I'M NOT MOVING, I CAN'T SLEEP - I'M FALLING: A REVIEW AND META-ANALYSIS OF PHYSICAL EXERCISE IN BALANCE AND SLEEP QUALITY

NO ME MUEVO, NO PUEDO DORMIR - ME CAIGO: UNA REVISIÓN Y META-ANÁLISIS DEL EJERCICIO FÍSICO EN EL EQUILIBRIO Y LA CALIDAD DEL SUEÑO

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I'm not Moving, I can't Sleep - I'm Falling

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Abstract

This systematic review and meta-analysis aim assess the impact estimation of physical exercise on sleep quality and balance in older adults. A rigorous literature search adhering to PRISMA guidelines was conducted across Web of Science, Scopus, and PubMed databases, yielding a total of 3885 articles. Following stringent inclusion and exclusion criteria, 14 articles were selected for analysis, with 4 ultimately meeting eligibility criteria. Participant ages were above 61 years old, varying sex distributions and intervention parameters. Assessment instruments included measures of balance, sleep quality, and physical fitness. The studies employed a range of exercise interventions, including whole-body vibration, forest therapy, structured physical activity, and traditional Chinese Qigong, to enhance balance, physical function, and sleep quality in older adults. Results indicate significant improvements in sleep quality, balance, and physical fitness following exercise interventions. Notably, interventions were found to alleviate sleeping issues and enhance physical performance. Significant small effect was showed of the exercise and physical activity in aged people balance and sleep quality. These findings underpin the potential of physical exercise in promoting overall well-being and functional capacity in aging populations.

Keywords: Aged, balance, exercise, sleep.

Resumen

Esta revisión sistemática y metaanálisis tiene como objetivo evaluar la estimación del impacto del ejercicio físico en la calidad del sueño y el equilibrio en adultos mayores. Se realizó una búsqueda bibliográfica rigurosa siguiendo las pautas PRISMA en las bases de datos Web of Science, Scopus y PubMed, que arrojó un total de 3885 artículos. Siguiendo estrictos criterios de inclusión y exclusión, se seleccionaron 14 artículos para el análisis, de los cuales 4 cumplieron finalmente los criterios de elegibilidad. Las edades de los participantes eran mayores de 61 años, con distribuciones de sexo variables y parámetros de intervención. Los instrumentos de evaluación incluyeron medidas de equilibrio, calidad del sueño y aptitud física. Los estudios emplearon una variedad de intervenciones de ejercicio, incluyendo vibración de cuerpo entero, terapia forestal, actividad física estructurada y Qigong tradicional chino, para mejorar el equilibrio, la función física y la calidad del sueño en adultos mayores. Los resultados indican mejoras significativas en la calidad del sueño, el equilibrio y la aptitud física después de las intervenciones de ejercicio. En particular, se encontró que las intervenciones aliviaban los problemas de sueño y mejoraban el rendimiento físico. Se mostró un pequeño efecto significativo del ejercicio y la actividad física en el equilibrio y la calidad del sueño de las personas mayores. Estos hallazgos respaldan el potencial del ejercicio físico para promover el bienestar general y la capacidad funcional en las poblaciones que envejecen.

Palabras Clave: Envejecida, equilibrio, ejercicio, sueño.

Introduction

Falling is one of the principal causes of dead in people over 65 years old (Kruschke & Butcher, 2017) and per year, 30 to 40% of the deaths are related to falls (Ambrose et al., 2013). The sociodemographic, medical, psychological, mobility and sensory factors have already been appointed as risks for falls (Ambrose et al., 2013) and the falls are considered a public health and wellbeing problem (Rodrigues et al., 2022). The wellbeing can be subjective, about the positive feelings and expectations, relationships, education and health (Togonu-Bickersteth et al., 2023) but mostly related to daily life activities (Hupkens et al., 2018; Rodrigues et al., 2022; Togonu-Bickersteth et al., 2023; Żurek et al., 2020).

