A systematic review examining the correlation between physical activity and sleep quality

Vithanala Srinivasa Rao
Research Scholar Department of Pharmacy, Sunrise University, Alwar, Rajasthan.
svvithanala@gmail.com

Dr. Sangamesh B. Puranik
Research Guide Department of Pharmacy
Sunrise University, Alwar, Rajasthan.

ABSTRACT

Introduction: Many studies have investigated the relationship between physical activity (PA) and sleep quality, but the effect of PA intensity on sleep quality has not been examined in previous studies.,
Aim: This systematic review aims at examining the impact of intensity of physical activity on the sleep quality of healthy individuals,
Methods: A systematic review was conducted by searching for relevant articles published between January 2010 and June 2018 using PubMed and Scopus databases. The search keywords "sleep quality" AND "physical activity" were used to identify suitable papers. A total of 14 papers were reviewed and analyzed systematically. A comparison was made between the physical effort and sleep quality based on the threshold of moderate to strong physical activity.
Results: The systematic review comprised a total of 14 papers, indicating that moderate physical activity had a greater impact on improving sleep quality than rigorous exercise. Notably, both young and elderly individuals benefited from moderate physical activity.
Conclusion: The findings suggest that exercise that was somewhat intense had a positive effect on sleep quality. Further research should consider age groups and provide specific exercise recommendations to enhance health promotion.

Abbreviations: *CDC: ACSM: American College of Sports Medicine; Centers for Disease Control and Prevention; NSF: National Sleep Foundation; PA: Physical Activity; Metabolic rates, or METs Rapid Eye Movement, or REM Randomized Control Trials, PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), MMAT (Mixed Method Appraisal Tool); Mixed Methodologies, Quantitative, Qualitative, and QUAN Pittsburgh Sleep Quality Index (PSQI)*

KEYWORDS *Sleep hygiene, sleep quality, physical activity, exercise, and general health.*

Introduction

In the last decade, studies have established that sleep disruption increases the risk of various medical conditions, including cancer and cardiovascular disease, as well as depression. Therefore, improving sleep quality is essential for better health [1]. Despite the frequent use of the term "sleep quality" in sleep medicine, there is a lack of understanding about its meaning. The National Sleep Foundation, NSF, identified key indicators of quality sleep in healthy individuals, such as sleep latency, frequency of awakenings, wake after sleep initiation, and sleep efficiency. However, this definition does not take into account sleep architecture or nap-related characteristics [2]. Although poor sleep quality is a significant aspect of insomnia, previous research has shown that people with insomnia and normal sleepers generally have a similar understanding of sleep quality [3]. Nonetheless, the NSF outlined the primary characteristics of high-quality sleep, which include sleeping for at least 85% of the total time in bed, falling asleep in 30 minutes or less, waking up no more than once per night, and being awake for 20 minutes or less after awakening [4].

Understanding the connection between PA and the caliber of one's sleep as well as accurately classifying PA intensity are crucial. How hard our bodies work during physical activity (PA) determines how intense that activity is. According to recommendations made by the CDC and the American College of Sports Medicine (ACSM), moderate activity is defined as exceeding 6.0 exercise metabolic rates (METs) (more than 7 kcal/min) and falling between 3.0 and 6.0 METs (below 3.5-7 kcal/min) [5]. The CDC advises a range of moderate and high intensity physical activity to improve health. Exercise is regarded as an excellent, non-pharmacological method to enhance sleep. Moreover, physical activity is advised as a substitute for or addition to current sleep disorders therapy [6]. Cross-sectional studies have shown that teenagers who are physically active have better sleep quality than those who are not [7, 8]. A systematic review conducted recently discovered that exercise in the evening may enhance sleep, while vigorous exercise may reduce the time it takes to fall asleep. The original work can be distributed, used, and reproduced in any medium for non-commercial purposes, provided that it is properly cited and remains unchanged [9]. While the benefits of physical activity and sleep quality have long been acknowledged, the association between the intensity of physical activity, such as moderate or intense exercise, and sleep quality still needs further clarification.

