; with multiple sclerosis, breast cancer, fibromyalgia and diabetes. These findings are however contrary to that reported in the reviews by Miranda and Marques [30], Denham-Jones et al. [31] and Cronin et al. [32]. Miranda and Marques [30] found moderate evidence of Pilates for improving health-related quality of life in individuals with a range of chronic cardiovascular diseases, chronic respiratory diseases, cancer and diabetes. Denham-Jones et al. [31] found significant quality of life effects of Pilates in older adults with a range of chronic musculoskeletal conditions, and Cronin et al. [32] found significant effects in favour of the Pilates intervention groups on quality of life in post stroke individuals.

In the context of physical function, Pilates was significantly better than control measures, however, treatment effects varied widely between studies. The limited number of included studies reporting on the effect of Pilates on physical function limited the exploration of potential moderator effects. Previous exploration into the effects of Pilates on physical function has produced inconsistent findings. Pinto-Carral et al. [28], in their meta-analysis of Pilates effect in women with breast cancer, reported that Pilates was statistically more effective than the interventions proposed for the control groups in improving the functional status. Similarly, Denham-Jones et al. [31] found significant physical functioning effects of Pilates in older adults with a range of chronic musculoskeletal conditions, while Sanchez-Lastra at al. [35] in their meta-analysis of Pilates effect in adults with multiple sclerosis reported that Pilates was not more statistically effective compared to other therapies.

Exploring effective strategies to manage fatigue in persons with chronic conditions is of utmost importance, given that fatigue is regarded as one of the main predictors of their quality of life [7–9]. Taken together, the findings of this review indicated that Pilates could have beneficial effect on health outcomes in chronic conditions. In terms of fatigue, over the course of 6–8 weeks, Pilates is significantly better than control measures, whiles physical function is also significantly better compared to control measures. All other measures, while indicating a positive change, were non-significant.

Strengths and limitations

This review took a novel transdiagnostic approach to investigate the effects of Pilates across multiple chronic conditions and provides novel insight into the effectiveness of Pilates to provide symptomatic relief within these conditions. This approach might enhance the generalisability of the findings and provide important insights into the effects of Pilates interventions across multiple chronic conditions. The adherence to established systematic review and meta-analysis methodologies which are aligned with internationally recognised standards and recommendations are strengths of this review and provides validity for the review findings.

Nonetheless the review has some limitations. The substantial heterogeneity observed in the overall pooled effect as well as the sub-group analyses may limit the generalisability of the study findings. Additionally, half of the included studies consisted of individuals with neurological conditions. Therefore, emphasis should instead be placed on the distributions and observed patterns in the synthesised data. Furthermore, in the current review, approximately 68% of the studies were judged to be low quality, and to have some concerns or high bias, primarily due to randomisation and concealment, deviation from intended intervention and measurement of outcome.

Conclusion

The systematic review and meta-analysis of Pilates in persons with chronic conditions associated with fatigue complaints demonstrates that Pilates had significant effect on physical function without worsening fatigue and quality of life. This finding provides valuable insight that Pilates exercises used in rehabilitation settings can influence health outcomes and highlights the importance of Pilates exercise in the standard care of persons with chronic conditions. The finding that minimal duration interventions (lasting 6–8 weeks) had significant effect on fatigue is important. This provides valuable insight that Pilates intervention is a plausible low-cost and attractive rehabilitation strategy that can be feasibly implemented in standard health care and can be suitable for persons who do not need more intensive forms of treatment. Furthermore, the findings that the type of population did not influence Pilates effects underscores the need for a transdiagnostic approach to fatigue management, and also highlights the universal benefits of Pilates across chronic conditions. Notwithstanding the beneficial effects of Pilates interventions reported in this systematic review and meta-analysis and the valuable indications regarding approach of future interventions, more research is required to identify optimal features of Pilates interventions.

Acknowledgment

This research received no specific funding from public, commercial, or non-profit sectors.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

ORCID

Ulric Sena Abonie http://orcid.org/0000-0003-2509-4413
Martin Ackah http://orcid.org/0000-0002-5045-1104
Michael Kelly http://orcid.org/0000-0002-2412-9226

Data availability statement

All associated data are included in the manuscript.