The daily life activities independence is a very important topic to maintain social, cognitive and physical activity (Parra-Rizo et al., 2021; Hupkens et al., 2018). Additionally, as higher the physical activity, more prone are the elderlies to experience social relations, decline ageing/related decline in brain cognition and functionality, reducing physical, mental, and social related problems (Parra-Rizo et al., 2021; Ballesteros et al., 2015; Hupkens et al., 2018; Stathi et al., 2002). On the other hand, physical inactivity is negatively related with overall health issues (Carlson et al., 2015; Maynou et al., 2021). A systematic review, revealed that old people barriers for physical activity and exercise are commonly related to health/physical impairment, poor balance, overweight, muscle weakness, shortness of breath and increased pain by physical activity, Lack of time, worry, fatigue, motivation, knowledge about exercise, fears and interest (Baert et al., 2011). However, it is also well-known that physical activity plays an important role in inflammatory response (Chang et al., 2013; Forte et al., 2022; Metsios & Kitas, 2018). The decreasing of inflammation levels, usually reduces the pain levels in inflammatory related health problems (Metsios & Kitas, 2018). Ageing cause body composition alterations, variations in energy balance, homeostatic regulation, and neurodegeneration, resulting in higher body inflammation (Bektas et al., 2018). This plethora of factors justify the reasons and fears to not participate in regular exercise or physical activity and the increased risk of falls in old people. Additionally, pain, inflammation and fatigue negatively affect the wellbeing and quality of life. Combined with medications, stress, and psychiatric disorders the risks for insomnia start to emerge and the dificulty to rest and recovery from fatigue results in poor sleeping quality (Brewster et al., 2022; Casagrande et al., 2022).

The literature presents associations between sleep quality, frailty, and quality of life among older adults (Lorber et al., 2023), highlighting the interplay between sleep, physical health, and overall well-being in aging populations. The socioeconomic status and sleep quality's influence on the prevalence of multimorbidity in older adults, underscoring the broader health implications of sleep disturbances in aging populations (Xue et al., 2022). The elderlies commonly experience deterioration in the visual and proprioceptive systems, which can impact balance and postural control (Martellucci et al., 2016; Pasma et al., 2015). In older adults, the proprioceptive information plays an important role in maintaining balance, where the exercise plays an important role (Soares et al., 2018; Zhou et al., 2022), enhancing ankle stability (lower limbs function), neuromuscular function (related to strength), and postural control system efficiency (de Bruin et al., 2015; Suzuki et al., 2012). A study from Serrano-Checa et al. (2020) identified a link between sleep quality and dynamic balance, indicating that poor sleep quality may be associated with dynamic imbalance in older adults. However, the authors failed to assess the effects of training exercise programs in physical fitness, sleep quality and balance. Epidemiological studies showed a significant relationship between sleep problems, falls, and physical inactivity among the elderly, highlighting the relevance of targeted interventions. Over 70% of older adults report sleep disorders, which are linked to cognitive impairments and increased fall risks, with sleep deprivation exacerbating postural instability and fall frequency (Cardinali et al., 2022; Ghobadimehr et al., 2022)). The global annual incidence of falls in individuals aged 65 and older ranges between 28% and 35%, highlighting the critical need for preventive strategies (Bosse et al., 2012; Hasegawa et al., 2019). Moreover, physical inactivity is a prevalent issue, contributing to avoiding functional decline and further diminishing the fall risks (Baixinho & Dixe, 2020; Tieland et al., 2018).

The relationship between sleep quality and physical activity and exercise in older adults is well-documented in the literature. The same occurs between balance and physical activity and exercise. However, the authors failed to found reviews studies analysing the interplay between sleep quality, balance, and physical exercise interventions in old people. Upon that, the aim of this study was to review the literature about the effects of exercise in balance and sleep quality in aged people and provide dose-effect estimations by meta-analysis approach. It was hypothesised that physical exercise programs positively improve aged people both sleep quality and balance.

Materials and Methods

Study Design

This review aimed to summarize the findings and conclusions reported in the literature on the effect of physical exercise in elderlies in sleep quality and balance. An extensive literature search was developed to identify published articles on the subject. The articles selected for the meta-analysis met the inclusion criteria.

Search Strategy

The systematic review followed the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Page et al., 2021). A Boolean method was applied for the search using AND/OR operators exclusively for studies. The analysis focused on original research articles investigating the impacts of resistance training on body composition. The search encompassed data up to April 17th, 2024, across three databases (Web of Science, Scopus, and PubMed) using the designated keywords: ("elderlies OR elderly OR old people OR aged ") AND ("training OR exercise OR Program") AND ("Sleep OR insomnia") AND ("Balance OR gait OR dynamic balance OR static balance") in vast combinations. The search specifically covered the past decade. Articles such as review articles (qualitative review, systematic review, and meta-analysis), commentaries, editorials, transversal and observational studies were excluded. Only studies involving physical exercise and

activity programs were considered. Following the elimination of duplicates, articles were screened based on their titles and abstracts, with irrelevant ones being excluded. The final selection of articles was made based on predetermined inclusion and exclusion criteria, a process overseen by two reviewers to minimize bias.

Inclusion and Exclusion Procedures

This research adhered to stringent inclusion criteria to ensure the selection of relevant research. Specifically, criteria were established to identify studies featuring experimental interventions focused on physical exercise and activity programs, with a particular emphasis on assessing their effects on sleep quality and balance among individuals aged 60 years and above.

