SYSTEMATIC REVIEW CRITIQUE FORM

(adapted from University of Colorado Health)

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Article Reviewed:
Pilates Reducing Falls Risk Factors in Healthy Older Adults: A Systematic Review and Meta-Analysis.
Da Silva LD, Shiel A, McIntosh C. Pilates Reducing Falls Risk Factors in Healthy Older Adults: A Systematic Review and Meta-Analysis. Front Med (Lausanne). 2021 Sep 1;8:708883. doi: 10.3389/fmed.2021.708883. PMID: 34540865; PMCID: PMC8440877.

Systematic Review:

It is a summary of evidence on a particular topic, conducted using a rigorous process for identifying, appraising, and synthesizing numerous studies to answer a clinical question.

Meta-analysis:

A systematic review is the quantitative synthesis of multiple studies. A meta-analysis produces a summary statistic that represents the effect of the intervention across multiple studies.

Choose the answer with an X in front of the box and provide rationale for answer under the critique item. Summarize the study in the Summary Evidence Table at the end of the critique form.

1. Article Purpose:		**Page number/comments**

a. Were the review question(s) clearly and explicitly stated?	Yes	No	Page 2 Does Pilates training in comparison to no exercise or other exercises reduce the risk of falls in healthy older adults?
2. *Evaluation of the Validity of the Review:*			
a. Was the critical question clearly focused with regard to:			
1. The population?	Yes	No	Page 3 Age 60 years of age and older (male and female). Healthy older adults is defined as older adults who have maintained functional ability, including participants of both genders, those with and without a fall history and those considered sedentary or active.
2. The intervention?	Yes	No	Page 3 All Pilates interventions including mats, accessories, and equipment.
3. The outcome measure?	Yes	No	Page 3 The primary and secondary outcomes selected are associated with decreased fall risk - mobility as the functional reach test, fear of falling, functional mobility, gait, postural stability, and number of falls during the study.
b. Was a systematic approach used for the literature search?	Yes but	No	Page 3 The search strategy section listed all the databases used and listed the date of the end of the search October 30, 2020 (but the range time of search was not specified). Authors listed the search terms and boolean operators. However, there were no details about the specific search strategy development process - e.g. identifying keywords, synonyms. Also no description of use of searching via term groupings like MeSH. No description of searching for 'gray literature.'

			It was described that there were 2 reviewers reviewing independently and came to a consensus at a later date. A Flow Diagram (Figure 1) was included - number of records from each database, duplicates, those screened and excluded, and reasons for exclusion
c. Was the search strategy clearly described including:			
1. Search terms?	Yes	No	Page 3 Search terms were listed: Pilates AND healthy older adults, OR elderly OR aged, fall prevention OR risk of fall, fear of falling, postural balance OR balance, functional mobility, gait OR spatiotemporal parameters of gait AND randomized controlled trial. Strategies for identifying the search terms (e.g. keywords and synonyms) were not described
2. Years searched?	Yes	No	The Search Strategy section states that databases were searched until October 30th2020. It does not clearly state the range of years searched. There is information about the dates of the studies that were used - In the Inclusion Criteria section (pg 3) it states that the studies used were dated between 2010 and 2020. And in the Study Selection section (pg 5) it states more specifically that studies used were conducted between 2012 and 2019
3. Databases used?	Yes	No	Page 3 Electronic databases used: EMBASE, Scopus, Google Scholar, MEDLINE (Ovid), Science Direct, Cochrane and the Cumulative Index to Nursing and Allied Health Literature (CINAHL)