References

[1] Valabhji J, Barron E, Pratt A, et al. Prevalence of multiple long-term conditions (multimorbidity) in England: a whole population study of over 60 million people. J R Soc Med. 2024;117(3):104–117. doi: 10.1177/01410768231206033.

[2] Hacker K. The burden of chronic disease. Mayo Clin Proc Innov Qual Outcomes. 2024;8(1):112–119. doi: 10.1016/j.mayocpiqo.2023.08.005.

[3] O'Mahoney LL, et al. The prevalence and long-term health effects of long Covid among hospitalised and non-hospitalised populations: a systematic review and meta-analysis. eClinicalMedicine. 2022;55:1–10. doi: 10.1016/j.eclinm.2022.101762.

[4] Zhan J, Zhang P, Wen H, et al. Global prevalence estimates of poststroke fatigue: a systematic review and meta-analysis. Int J Stroke. 2023;18(9):1040–1050. doi: 10.1177/17474930221138701.

[5] Kang YE, Yoon JH, Hyun Park N, et al. Prevalence of cancer-related fatigue based on severity: a systematic review and meta-analysis. Sci Rep. 2023;13(1):12815. doi: 10.1038/s41598-023-39046-0.

[6] Oliva Ramirez A, Keenan A, Kalau O, et al. Prevalence and burden of multiple sclerosis-related fatigue: a systematic literature review. BMC Neurol. 2021;21(1):468. doi: 10.1186/s12883-021-02396-1.

[7] J. DeLuca, Fatigue in multiple sclerosis: can we measure it and can we treat it? J Neurol. 2024;271(9):6388–6392. doi: 10.1007/s00415-024-12524-9.

[8] Fernández-de-Las-Peñas C, Palacios-Ceña D, Gómez-Mayordomo V, et al. Fatigue and dyspnoea as main persistent post-COVID-19 symptoms in previously hospitalized patients: related functional limitations and disability. Respiration. 2022;101(2):132–141. doi: 10.1159/000518854.

[9] Knoop V, Cloots B, Costenoble A, et al. Fatigue and the prediction of negative health outcomes: a systematic review with meta-analysis. Ageing Res Rev. 2021;67(February):101261. doi: 10.1016/j.arr.2021.101261.

[10] Larsson P, Bidonde J, Olsen U, et al. Association of post-stroke fatigue with physical activity and physical fitness: a systematic review and meta-analysis. Int J Stroke. 2023;18(9):1063–1070. doi: 10.1177/17474930231152132.

[11] Oliveira MR, Hoffman M, Jones AW, et al. Pulmonary rehabilitation following COVID-19 effect of pulmonary rehabilitation on exercise capacity, dyspnea, fatigue and peripheral. Arch. Phys Med Rehabil. 2024;000:1–12. doi: 10.1016/j.apmr.2024.01.007.

[12] Torres-Costoso A, Martínez-Vizcaíno V, Reina-Gutiérrez S, et al. Effect of exercise on fatigue in multiple sclerosis: a network meta-analysis comparing different types of exercise. Arch Phys Med Rehabil. 2022;103(5):970–987.e18. doi: 10.1016/j.apmr.2021.08.008.

[13] Hulme K, Safari R, Thomas S, et al. Fatigue interventions in long term, physical health conditions: a scoping review of systematic reviews. PLOS One. 2018;13(10):e0203367. doi: 10.1371/journal.pone.0203367.

[14] Belloni S, Arrigoni C, Caruso R. Effects from physical exercise on reduced cancer-related fatigue: a systematic review of systematic reviews and meta-analysis. Acta Oncol. 2021;60(12):1678–1687. doi: 10.1080/0284186X.2021.1962543.

[15] Barakou I, Sakalidis KE, Abonie US, et al. Effectiveness of physical activity interventions on reducing perceived fatigue among adults with chronic conditions: a systematic review and meta – analysis of randomised controlled trials. Sci Rep. 2023;13(1):14582. doi: 10.1038/s41598-023-41075-8.