The study's inclusion criteria comprised the following: (1) experimental interventions featuring a standalone physical exercise and activity regimen; (2) assessments of the impacts of physical exercise programs on sleep quality and balance; (3) participants aged over 60 years on average; (4) inclusion of pre- and post-intervention data for the analyzed variables; (5) presence of at least one intervention group (utilizing a physical exercise program) and a control group (lacking physical exercise program intervention).

The study exclusion criteria were: (1) literature reviews; (2) singular cognitive or educational activities; (3) studies focusing on variables differing from those specified in inclusion criterion (2); (4) participants averaging below 60 years old; (5) studies lacking analysis of variables pre- and post-intervention

Quality Assessment

To evaluate the methodological quality of this review, two independent reviewers conducted an analysis based on the criteria outlined by The Cochrane Collaboration (Yoshii et al., 2009)listing elements that should be in the description. Complete documentation of the search strategy allows readers to evaluate the search when critically appraising a review's quality. Objective: The research analyzed recently published Cochrane reviews to determine whether instructions for describing electronic database search strategies were being followed. Methods: Eighty-three new reviews added to the Cochrane Database of Systematic Reviews in the first quarter of 2006 were selected for analysis. Eighteen were subsequently excluded because their searches were conducted only in the specialized registers of Cochrane review groups. The remaining sixty-five reviews were analyzed for the seven elements of an electronic database search strategy description listed in the Cochrane Handbook, using dual review with consensus. Results: Of the 65 reviews analyzed, none included all 7 recommended elements. Four reviews (6%. These criteria encompassed aspects such as the generation of random sequence, concealment of allocation, blinding procedures for participants, professionals, and outcome evaluators, completeness of outcomes reporting, disclosure of selective outcomes, and identification of other potential sources of bias. Ratings of high, low, or uncertain risk of bias were assigned to each criterion. In instances of disagreement regarding study quality assessments, a third reviewer was consulted for resolution.

Data Extraction and Analysis

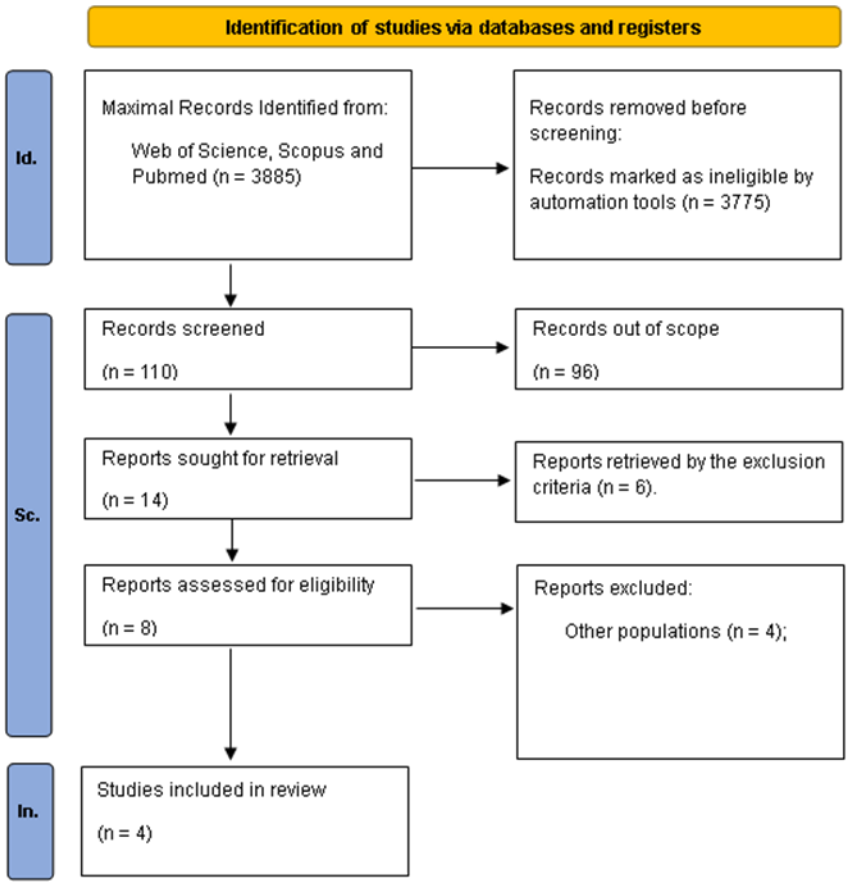
Relevant data were extracted from the included studies, such as first Author, Publication year, Sample size, Age, Sex, Volume and frequency, Intervention duration (weeks), Study type, and Objective. The variables analyzed in the articles (i.e., Balance measurement instruments, Sleep quality measurement instruments, Physical fitness instruments, and main results) were extracted and are detailed. The data extraction was in agreement with the literature (Silva et al., 2022). The meta-analysis to determine the effect of the physical exercise and activity programs on aged people's sleep quality, balance, and physical fitness was conducted using JASP software (University of Amsterdam, Netherlands, version 0.18.3.0). There was a control group in all the studies. The means and standard deviation from pre- and post-intervention were used to determine the intervention effect, which was calculated using the maximal likelihood (SMD) for each study by the Cohen d effect size and the effect size standard error at 95% confidence intervals (95% CI) (Eickhoff et al., 2012). The mean estimation effect was assessed for balance and sleep-divided meta-analysis. The Precision Effect Estimate with Standard Error (PEESE) method allowed us to assess sufficient evidence to reject the null hypothesis. Additionally, the Precision Effect Test (PET) assessed if an individual study characteristic affects the potential impact on the final meta-analysis results (Eickhoff et al., 2012). These procedures (PEESE and PET) allowed to strengthen the meta-analysis results. The results were considered statistically significant at $p < 0.05$, and to classify the magnitude of the intervention effect the category of Cohen was selected (d values between 0.2 and 0.5 represent a small effect size; between 0.5–0.8 a medium effect size; greater than 0.8 a large effect size) (Eickhoff et al., 2012). Regarding the effects of RT, intervention benefits from improvements in balance and sleep quality.