	4. Number of Studies included? (systematic review; meta-analysis)	Yes	No	Page 5 Twelve studies were included in the qualitative synthesis and 11 studies were in the meta-analysis (quantitative synthesis). See Figure one
	d. Were the criteria for the selection of studies for systematic review to be included in the review clearly defined and described?	Yes	No	Page 3 Studies met the following PICOS inclusion criteria: Population-Healthy older adults 60 years of age and older (male and female) Intervention-All Pilates interventions, including mats, accessories, and equipment. Comparators-A comparison of Pilates training with parallel groups, including a control group with no intervention and a control group with other exercises. Outcomes-pre and post-tests with regard to fear of falling, mobility, functional mobility, gait and postural stability by platform. Study designs-RCTs and peer-reviewed publications written in the English language and dated between 2010 and 2020. Exclusion criteria: participants with neurological impairment, orthopedic conditions such as low back pain, the use of dynamic balance to evaluate balance and with no platform used for postural stability and non-RCT studies, such as semi-or quasi-experimental studies.
	e. Were the criteria for the selection of studies for meta-analysis review clearly described?	Yes	No	It appears that one study was excluded from the meta-analysis - see figure 1 on Pg 4. The description in the Study Selection section reports that one study was excluded because the authors included path length variable instead of ML and AP variables of balance

e. Is there a table of the studies included in the review with a brief synopsis of each study?	Yes	No	Pages 6-9- Table 1 describes References/Country, Design, Setting or Recruitment, Aims, Inclusion criteria, total sample size (n), and between intervention groups, Mean (SD) Age between groups. Table 3 on pg 10 has a synopsis (recommendations) that resulted from the studies Table 2 pg 9 also reviews the studies related to quality
f. Were the methods used to critique the studies described?	Yes	No	Pg 3 under Study Selection - authors described use of the Covidence systematic review software to import citations, manage screening & data extraction; which included recognition of duplicate studies. Titles and abstracts were screened by two independent reviewers & any disagreements were mutually resolved to reach a consensus. Potentially eligible articles were then reviewed in full text by the two reviewers and any disagreements were mutually resolved The data were extracted independently by the 2 reviewers. Consensus was then reached at a later meeting. The article outlined details of the data that was reviewed - e.g. demographics, study details & design Page 14,16,17 The authors also reviewed the study details - e.g., quality, if it was blinded, differences between studies like sample size & heterogeneity. As recommended in PRISMA guidelines, these authors provided a brief summary of the characteristics and risk of bias among the included studies.
g. Were the critiques carried out by more than one person?	Yes	No	Pg 3 Two independent reviewers screened the studies. Any disagreements were mutually resolved.

3. *Interpreting the Results:*			
a. Were the results consistent across studies? · Number of total subjects included · Range of number of subjects in studies	Yes	No	Yes. When there were significant results, the studies consistently showed that there was improvement in various outcome measures after Pilates intervention. The measures to assess outcome were varied but overall results favored Pilates in all subgroups but one - Postural stability - anteroposterior Number of total subjects = 702 The range of the number of total subjects in the studies was from 31 to 110
b. What were the overall results of the review?			Pg 18. There is some evidence that Pilates reduces certain risk factors for falls. Pilates intervention compared to control groups was shown to improve functional mobility, general mobility, postural balance, gait, and fear of falling of healthy older adults. Pilates did not show improvement in functional mobility compared to other exercises but showed greater improvement in mobility. 4-6 weeks of Pilates without equipment had positive results on general mobility. Pilates was found to improve fear of falling and postural stability in the mid-lateral directions with eyes open and closed. These outcomes are presumed to be associated with a decrease risk of falls
c. Interpret the Forest Plots			Pg 13 **Plot Figure 2.** 2 studies were reviewed that studied Pilates and Fear of Falling. Horizontal CI lines are short so there is some precision in the studies.

	The Badiel et al study was more heavily weighted as seen in the weight data value (59.3% vs 40.7%) and in the larger square. The pooled effect is shown in the diamond - the midpoint of diamond is the pooled effect size (value of -8.61) and the sides of the diamond represent the pooled confidence intervals, in this case not very elongated horizontally (i.e. CI's without a large range). Neither study crosses the line of no effect; they both show a decrease fear of falling score in favor of Pilates. Significant P = <0.00001. The heterogeneity between studies (extent to which the effect size varies) was significant, which can be seen in the minimal overlap in the horizontal lines of each study, and as the listed I2 of 88% with significance P= 0.003 **Figure 3 Forest plot for studies comparing mediolateral, eyes open:** CI - Bird et al study had less precision as seen by the long CI line/range and listed data (-2.91 to 731). The 3 other studies had shorter CI range, more precision Weight - the Gabizon et al study was most heavily weighted seen by larger square and data (26.7% weight). Two other studies had similar weights to each other (at 20.1% and 18.1%). The study with least weight (4.4% and tiny box) was also the least precise as shown in the wide CI values and long line. Pooled Effect - the pooled effect showed significance favoring Pilates for this measure, with the diamond on the 'favors' Pilates side. The diamond is a little elongated horizontally due to some wide CI ranges in the studies. Significance/results - 3 of the 4 studies crossed the line of no effect. However, the total overall effect is significant with a P = 0.01 and the diamond figure represents this on the side favoring Pilates. Heterogeneity - heterogeneity between studies was not significant