[16] Larun L, Brurberg KG, Odgaard-Jensen J, et al. Exercise therapy for chronic fatigue syndrome. Cochrane Database Syst Rev. 2024;12(12):CD003200. doi: 10.1002/14651858.CD003200.

[17] Roehrs TG, Karst GM. Effects of an aquatics exercise program on quality of life measures for individuals with progressive multiple sclerosis. J Neurol Phys Ther. 2004;28(2):2004. doi: 10.1016/S1607-551X(10)70060-7.

[18] Kujawski S, Cossington J, Słomko J, et al. Prediction of discontinuation of structured exercise programme in chronic fatigue syndrome patients. J Clin Med. 2020;9(11):3436. doi: 10.3390/jcm9113436.

[19] Ackah M, Barakou I, Abonie US, et al. Adherence to exercise in breast cancer survivors during and after active treatment: a systematic review and meta-analysis. JSAMS Plus. 2024;4(March):100071. doi: 10.1016/j.jsampl.2024.100071.

[20] MacDonald CS, Ried-Larsen M, Soleimani J, et al. A systematic review of adherence to physical activity interventions in individuals with type 2 diabetes. Diabetes Metab Res Rev. 2021;37(8):e3444. doi: 10.1002/dmrr.3444.

[21] Correale L, Martinis L, Tavazzi E, et al. Barriers to exercise and the role of general practitioner: a cross-sectional survey among people with multiple sclerosis. Front Neurol. 2022;13(v):1016143. doi: 10.3389/fneur.2022.1016143.

[22] Vilafranca Cartagena M, Tort-Nasarre G, Rubinat Arnaldo E. Barriers and facilitators for physical activity in adults with type 2 diabetes mellitus: a scoping review. Int J Environ Res Public Health. 2021;18(10):5359. doi: 10.3390/ijerph18105359.

[23] Afshari M, Yang A, Bega D. Motivators and Barriers to exercise in Parkinson's disease. J Parkinsons Dis. 2017;7(4):703–711. doi: 10.3233/jpd-171173.

[24] Parveen A, Kalra S, Jain S. Effects of Pilates on health and well-being of women: a systematic review. Bull Fac Phys Ther. 2023;28(1):17. doi: 10.1186/s43161-023-00128-9.

[25] Wells C, Kolt GS, Bialocerkowski A. Defining Pilates exercise: a systematic review. Complement Ther Med. 2012;20(4):253–262. doi: 10.1016/j.ctim.2012.02.005.

[26] Fleming KM, Herring MP. The effects of pilates on mental health outcomes: a meta-analysis of controlled trials. Complement Ther Med. 2018;37:80–95. doi: 10.1016/j.ctim.2018.02.003.

[27] Liu N, Wang J, Chen D, et al. Effects of exercise on pregnancy and postpartum fatigue: a systematic review and meta-analysis. Eur J Obstet Gynecol Reprod Biol. 2020;253:285–295. doi: 10.1016/j.ejogrb.2020.08.013.

[28] Pinto-Carral A, Molina AJ, de Pedro Á, et al. Pilates for women with breast cancer: a systematic review and meta-analysis. Complement Ther Med. 2018;41:130–140. doi: 10.1016/j.ctim.2018.09.011.

[29] Abonie US, Addo RA, Kumah L, et al. Effect of treadmill ambulatory training on glucose control and blood pressure in persons with type 2 diabetes: a pilot study. PLOS One. 2024;19(4):e0298179. doi: 10.1371/journal.pone.0298179.

[30] Miranda S, Marques A. Pilates in noncommunicable diseases: a systematic review of its effects. Complement Ther Med. 2018;39:114–130. doi: 10.1016/j.ctim.2018.05.018.

[31] Denham-Jones L, Gaskell L, Spence N, et al. A systematic review of the effectiveness of Pilates on pain, disability, physical function, and quality of life in older adults with chron-

ic musculoskeletal conditions. Musculoskeletal Care. 2022;20(1):10–30. doi: 10.1002/msc.1563.