Results

The preliminary search resulted in a total of 3885 articles. Subsequently, 3775 studies were excluded following a review of titles and abstracts and duplicates. Upon assessment of the full texts of the remaining 110 articles, 96 were deemed

ineligible for various reasons, leaving 14 articles for analysis of physical exercise and activity effects on aged people balance and sleep quality. From the 14 articles, 6 were excluded by the exclusion criteria after full text reading, and finally, 4 more articles were removed. A total of 4 articles were included in this research. A visual representation of the study identification and selection process focusing on RT effects in obese adolescents is depicted in Figure 1.

Figure 1
PRISMA Flow Diagram for Studies Regarding Sleep Quality, Physical Fitness and Balance. Legend: Inclusion (Inc.), Screening (Sc.) and Inclusion (In.)



Systematic Review

The participants' ages ranged from about 61 years old to an approximated age of 83 years. Sex distribution varied, with different. Intervention volumes and frequencies ranged from 15 minutes, three times per week, to 30 minutes, five times per week, to four 45-minute sessions per week. Intervention durations ranged from 12 weeks to 24 weeks, with one study having a longer duration. Study types included quasi-experimental designs and randomized trials, highlighting diverse methodologies employed across the research. The table 1 presents the study identification (author and date), age, sex, volume and exercise frequency, duration of the intervention and the type of study.

The objectives of the studies ranged from assessing the effect of whole-body vibration on older individuals with sarcopenia to determining the effect of a forest healing anti-aging program on psychological, physiological, and physical health in older people with mild cognitive impairment. Measurement instruments for balance included one-foot balance, dynamic and static assessments such as the Dynamic: 8-ft up and go test and the AMTI AccuSway. Sleep quality was measured using instruments like the PSQI (Pittsburgh Sleep Quality Index scores from 0-21: values higher than 5 indicate sleep disturbances) and Parkinson's Disease Sleep Scale-2 (scores between 0 and 60: above 18 indicate clinically relevant sleep disturbances in Parkinson's disease patients). Physical fitness was assessed using various tests like the Senior Fitness Test, Short Physical Performance Battery (SPPB), and the 6-minute walk test. Main results showed improvements in sleep quality, balance, and physical fitness across the studies, with specific improvements noted in areas such as shoulder-arm flexibility, walking speed, grip strength, and sit-stand repetitions. Additionally, interventions were found to have a significant effect on reducing sleeping issues and improving physical performance, particularly in dynamic balance and gait speed, among older adults. The table 2 presents the identification (author and date), objective, balance, sleep quality and physical fitness measures and main results.