According to current understanding, a healthy lifestyle depends on getting a decent night's sleep, which is known to be impacted by biological variables and way of life. Both a biological and physiological approach have been used to analyze the advantages of physical activity. Yet of days, sleep deprivation is becoming more common [10]. Inadequate sleep and erratic sleep-wake patterns, which have been seen in younger adolescents, were disturbing among college students [11]. Poor sleep quality has a negative impact on cognitive function and academic achievement [12]. Throughout middle school through college, teenagers' academic performance is inversely correlated with their sleep quality [13]. While sleep is biologically necessary, it has been compromised in modern society to meet social and professional demands. Also, getting enough sleep is crucial for personal success [14].

Physical activity is often considered to be a therapeutic behavior that encourages sleep [6, 15]. We now understand that different manifestations of changes in physical exercise functions are influenced by the amount and/or quality of sleep. Exercise at leisure time increases overall energy consumption [16]. Also, it has been shown that exercising may enhance older individuals' subjective sleep quality and cognitive function [17]. A critical indicator of how exercise affects sleep is rapid eye movement (REM) sleep. Activity is significantly associated with a reduction in REM sleep [18], which clarified how PA effects on sleep work.

Activities that are both vigorous and moderate may help middle-aged people with metabolic issues [19]. When describing the connection between PA and sleep quality, it is important to take activity intensities into account. Self-rated sleep quality was shown to improve with a low to moderate intensity Tai Chi program [20]. It was shown that middle-aged and older persons who participated in a fitness training program reported better sleep [6]. This would suggest that physical activity may cause more significant alterations in sleep.

Examining the incidental influence of age is crucial given that it is probably a key mediating factor affecting the intensity of physical activity. There is a significant frequency of physical impairment among the aging population. It has been shown that in older men, fragmented sleep and hypoxia are related to impaired physical function [21]. Nonetheless, it was said that when teenagers are athletes, intense activity is favorably associated to their sleep. Further research is needed to understand how age and physical intensity combine to affect sleep.
Physical inactivity is a significant role in the causative constellation of risk factors for cardiovascular disease, as documented [22]. What levels of PA intensity are suggested for the general population? It is important to approach a wide public common conclusion. So, there are two goals for this study. First, to show how, among the general population, PA intensity and sleep quality are related. Second, investigate how age may operate as a mediator between exercise's impacts on sleep quality.

Materials and methods

Search strategy

From January 2010 to June 2018, papers were identified for inclusion using two search engines: PubMed and Scopus. Separate searches were done on the two databases. To find the research, we searched PubMed using the terms "sleep quality" AND "physical activity" or "sleep quality" AND "exercise." In contrast, we manually entered our search phrases into Scopus's searching box by choosing the appropriate site links since Scopus' searching box differs from PubMed's. Only English articles were taken into account for both data sets. The existing research on the relationship between PA (such as Taichi, Baduanjin, etc.) and sleep quality were manually searched for any further studies that could be pertinent.

Study selection

The selection procedure included articles from the internet databases Scopus (n = 926) and PubMed (n = 482). After screening titles and abstracts, 1408 records were found using the search method, and 81 articles were selected for full-text review. 67 papers were carefully

reviewed in full and then eliminated for a variety of reasons (listed in Figure 1).
In November 2018, the database search took place over the course of one week. After reviewing the title and abstract of the studies done with ineligible individuals that were displayed among the search results on a computer screen, they were disqualified. Studies that could fit the inclusion criteria were chosen and held out for the second round of review. The chosen papers from the two databases were pooled together for a full-text check after being screened by title and abstract. When the judgment couldn't be made based on the opaque abstract, articles that were retrieved based on the title and abstract underwent full-text evaluation. Studies have been included into the systematic review after full-text evaluation. After a full-text search, the qualifying studies' duplication was manually checked. The studies that were included were stored and managed using Mendeley (version: 1.19.2). Full-text access was facilitated by the librarian.
The procedure of selecting studies was described using the PRISMA flow diagram [23].

Eligibility criteria

Studies were considered if they satisfied the following requirements:
(1) Observational investigations, including as longitudinal, cross-sectional, pre-post, and case-control studies aswell as randomised control trials.
(2) None of the participants were in the hospital or receiving medical care (e.g. pregnant women, people with facilities, etc.).
(3) Trials involving people who had mental issues were excluded (e.g. hypomania, etc.).