[32] Cronin E, Broderick P, Clark H, et al. What are the effects of Pilates in the post stroke population? A systematic literature review & meta-analysis of randomised controlled trials. J Bodyw Mov Ther. 2023;33:223–232. doi: 10.1016/j.jbmt.2022.09.028.; Kalron A, Rosenblum U, Frid L, et al. Pilates exercise training vs. physical therapy for improving walking and balance in people with multiple sclerosis: a randomized controlled trial. Clin Rehabil. 2017;31(3):319–328. doi: 10.1177/0269215516637202.

[33] Xu M, Tian C, Wang Y, et al. Pilates and multiple health outcomes: an umbrella review. J Sci Med Sport. 2023;26(4–5):232–240. doi: 10.1016/j.jsams.2023.03.011.

[34] Leng Y-N, Zhang M, Li Y-Q, et al. Effects of Pilates exercise on balance, walking and lower limbs motor function in stroke patients: a meta-analysis. Med. Data Min. 2019;2(3):110. doi: 10.12032/mdm2018022.

[35] Sánchez-Lastra MA, Martínez-Aldao D, Molina AJ, et al. Pilates for people with multiple sclerosis: a systematic review and meta-analysis. Mult Scler Relat Disord. 2019;28:199–212. doi: 10.1016/j.msard.2019.01.006.

[36] Fleming KM, Coote SB, Herring MP. Home-based Pilates for symptoms of anxiety, depression and fatigue among persons with multiple sclerosis: an 8-week randomized controlled trial. Mult Scler. 2021;27(14):2267–2279. doi: 10.1177/13524585211009216.

[37] Soysal Tomruk M, Uz MZ, Kara B, et al. Effects of Pilates exercises on sensory interaction, postural control and fatigue in patients with multiple sclerosis. Mult Scler Relat Disord. 2016;7:70–73. doi: 10.1016/j.msard.2016.03.008.

[38] Yentür SB, Ataş N, Öztürk MA, et al. Comparison of the effectiveness of Pilates exercises, aerobic exercises, and Pilates with aerobic exercises in patients with rheumatoid arthritis. Ir J Med Sci. 2021;190(3):1027–1034. doi: 10.1007/s11845-020-02412-2.

[39] Torres DM, de Menezes Fireman K, Fabro EAN, et al. Effectiveness of mat Pilates on fatigue in women with breast cancer submitted to adjuvant radiotherapy: randomized controlled clinical trial. Support Care Cancer. 2023;31(6):362. doi: 10.1007/s00520-023-07824-1.

[40] Eyigor S, Karapolat H, Yesil H, et al. 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):481–487.

[41] Fox EE, Hough AD, Creanor S, et al. Effects of Pilates-based core stability training in ambulant people with multiple sclerosis: multicenter, assessor-blinded, randomized controlled trial. Phys Ther. 2016;96(8):1170–1178. doi: 10.2522/ptj.20150166.

[42] Menting J, Tack CJ, Bleijenberg G, et al. Is fatigue a disease-specific or generic symptom in chronic medical conditions? Health Psychol. 2018;37(6):530–543. doi: 10.1037/hea0000598.

[43] Goërtz YMJ, Braamse AMJ, Spruit MA, et al. Fatigue in patients with chronic disease: results from the population – based Lifelines Cohort Study. Sci Rep. 2021;11(1):20977. doi: 10.1038/s41598-021-00337-z.

[44] Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. doi: 10.1136/bmj.n71.

[45] Ackah M, et al. 30-day in-hospital stroke case fatality and significant risk factors in sub-Saharan–Africa: a systematic review and meta-analysis. PLOS Glob Public Heal. 2024;4(1):1–21. doi: 10.1371/journal.pgph.0002769.

[46] Abonie US, Edwards AM, Hettinga FJ. Optimising activity pacing to promote a physically active lifestyle in medical settings: a narrative review informed by clinical and sports pacing research. J Sports Sci. 2020;38(5):590–596. doi: 10.1080/02640414.2020.1721254.