Table 1
Author and Date, age, sex, Volume and Exercise frequency, Duration of the Intervention and the Type of Study

First Author (Publication Year)	Sample Size	Age (M ± SD)	Sex	Volume and Frequency	Intervention Duration (Weeks)	Study Type
Pei-Chen et al. (2020)	17	>65	12 males 5 females	15 min, 3 times per week	Whole-body vibration (12 weeks)	Quasi experimental
Baek et al. (2022)	22	61.90 ± 1.14	7 males 15 females	2 sessions per week	Forest healing anti-aging program (3 weeks and follow-up after one month).	Quasi experimental
Fragoso et al. (2015)	1635	78.7 ± 5.2	Males = 33.1% Females = 66.9%	30 min/session, 5 times per week	Structured physical activity (288-360 weeks)	Randomized trial
Xiau & Zhuang (2016)	100	67.53 ± 8.56	Men and women (No data)	four 45-min sessions per week	Baduanjin Qigong (24 weeks)	Randomized trial

Table 2
Study Identification, Objective, Balance, Sleep Quality and Physical Fitness Measures and Main Results

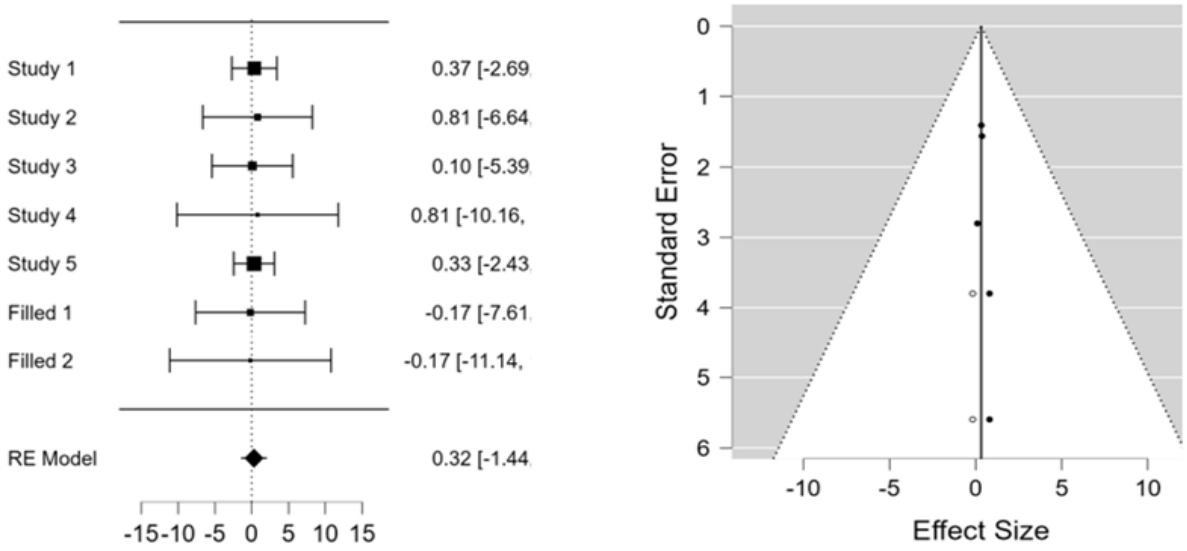
First Author (Publication Year)	Objective	Balance Measurement Instruments	Sleep Quality Measurement Instruments	Physical Fitness Instruments	Main Results
Pei-Chen et al. (2020)	Assessing the effect of whole-body vibration on older people with sarcopenia, and their physical capability, activities of daily living, and sleep quality.	One Foot Balance; Five sit–stand repetitions.	PSQI.	One-foot balance, shoulder and arm flexibility, walking speed, grip strength, and five sit–stand repetitions;	Sleep quality maintained Balance improved. Physical Fitness improved in: Shoulder–arm flexibility; walking speed; Grip strength (right hand); Grip strength (left hand); Five sit–stand repetitions.
Baek et al. (2022)	To determine the effect of a forest healing anti-aging program on psychological, physiological, and physical health in older people with mild cognitive impairment.	Dynamic: 8-ft up and go; Static and dynamic: AMTI AccuSway.	PSQI.	Senior fitness test.	Sleep quality improved after follow-up. Physical Fitness and dynamic balance improved pre and after follow-up. Static balance (AMTI AccuSway) did significantly improved, but dynamic (AMTI AccuSway) improved pre- and after the follow-up.
Fragoso et al. (2015)	Access the effect of structured physical activity on sleep–wake behaviors in sedentary elderly adults with mobility limitations.	400-m walk test (400MWT): walking pace over a 40-m course defined as slow gait speed when less than 0.8 m/s.	PSQI; Epworth Sleepiness Scale; ISI: The seven-item questionnaire based on the Diagnostic and Statistical Manual of Mental Disorders.	Short Physical Performance Battery (SPPB)	Physical Activity have significant effect in reducing sleeping issues in PSQI. However, women trend to present better sleep quality in comparison to men after intervention. Balance and Physical performance: *Not reported in the article and supplementary file impossible to access.
Xiau & Zhuang (2016)	Investigated the effectiveness of Baduanjin Qigong on symptoms related to gait, functional mobility and sleep in Parkinson disease (PD) patients	Berg Balance Scale; Timed Up & Go.	Parkinson's Disease Sleep Scale-2.	Berg Balance Scale 6-minute walk test Timed Up & Go	Sleep quality significantly improved reducing the disturbed sleep; Balance: Time up and go performance significantly improved after 6 months of intervention; gait speed also improved after the intervention; Physical performance improved, evaluated by the 6-minute walk test.