	Figure 3, Mediolateral, eyes closed CI - most precision/short CI line was in the 1st study listed. Next 2 listed studies with wide CI line/ranges so less precision Weight - most weight (largest square & 20.7%) was given to the 1st study, which was also significant and did not cross the line of no effect Pooled Effect - pooled effect diamond was on significant side, not crossing the line of no effect; it was elongated due to some large CIs in 2 of the studies Significance/results- was significant with P = 0.03 and pooled results diamond on the side favoring Pilates for this measure Heterogeneity - heterogeneity in these 3 studies was not significant **Overall Effect for Mediolateral outcome** with eyes open or closed: Pooled data was significant (diamond on the side favoring Pilates) and P = 0.001 **Figure 4 Anteroposterior, eyes open.** CI all 3 studies had precision, as seen in the relatively short 95% CI ranges/horizontal lines Weight - most weight given to Gabizon et al study (26%, largest square) Pooled Effect - pooled effect represented by the diamond crossed the line of no effect so was not significant Significance/Results - pooled effect did not show significance (see diamond crossing the line) and P = 0.15 Heterogeneity - was not significant **Anteroposterior, eyes closed** CI - the horizontal lines of the studies appear short visually but the visual diamond is elongated representing a longer pooled

	confidence interval range, which was reported as -6.48 to 4.22 Weight - equally weighted (squares same size and weight 18.8% and 18.9%) Pooled Effect - diamond crosses the line of no effect so pooled results were not significant. CI range seems fairly large, so less precision in these studies Significance/Results - pooled results cross the line of no effect, not significant and P = 0.68 Heterogeneity - was significant between these studies. Also seen visually as the minimal overlap in horizontal lines for each study **Overall total effect data for this subgroup** for the measures of anteroposterior eyes open and closed is not significant - diamond slightly crosses the line of effect and the P = 0.15. So with these measures there were no significant results that favored Pilates. **Figure 5 DGI group**: The Barker et al study crossed the line of no effect so no significant difference was seen. The other study had significance favoring Pilates, had a short CI range (more precision), and this study was more heavily weighted (see the larger square). Total effect showed significance P = 0.06; favoring Pilates on this DGI measure. There was statistically significant heterogeneity between the studies **Figure 6 TUG for Pilates vs Control:** Five studies were included. Two studies showed significance favoring Pilates. The Vieira et al study showed significance (and just touched the line of no effect) and also had more precision (a short CI line). It was most heavily weighted, but

	only slightly more heavily weighted than the Bird et al study. The other study that did not cross the line of no effect and did show significance was from Mesquita et al. It had a rather long CI line so less precision. It was less heavily weighted (visually seen in a small square) The total effect (diamond and the values) showed significance with P=0.05; favoring Pilates on this measure. There was a very statistically significant amount of heterogeneity between studies **Figure 7 TUG for Pilates vs Other exercise groups** 2 significant studies (did not cross the line of effect) favored Pilates; and both of those had short CI lines (showing good precision), and they were the most heavily weighted (larger squares, plus noted in the values). The other 2 studies crossed the line of no effect. The total effect showed significance with the test for overall effect P = 0.03; so overall favored Pilates on this measure, over other exercise groups **Figure 8 FRT for Pilates vs Control** All 3 studies showed significance (did not cross the line of no effect) and had short CI horizontal lines visually *but* the values on the X axis are so large that the short CI line is not necessarily a reflection of a short/small CI range - see the values where the CIs reported are 9.44 and 17.36 for the Mesquita et al study. In any case, the total effect is significant with P= 0.00001 favoring Pilates in this group where the FRT was the measure. There was significant heterogeneity in these studies **Figure 9 FRT Pilates vs Other Exercise** In this group there were 2 studies. One study showed significance (did not cross the line of