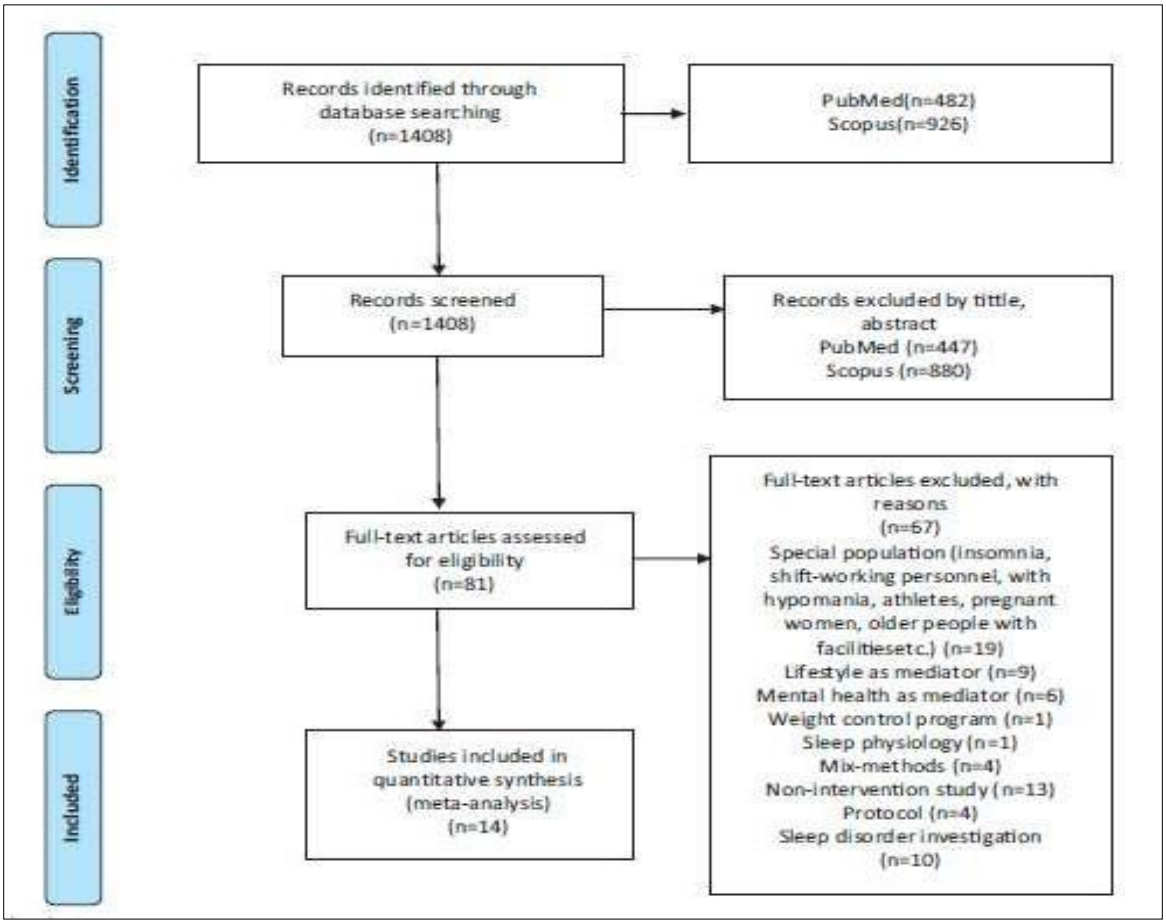

Figure 1. Study selection process.

(4) Shift workers were excluded as well since it has been thrown off.
(5) Research protocol was not included.
(6) Research have shown the effectsof irrelevant variables (such as mental health or lifestyle) on sleep or have used sleep as a riskfactor. If any additional studies couldn't fulfill the inclusion criteria, they were all eliminated.

Quality assessment

We employed the 2011 version of MMAT, designed to assess the quality of mixed methods, quantitative, and qualitative reviews [24,25]. The present review considers various study designs, not just randomized controlled trials, based on the inclusion criteria. The MMAT tool is designed to evaluate systematic reviews in a comprehensive manner. The tool comprises five domains, each of which has five scoring metrics for qualitative, quantitative randomized controlled, quantitative non-randomized, and quantitative descriptive studies, as well as three items for mixed-methods studies.