Meta-Analysis

The analysis revealed significant (t = 4.501; *p* = 0.011) small effect (d = 0.361) of exercise in sleep quality. The PEESE did not present significant effect (t = 3.031; *p* = 0.056) and the same was observed for the PET for the effect size (t = 1.049; *p* = 0.371) and the publication bias (t = 1.055; *p* = 0.369). Figure 2 presents the forest and funnel plots. Forest plot (left picture) with effect sizes for each study, and intervals of confidence and funnel plot (right picture) for the selected studies with effect sizes and standard errors variations per study assessing the effects of exercise in sleep quality.

Figure 2

Forest Plot and Funnel Plot for the Studies Assessing the Effects of Exercise in Sleep Quality

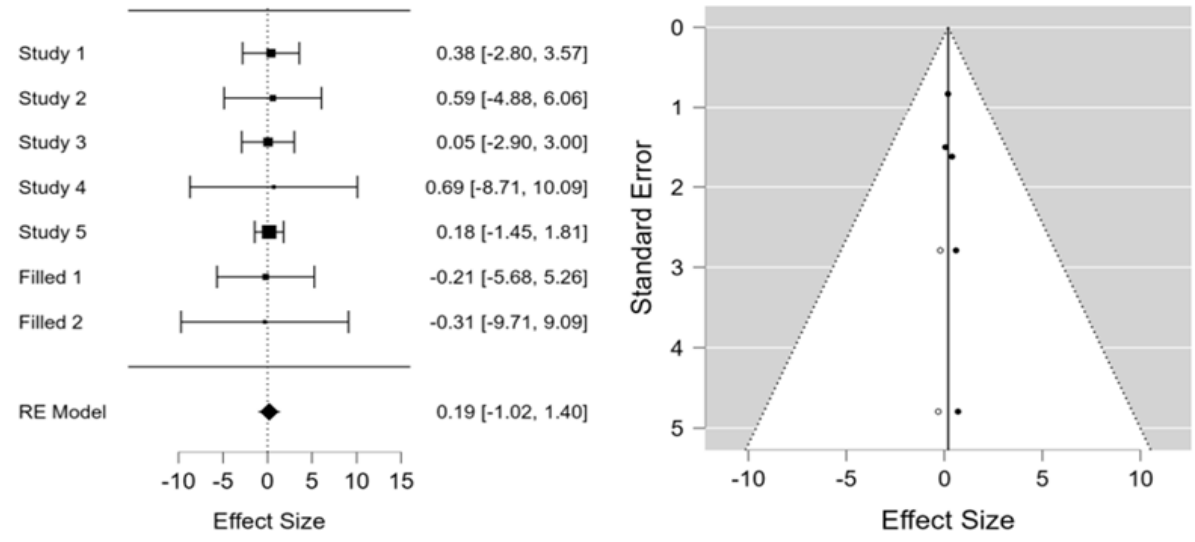


Note. Study 1: Pei-Chen et al. (2020) – satisfactory sleep; Study 2: Baek (2022); Study 3: Fragoso (2015); Study 4: Xiau (2016); Study 5: Pei-Chen et al. (2020) – unsatisfactory sleep.

The analysis revealed significant (t = 3.002; *p* = 0.040) small effect (d = 0.219) of exercise in balance. The PEESE did not present significant effect (t = 2.164; *p* = 0.119) and the same was observed for the PET for the effect size (t = 0.291; *p* = 0.790) and the publication bias (t = 1.703; *p* = 0.187). Figure 3 presents the forest and funnel plots. Forest plot (left picture) with effect sizes for each study, and intervals of confidence and Funnel plot (right picture) for the selected studies with effect sizes and standard errors variations per study assessing the effects of exercise in balance.