[47] Abonie US, Hettinga FJ. Effect of a tailored activity pacing intervention on fatigue and physical activity behaviours in adults with multiple sclerosis. Int J Environ Res Public Health. 2021;18(1):1–10. doi: 10.3390/ijerph18010017.

[48] Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials as an essential component of a. BMJ. 2019;366:l4898. doi: 10.1136/bmj.l4898.

[49] Cashin AG, McAuley JH. Clinimetrics: physiotherapy Evidence Database (PEDro) Scale. J Physiother. 2020;66(1):59. doi: 10.1016/j.jphys.2019.08.005.

[50] Maher CG, Sherrington C, Herbert RD, et al. Reliability of the PEDro scale for rating quality of randomized controlled trials. Phys Ther. 2003;83(8):713–721. doi: 10.1093/ptj/83.8.713.

[51] DerSimonian R, Laird N. Meta-analysis in clinical trials. Control Clin Trials. 1986;7(3):177–188. doi: 10.1016/0197-2456(86)90046-2.

[52] Hedges LV, Olkin I. Statistical methods for meta-analysis. Am J Sociol. 1986;92(1):38–40.

[53] Higgins JPT, Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat. Med. 2002;21(11):1539–1558. doi: 10.1002/sim.1186.

[54] Rothstein HR, Sutton AJ, Borenstein M. Publication bias in meta-analysis: prevention, assessment and adjustments. Chichester (England): Wiley & Sons; 2006. doi: 10.1002/0470870168.

[55] Boing L, Fretta TdB, Lynch BM, et al. Mat Pilates and belly dance: effects on patient-reported outcomes among breast cancer survivors receiving hormone therapy and adherence to exercise. Complement Ther Clin Pract. 2023;50:101683. doi: 10.1016/j.ctcp.2022.101683.

[56] Bulguroglu I, Guclu-Gunduz A, Yazici G, et al. The effects of Mat Pilates and Reformer Pilates in patients with multiple sclerosis: a randomized controlled study. NeuroRehabilitation. 2017;41(2):413–422. doi: 10.3233/NRE-162121.

[57] Çağlar D, Güçlü Gündüz A, Tüfekçi A, et al. The effect of clinical Pilates on core muscle thickness, physical performance, fatigue, activities of daily living, and quality of life in patients with Parkinson's disease: a randomized controlled trial. J Exerc Ther Rehabil. 2024;11(2):71–80. doi: 10.15437/jetr.1376656.

[58] Eftekhari M, Eftekhari E. Impact of clinical Mat Pilates on body composition and functional indices in female patients with multiple sclerosis. Crescent J Med Biol Sci. 2019;5(4):297–305.

[59] Ekici G, Unal E, Akbayrak T, et al. Effects of active/passive interventions on pain, anxiety, and quality of life in women with fibromyalgia: randomized controlled pilot trial and quality of life in women with fibromyalgia. Women Health. 2017;57(1):88–107. doi: 10.1080/03630242.2016.1153017.

[60] Eldemir K, Guclu-Gunduz A, Eldemir S, et al. Effects of Pilates-based telerehabilitation on physical performance and quality of life in patients with multiple sclerosis. Disabil Rehabil. 2024;46(9):1807–1814. doi: 10.1080/09638288.2023.2205174.

[61] Fleming KM, Coote SB, Herring MP. The feasibility of Pilates to improve symptoms of anxiety, depression, and fatigue among people with multiple sclerosis: an eight-week ran-

domized controlled pilot trial. Psychol Sport Exerc. 2019;45:1–9. doi: 10.1016/j.psychsport.2019.101573.

[62] Kavya G, Ramalingam V, Rajendiran K. Assessing the quality of life with cardiovascular training and Pilates for breast cancer survivors. Indian J Physiother Occup Ther. 2024;18:500–505. doi: 10.37506/nrb9he67.

[63] Küçük F, Kara B, Poyraz EÇ, et al. Improvements in cognition, quality of life, and physical performance with clinical Pilates in multiple sclerosis: a randomized controlled trial. J Phys Ther Sci. 2016;28(3):761–768. doi: 10.1589/jpts.28.761.