The MMAT will be used to determine an overall quality score for each retained study. Quartile descriptors may be used to display the score. As there are four questions in each area (except from the mixed methods domain) in the evaluation, the possible scores range from 1 (one criterion satisfied) to 4 (can't tell) (all criteria met). This final score (quality score) was determined for both qualitative and quantitative investigations based on the percentage of criteria that were satisfied. The overall quality score for mixed-methods research projects receives the lowest rating of the study's component parts. For instance, the score is 1 when QUAL, QUAN, or MM all equal 1, 2, 3, or 4, respectively (where QUAL is the qualitative component score, QUAN is the quantitative component score, and MM is the mixed methods component score) [24]. The score is 2 when QUAL, QUAN, or MM all equal 2, 3, or 4, respectively.

Each domain's questions were labeled Q1 - Q4 based on their position in the original scale order. If the response is "yes," we code 1, "no," or "cannot tell." If the response is "cannot tell," we code 0. To illustrate the percentage of study quality in various strata, a summary of the number of "yes" responses was created.

Data extraction

The study was redefined according to the following criteria:, 1, Was the study designed as a randomized controlled trial?, 2, Did it use the PSQI to assess the quality of participants' sleep?, 3, Did it have complete outcome data?, 4, Were the samples appropriately selected?, 5, Did it include case- and control-group studies? These criteria were considered as risk factors while exploring the relationship between physical activity and sleep quality.

RESULTS AND DISCUSSION:

Finally, after screening, a total of 14 studies were included in the systematic review, comprising both RCTs and non-RCTs. The retrieved standardized headers in Table 1

encompassed information about the authors, publication years, number of participants, age range, treatments, research design, sleep measurements, and outcomes. The studies included various age groups and both moderate and vigorous physical activity, with moderate physical activity such as walking, Tai chi, daily home exercise, and Pilates being initiated more often. The interventions ranged from 35 minutes to 24 weeks in duration. Young adults (18 to 45 years old) comprised half of the participants, while 36% were seniors above 45 and 14% were children under 18. The majority of the research yielded positive outcomes for the PSQI's global sleep score. However, the two qualitative and cross-sectional investigations examining the effects of strenuous physical activity on sleep quality revealed otherwise.

Quality appraisal

Three quantitative descriptive studies (cross-sectional studies) are included in the quality evaluation together with one qualitative investigation. Ten articles included experimental research that was either non-RCT or RCT organized. Except for one prospective research, all of the non-RCT trials were pre-post studies. Table 2 is a list of the quality assessment's findings. The only research domains discovered in the chosen papers were "quantitative non-randomized control trail," "quantitative randomized control trail," "quantitative descriptive," and "qualitative." Three criteria were satisfied by 43% of the articles that were included. Studies that matched four criteria were found in somewhat more studies (29%) than those that only met two criteria (21%) were found in. 7% of the studies (n = 1) only satisfied one criterion.

Positive results of moderate exercise

Scientific studies that promoted improving health conditions often included physical exercise. Health professionals and academics pay close attention to sleep health and quality. Several studies examined the effects of exercise on sleep quality. Yet, despite the kinds and targeted samples, other research had shown more encouraging outcomes. Almost all forms of physical activity are thought to improve sleep quality. Menopausal women's quality of sleep increased by increasing their weekly walking distance by 500 steps [33]. Walking exercises not only enhanced the subjective sleep quality of menopausal women but also of secondary school students [31]. Moreover, an observational study showed that walking exercises are beneficial in improving subjective sleep quality in both physically active and inactive adults [28]. In a randomized controlled trial involving elderly people living in the community, aerobic activities such as Tai Chi and home exercise were evaluated, and the findings revealed that the participants who exercised had better sleep quality than those who did not exercise [26, 27, 32]. Moderate-intensity physical activities such as roller skating, biking, baseball, walking, and running improved sleep in a program initiated in college students (nine exercisers and ten non-exercisers) [30]. According to the evidence, exercise may help with some aspects of sleep, as 30 minutes of home-based Pilates exercises significantly improved daytime dysfunction, subjective sleep quality, sleep latency, and the overall PSQI score, but not sleep length, habitual sleep efficiency, or sleep disturbance [34]. The majority of physical activity programs with beneficial outcomes were moderate exercise or exercise ranging from moderate to intense intensity. The age and health of the participants must be taken into account while implementing physical activity. PA duration and intensity for sleep benefits are being explored.