Figure 3

Forest Plot and Funnel Plot for the Studies Assessing the Effects of Exercise in Balance

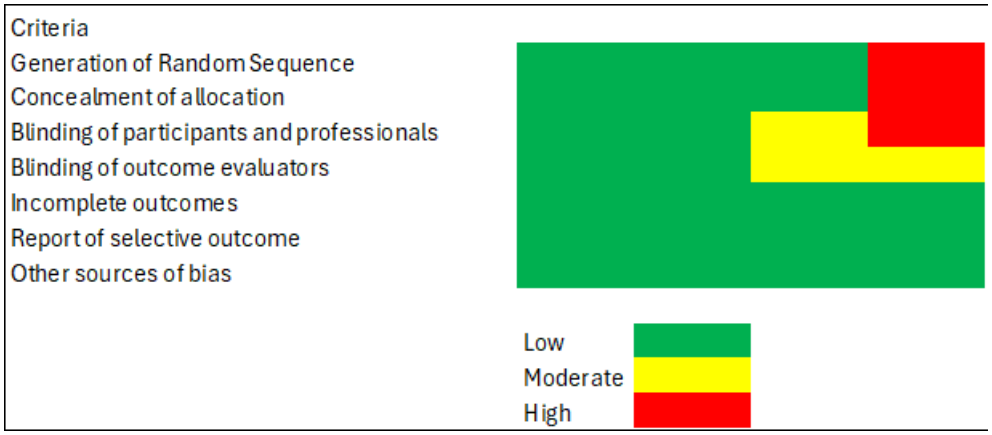


Note. Study 1: Pei-Chen et al. (2020); Study 2: Baek et al. (2022); Study 3: Fragoso et al. (2015); Study 4: Xiau & Zhuang (2016); Study 5: Pei-Chen et al. (2020) – unsatisfactory sleep.

Studies Quality

The analysis revealed predominantly low or unclear risk of bias across key criteria in most of the articles (Figure 4).

Figure 4
Risk-of-bias Item Presented as Percentages Across all Included Studies



Notably, a significant proportion of articles exhibited low risk in criteria such as incomplete outcome data, selective reporting, random sequence generation, and other biases. Few articles demonstrated low risk in random sequence, allocation concealment and blinding of participants and professionals. Moderate risk was observed in blinding outcomes evaluators. Additionally, a small subset indicated high risk of bias concerning the generation of random sequence and allocation concealment and blinding participants and professionals, as illustrated in Figure 5.

Figure 5
Judgments About Each Risk-of-bias Item for Each Included Study

Study/Criteria	Pei-Chen Lin (2020)	Baek (2022)	Fragoso (2015)	Xiau (2016)
Generation of Random Sequence	+	-	+	+
Concealment of allocation	-	+	+	+
Blinding of participants and professionals	?	-	+	+
Blinding of outcome evaluators	+	+	?	?
Incomplete outcomes	+	+	+	+
Report of selective outcome	+	+	+	+
Other sources of bias	+	+	+	+

Note. + Indicates Low Risk; ? Indicates Unclear Risk; − Indicates High Risk (Panel B)

Discussion

The aim of this study was to review the literature about the effects of exercise in balance and sleep quality in aged people and provide dose-effect estimations by meta-analysis approach. It was hypothesized that; physical exercise programs positively improve aged people both sleep quality and balance. The present study supported the hypothesis where physical activity and exercise plays an important role in sleep quality and balance.

The search for studies resulted in a total of 4 articles. The literature is controversial regarding the number of studies to include in a meta-analysis. Some of the kinds have been conducted with two studies (Rahman et al., 2023), four (De Wilde et al., 2016) or even fourteen studies (Kulinskaya & Wood, 2014). However, it is important to highlight that the PRISMA Guidelines do not state the required minimum of studies (Hallyburton & Evarts, 2014; Page et al., 2021). That can be explained by the diversity and dependency of the number of studies and the statistical approaches to run meta-analysis (Willis & Riley, 2017).