			no effect) and was most heavily weighted (large square). The other study did not show significance. The total effect showed significance with P = 0.00004, favoring Pilates over other exercise using the FRT. The heterogeneity between the studies was not significant
	d. Are the conclusions or summary supported by the reported data and statistical analysis? (explain your answer)	Yes	No	Pg 18. The conclusion is supported by the reported data and statistical analysis. The data was presented for each subgroup. All but one of the subgroups of studies showed significant results in the pooled data, favoring Pilates. The conclusions describe the outcomes related to the measures and reported data. Additionally, the authors used a comprehensive approach in reviewing and comparing studies, guided by PRISMA, and reported characteristics, and results of data in the included studies. This was considered in the conclusions.
4. *Applicability of Results to Practice:*				
	a. Did you understand how the researcher collected data?	Yes	No	Pg 3 - two independent reviewers extracted data independently and consensus was later obtained. Authors described the software used. Multiple pages - pg 5, Tables 1,2,3 described the data collected for each of the studies
	b. Are instruments/tools used reliable and valid?	Yes	No	The instruments and tools used are valid because they measured what they intended to measure. There are many contributing factors to the risk of falls. The instruments and tools used have content validity because they measure different factors contributing to fall risk. Each of the instruments has varying levels of statistical reliability, but all are recognized as reliable. Some instruments and tools have increased reliability when

			used with other instruments or tools. Overall, the study incorporated several valid and reliable instruments and tools to assess the various factors contributing to fall risk. The Timed Up and Go (TUG) test is a performance-based measure of functional mobility evaluated and modified by Podsiadlo and Richardson (1991). The reliability and validity were verified by incorporating a timed component into the modified “Up & Go” test, which permits the comparison of measurement changes over time. The test also correlates with other measures of gait speed, functional ability, and balance (Podsiadlo & Richardson, 1991). The TUG test, recommended by the CDC (2023), Stopping Elderly Accidents, Deaths, and Injuries (STEDI) initiative, aimed to help reduce fall risk among older adults. In a community-dwelling older adult, a >12s time indicates an increased fall risk. This test is a commonly used standardized performance test used to test the functional mobility of older adults. The Functional Reach Test (FRT) is another easy-to-administer mobility measure that is reliable and valid. According to the study of FRT in people with multiple sclerosis, Soke et al., (2021), determined the FRT correlated with other outcome measures and demonstrated good to excellent test-retest reliability. Fear of Falling: The fall efficacy scale (FES) is an internationally recognized tool to measure concern about falling during physical activities inside and outside the home (Greenberg, 2023). The FES, developed by Tinetti et al. (1990), provides a valid and reliable measure of one’s fear of falling. The FES has been adapted for international use and is available in many languages. The FES-I demonstrated validity and reliability in older adults with and without cognitive impairment (Greenberg et al.,

			2019). The FES can be given as needed or yearly to assess one's fear of falling. Postural Stability by Force is measured by center of pressure (COP) displacement to evaluate the parameters of postural stability. Measuring this on a force platform provides quantifiable data. Postural stability was divided into two subgroups for assessing mediolateral and anteroposterior direction variables. In reliability testing, older adults demonstrated excellent reliability in the mean distance for anteroposterior compared to younger adults in the conditions of eyes open, and eyes closed (Lo et al., 2022). Conversely, Lo et al. (2022) also found that the reliability in the mean distance for mediolateral was poor to good for older adults compared to excellent for younger adults. Measuring gait speed, changes, or variability is an objective measure of functional mobility that is simple to assess and considered reliable and valid. Gait can be measured over different amounts of time and different distances. Falls within the past year and the number of falls recorded during the study were reported as exploratory. The self-reported data is valid and used as a screening tool in the STEDI algorithm.
c. Was the process for data analysis explained?	Yes	No	Pg 5 Data Analysis section explained the full process of analysis. They reported the statistical software used. Stated the alpha value. How data were entered as mean and SD They considered if intention-to-treat analysis was used in studies. They described how continuous data were reported and the Confidence Interval. Authors describe the subgroups analyzed. They stated that they assumed Pooled effects.