[64] Leite B, Denig LA, Boing L, et al. 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. doi: 10.1016/j.jbmt.2023.09.002.

[65] Ozkul C, Guclu-Gunduz A, Eldemir K, et al. Combined exercise training improves cognitive functions in multiple sclerosis patients with cognitive impairment: a single-blinded randomized controlled trial. Mult Scler Relat Disord. 2020;45:102419. doi: 10.1016/j.msard.2020.102419.

[66] Saraiva PSDS, Boing L, Fausto DY, et al. Effects of Mat Pilates on quality of life, fatigue and body image in head and neck cancer survivors: a randomized clinical trial. Disabil Rehabil. 2025;47(6):1553–1560. doi: 10.1080/09638288.2024.2377417.

[67] Yucel H, Uysal O. Pilates-based mat exercises and parameters of quality of life in women with type 2 diabetes. Iran Red Crescent Med J. 2016;20(S1):1–7. doi: 10.5812/ircmj.21919. Research.

[68] Yellen SB, Cella DF, Webster K, et al. Measuring fatigue and other anemia-related symptoms with the Functional Assessment of Cancer Therapy (FACT) measurement system. J Pain Symptom Manage. 1997;13(2):63–74. doi: 10.1016/S0885-3924(96)00274-6.

[69] Kos D, Kerckhofs E, Carrea I, et al. Evaluation of the Modified Fatigue Impact Scale in four different European countries. Mult Scler. 2005;11(1):76–80. doi: 10.1191/1352458505ms1117oa.

[70] Mendoza TR, Wang XS, Cleeland CS, et al. The rapid assessment of fatigue severity in cancer patients: use of the brief fatigue inventory. Cancer. 1999;85(5):1186–1196. doi: 10.1002/(SICI)1097-0142(19990301)85:5<1186::AID-CNCR24>3.0.CO;2-N.

[71] Fisk JD, Ritvo PG, Ross L, et al. Measuring the functional impact of fatigue: initial validation of the fatigue impact scale. Clin Infect Dis. 1994;18(Supplement_1):S79–S83. doi: 10.1093/clinids/18.Supplement_1.S79.

[72] Bennett R. The Fibromyalgia Impact Questionnaire (FIQ): A review of its development, current version, operating characteristics and uses. Clin Exp Rheumatol. 2005;23(5 Suppl. 39):S154–S162.

[73] Brown RG, Dittner A, Findley L, et al. The Parkinson Fatigue Scale. Parkinsonism Relat Disord. 2005;11(1):49–55. doi: 10.1016/j.parkreldis.2004.07.007.

[74] Bijur PE, Silver W, Gallagher EJ. Reliability of the visual analog scale for measurement of acute pain. Acad Emerg Med. 2001;8(12):1153–1157. doi: 10.1111/j.1553-2712.2001.tb01132.x.

[75] Bellet RN, Adams L, Morris NR. The 6-minute walk test in outpatient cardiac rehabilitation: validity, reliability and responsiveness-a systematic review. Physiotherapy. 2012;98(4):277–286. doi: 10.1016/j.physio.2011.11.003.

[76] Fischer JS, LaRocca NG, Miller DM, et al. Recent developments in the assessment of quality of life in multiple sclerosis (MS). Mult Scler. 1999;5(4):251–259. doi: 10.1177/135245859900500410.

[77] Aaronson NK, Ahmedzai S, Bergman B, et al. The European organization for research and treatment of cancer QLQ-C30: A quality-of-life instrument for use in international clinical trials in oncology. J Natl Cancer Inst. 1993;85(5):365–376. doi: 10.1093/jnci/85.5.365.

[78] Tijhuis GJ, de Jong Z, Zwinderman AH, et al. The validity of the Rheumatoid Arthritis Quality of Life (RAQoL) questionnaire. Rheumatology. 2001;40(10):1112–1119. doi: 10.1093/rheumatology/40.10.1112.

[79] Jenkinson C, Coulter A, Wright L. Short form 36 (SF 36) health survey questionnaire: normative data for adults ofworking age. Heal Inequal Appl Public Heal Res to Policy Pract. 1993;306:1437–1440.