The studies content analysis allowed to present information about sample, intervention, measured variables and main results. The studies samples ages were above 61 years old. The literature presents some recent systematic reviews and meta-analysis considering ages above 60 years old for physical fitness and health related quality of life in aged people (Ogonowska-Slodownik et al., 2021; Willis & Riley, 2017). In the current study, the physical activity and exercise interventions were from moderate to vigorous physical activity levels and structured programs, whole-body vibration, and the Baduanjin Qigong program, which increases the variability of conclusion due the heterogeneity of methods. A systematic review with meta-analysis (Li et al., 2022) showed that the interventions to improve physical fitness and frailty in aged people can be of different types, specially strength training (Seino et al., 2017; Serra-Prat et al., 2017; Yu et al., 2020), balance training (Liao et al., 2019; Yu et al., 2020), aerobic training (Liao et al., 2019; Yu et al., 2020) or flexibility training (Barrachina-Igual et al., 2021). The literature also presents studies assessing the effects of physical activity in aged people physical fitness (López-Ortiz et al., 2023; Monteiro et al., 2019). Concluding the training programs, an umbrella review of systematic reviews revealed that the multicomponent training programs seems to have the best results in aged people (>60 years old) physical fitness and frailty (López-Ortiz et al., 2023). As for the assessed variables, the balance was mostly measured by time and speed to complete a distance and return to seat (such as time-up and go), but also static measurements with equipment's, and scales were used. Another meta-analysis (Cadore et al., 2013) revealed that balance is mostly assessed by the time-up and go test (Rodrigues et al., 2022), followed by Berg scale. However, other kinetics and kinematics instruments and equipment's are used to assess balance (Duarte et al., 2022). Regarding the sleep quality, the PSQI seemed to be the most used instrument in aged people in the present study and it is in agreement with literature, where this scale is appointed as the most used (Rodrigues et al., 2022). Finally, the main results were somehow concordant with the literature, where the interventions by physical activity and exercise improved or maintained the sleep quality and balance (Lam et al., 2018). However, no review studies were founded accessing the effects of exercise and physical activity programs in both balance and sleep quality.

The meta-analysis methodology of this study allowed to support the previous theoretical associations between exercise, sleep quality and balance in aged people. The results showed that the exercise has significant small effect as beneficial therapy to improve sleep quality. Also, a significant small effect was observed regarding the balance. Lower risk of bias was presented for both analyses. These results are in line with the literature, where different meta-analysis reported the beneficial effect (mostly low to moderate effect) of exercise in balance (López-Ortiz et al., 2023) and sleep quality (Hasan et al., 2022; Rubio-Arias et al., 2017).

This study presents important evidence about the relationships between physical exercise and activity, balance, and sleep quality. However, it is not without limitations and therefore requires careful interpretation when analysing it: (i) the study only included research articles with experimental interventions by exercise and physical activity assessing both balance and sleep quality; (ii) only the last decade of studies was assessed and so, some older studies were not included: (iii) more studies would strengthen the meta-analysis outputs; (iv) it was not possible to control the effects by sex; (v) the effects of different training programs in separate variables (independent studies evaluating balance or sleep quality) were not assessed; (vi) this study do not allow to assess the effects of different training types (aerobic, resistance, concurrent, etc.) in sleep quality and dynamic balance. Nevertheless, it is important to consider the strengths: (i) this is the first review and meta-analysis assessing the effects of physical exercise and activity in both balance and sleep quality. (ii) quantitative effect was presented about the effects of exercise in both balance and sleep quality. Finally, some future directions are possible to point out: (i) there's a need to perform pre-post analysis of exercise interventions and the relationships between balance, sleep quality and physical fitness; (ii) sex comparisons of exercise programs in both balance and sleep quality; (iii) comparing the effect of different training types in both balance and sleep quality; (iv) modulate balance predictions based on sleep quality and physical fitness.

The study provides important recommendations regarding the benefits of exercise for older adults. Healthcare professionals should prescribe tailored exercise or physical activity programs to improve balance and sleep quality, manage chronic diseases (i.e., metabolic), and prevent falls. Fitness trainers can design effective workouts targeting balance, strength, flexibility, and coordination. Older adults may prioritize physical activity, with professional supervision, and make exercise a regular habit to enhance their overall well-being. By incorporating these practical applications, older subjects may experience a healthier and more active lifestyle.

Conclusion

This study reviewed and estimated the effects of exercise on balance and sleep quality in aged individuals, utilizing a meta-analysis approach to provide dose-effect estimations. The variability in interventions and assessment methods highlights the complexity of drawing conclusions in this field without some risk of bias. However, the results align with existing literature, affirming the beneficial effects of exercise on both balance and sleep quality in older adults. It is possible to conclude that the physical activity and exercise programs positively impact both sleep quality and balance in the elderlies.

Ethics Committee Statement

Not applicable due to the type of the manuscript: review article.

Conflict of Interest Statement

None.

Funding

None.

Authors' Contribution

Conceptualization P.F. & A.M.M.; Methodology T.M.B, P.F.; Software P.F.; Validation D.P-M., A.M.M. & T.M.B.; Formal Analysis T.M.B.; Investigation P.F.; Resources D.P-M.; Data Curation A.M.M.; Writing – Original Draft P.F.; Writing – Review & Editing A.M.M, T.M.B., D.P-M.; Visualization D.P-M.; Supervision A.M.M, T.M.B., D.P-M.; Project Administration A.M.M, T.M.B., D.P-M.; Funding Acquisition T.M.B. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author (p.gomes@edu.uah.es).

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