			They noted that they used Forest Plots. They described their process if there was incomplete data. They described that the data related to falls in last year or during intervention were exploratory because of insufficient data
5. Findings/Results and Conclusions			
a. What are the clinical implications based on the results of this study?			Conclusions made by the authors were that Pilates may be effective in decreasing the risk of falls in older adults (but that further robust RCTs are needed because of the lack of current high-quality evidence). Clinically, reduction in falls could have a positive impact on various outcomes. The study authors state that falls are a leading cause of morbidity, mortality, functional deterioration, hospitalization, and institutionalization. Falls are also associated with significant financial burden to health and social care services.
e. Is the intervention feasible in my setting?	Yes	No	The intervention isn't feasible in my specific inpatient hospital setting. Implementing a Pilates program during an inpatient hospitalization is not appropriate or safe. The time available, acute illness and other factors that may increase risk of falls or safety of participation of the activities prevent this being a feasible study in the inpatient hospital setting. A Pilates intervention could be feasible in an ambulatory setting.
f. Do the benefits outweigh the potential harm/risk?	Yes	No	Yes. Pilates as a low impact exercise likely has a very low chance of harm in healthy older adults. There was not sufficient data related to falls during the Pilates Intervention. Data that would support a reduction in falls would increase the benefit of the PIlates Intervention.
g. What is my clinical assessment of the patient or practice setting and are there any contraindications or circumstances that would inhibit implementing the treatment/intervention?			The study included healthy older adults in ambulatory settings - e.g., community setting, church group, senior centers. These settings will have participants who are healthy with few contraindications. However, there are potential contraindications and circumstances

	that could prohibit an older adult from implementing the Pilates intervention. Fall risk is impacted by new medications, unfamiliar environment, and even the presence of a simple urinary tract infection in an elderly person. Participants on high fall risk medications, or on new medications that could increase fall risk probably should not participate in the treatment/intervention.

6. Conclusion/Discussion

a. What are the strengths and limitations of the study?

Strengths include that this review included only RCTs so the quality and rigor of reviewed studies was overall better than other types of studies.

Another strength was the authors' use of the PRISMA system to guide the review. For example, they included a review of the characteristics and risk of bias in the included studies.

Limitations include that the systematic review included only RCTs that were in English and only if full text was available.

There were a low number of studies included.

The Pilates intervention could not be compared to other exercise for the selected measures.

Not all studies included a focus on falls - there was lack of data in the reviewed studies on fallers and no fallers

The heterogeneity of the Pilates intervention methods may be a limitation. However, the authors cite support that this heterogeneity may not have an effect on postural balance measures. And all types of Pilates interventions were included due to the low number of RCTs

b. What are the biases of the study?

There is potential bias in selecting the quality of the included studies. However, the authors describe that the PEDro scale for RCTs was used and 2 independent reviewers reached consensus on assigning quality, so this bias does not seem to be present.

There is a possible publication bias. There is no description of searching the grey literature and no analysis performed to evaluate publication bias (like use of a Funnel Plot).

c. Were populations inclusive in the studies included within the systematic review and meta-analysis? If not what populations were missing based on the study purpose?

Based on the well-defined study purpose, the populations were inclusive and none appeared to be missing (page 1,2). Page 1.Populations included healthy older adults who have maintained functional ability. Both men and women were included. Participants with and without falls history were included. Both sedentary and active participants were included. Page 3. Exclusions were participants who had any type of neurological impairment and orthopedic condition such as low back pain.Otherwise healthy adults may experience mild forms of both conditions.

d. Overall impression of the study

This systematic review and meta-analysis seem to be of high quality, following many of the PRISMA guidelines and including RCTs. It was a complex review because of the multiple measures used in the studies to assess the benefit of Pilates intervention. However, the authors' descriptions and reviews methodically addressed the studies and the measures in a coherent fashion. The statistical analyses were outlined, and results were reported clearly for each set of measures.

The study has clinical relevance. The authors described poor outcomes associated with falls, including increased risk with aging. Hence, this study evaluating Pilates intervention as a fall prevention technique adds knowledge toward this clinically relevant topic.

e. Provide a 5-7 sentence paragraph summary of the article.

Elements should include: Purpose, Research Method, Results to include Statistical

This systematic review and meta-analysis was performed to synthesize the evidence from randomized control trials of Pilates intervention compared to control groups and other exercises, for falls prevention in healthy older adults. The primary and secondary outcomes were associated with a decreased fall risk and were clearly described. The authors appeared to closely follow the PRISMA guidelines and described their methods and results in detail. The Meta-analysis showed that the pooled data for each of the measures in all but one of the subgroups was significant, favoring Pilates. The pooled data for the subgroup for Postural stability - anteroposterior, both eyes open and eyes closed did not reach significance. Conclusions made by the authors were that Pilates may be effective in decreasing the risk of falls in older adults but that further robust RCTs are needed because of the lack of current high-quality evidence.

f. Did the article answer the PICO question? (support your answer based on the article)

The study answered parts of the PICO question and also answered it somewhat indirectly. The PICO was - In healthy older adults does Pilates compared to control groups and other exercises, prevent falls?
The study answers the PICO question overall with the authors' statement "There is still insufficient evidence in the literature to state conclusively that Pilates is an effective form of exercise to prevent falls."
The authors also state that "there is some evidence to suggest that Pilates reduces certain risk factors for falls in healthy older adults." Risk factors for falls were assessed via various measures/tools that are associated with a decreased risk of falls - e.g. postural stability, functional mobility, gait.
The results related to these measures are:
-Pilates intervention compared to control groups was shown to improve functional mobility, general mobility, postural balance, gait, and fear of falling of healthy older adults.

-Pilates did not show improvement in functional mobility compared to other exercises but showed greater improvement in mobility.

-4-6 weeks of Pilates without equipment had positive results on general mobility.

-Pilates was found to improve fear of falling and postural stability in the mid-lateral directions with eyes open and closed.

One of the ‘C’ comparators “other exercise groups” could not be analyzed in terms of the most selected measures.
Additionally in this study there was lack of data for fallers and non fallers so the ‘O’ outcome of fall prevention could not be assessed.

Complete the Evidence Table for this article:

References:

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Evidence Table for Systematic Review / Meta-Analysis Critique **Names:**
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Author/ year/Title/ Jo ur nal	L O E	Aim/ Purpose	Theoretical Framework	Design/ Methods/ Instruments	Sample/ Setting	Variables Studied	Data analysis	Relev Findi
Larissa Donatoni da Silva, Agnes Shiel, & Caroline McIntosh /2021 Pilates Reducing Falls Risk Factors in Healthy Older Adults: A Systematic Review and Meta-Analysis.	Level One	Synthesize evidence of RCTs of Pilates interventions compared to control groups with no exercise and to other exercises to reduce the risk of falls and fall risk factors.	Not Stated	Systematic review and meta-analysis of RCTs of pilates intervention Studies selected met the following criteria: Healthy older adults age 60 and older (males and females). The intervention was all Pilaties interventions to include mats, accessories, and equipment. Comparison of Pilates with control group with no intervention and control group with other exercises. Outcomes were measured with pre-and post tests regarding fear of falling, functional mobility, gait, and postural stability by platform. RCTs and peer-reviewed publications dated 2010 to 2020 and written in English were used in the study. .	12 studies 11 used in the meta analysis 702 total subjects. Range of number of subjects in studies: 31-110 The setting of studies: Unspecifie d community settings, church group, senior centers, day care center	**Independent Variables** :Pilates No exercise Other Exercise **Dependent Variable** Risk of Falls	Meta Analysis Studies grouped into subgroups that used the same measures Pooled Data was reported in Forest Plots All subgroups but one showed significance favoring Pilates intervention. The measures of anteroposter ior with eyes open and closed did not show significance	There i evidenc Pilates certain for falls Pilates control shown functio general postura gait, an falling Pilates show in in funct mobilit to othe but sho improv mobilit 4-6 wee withou had pos on gene mobilit Pilates to impr falling a stability lateral with ey closed.