Negative/novel results of moderate exercise

While the selected publications included more good findings, there were still some unexpected or unfamiliar outcomes. There was no discernible impact on sleep quality in a floor-seated exercise program done in 77 elderly participants (between 71 and 85 years old) [36]. Reduced PA may be related to poor sleep, as shown by a cross-sectional research conducted in an urban region with low socioeconomic level [35,37]. It was suggested that PA could be a risk factor that might be changed to enhance sleep [35].

Vigorous exercise and sleep quality

It was shown that there was no correlation between vigorous PA and sleep quality and amount in a cross-sectional research with individuals from 23 countries [38]. A qualitative research that looked at how acute activity affected sleep came to no conclusion that intense PA had any impact on the quality of the sleep [29]. Nonetheless, several results contradicted the conclusion. Acute morning exercise among those with insomnia seemed to enhance the quality of nocturnal sleep in those who had trouble falling asleep [39]. Also, it has been shown that higher PA levels are favorably linked to sleep restoration, and that robust PA levels appear to be a stronger indicator of restful sleep than moderate PA levels [40]. As far as we can tell, there aren't many research examining how active PA affects the quality of sleep.

1: the answer is yes; 0: the answer is no; CT: cannot tell. Analysis of physical activity and sleep quality

In scientific studies, physiotherapy techniques to enhance sleep quality were more often associated with moderate physical activity. It is a good idea to talk about how physical intensity and length affect the quality of sleep. According to a cross-sectional research, neither the duration nor the intensity of PA was related to the amount or quality of sleep [41]. Regular moderate-intensity exercise programs have been strongly suggested to enhance self-rated sleep quality in older persons with moderate sleep problems [42]. It is logical to conclude that physical intensity may be connected to sleep quality in light of the data shown above, while more research is still required [43].

Among daytime workers, it has been hypothesized that sleepiness is correlated with age [44]. In this review, age did not provide adequate evidence to moderate the association between PA and sleep quality.

Risk of bias

Eighty eight percent of the older adults who participated in the study on the effects of home exercise on sleep quality and daytime drowsiness were women [28], therefore gender bias was unavoidable. Participation in sports is predominantly influenced by gender differences in exercise motivation [45]. The 12-week physical activity program on sleep [30] had 19 individuals; 10 were in the intervention group and 9 were in the control group. Since the sample size was too small to guarantee confidentiality, there was a chance that the retrieved data would be biased. It may be useful to take regional differences in sleep patterns into account in the cross-sectional research that examined the vigorous PA, perceived stress, sleep, and mental health among university students from 23 low- and middle-income countries.

Limitations

Despite the inclusion criteria being closely applied to the selection of each study, there are still certain restrictions. The categorization of physical activity levels, to start, is ill-defined and poorly articulated in scientific study. In order to categorize the terms "moderate physical activity" and "vigorous physical activity," we used the CDC's recommended exercises as a guide. Second, it was shown that obesity had a mild impact on both PA and sleep quality [46]. The individuals' body weight was not taken into account in this review. Technically, the selection scope was constrained since we only took into account English-language papers for the research.

Conclusions

According to the current review, there is not enough experimental support for a link between physical exertion and sleep quality. The elements included in this review were crucial for enhancing sleep quality. Moreover, there was a lack of comprehensive information about potential age influences on how PA and sleep quality interacted. Data demonstrating the impact of acute exercise on sleep and sleep disorders were equivocal [39,47]. There is little evidence that active PA improves sleep quality. Given that spiritual and religious activities was projected to be associated with several aspects of sleep quality, cultural and religious views may have an impact on how people see sleep. Given that physical intensity is generally recognised, this research reveals that moderate physical activity improves sleep quality in all age groups in healthy populations. The statistics that are now available, however, do not truly support the gender interaction while engaging in physical activity. There aren't many scientific studies that specifically address this topic, although few studies have looked at how long physical activity lasts until it becomes insufficient for moderate activity. People are allowed to engage in various kind of activities since physical exercise is arbitrary and personal. Recommendations and guidelines of high quality are crucial.

The current research showed that moderate PA has an effect on sleep quality, although specific recommendations for organized physical activity types lack experimental support. Further research is advised to define the ideal level of moderate physical activity for enhancing sleep quality and to elucidate the connection between physical exertion and sleep quality. Additional research also recommended investigating specific exercise recommendations while taking into account various age groups in order to provide precise, evidence-based recommendations for health promotion.

REFERENCES

1. *Irwin MR. Why sleep is important for health: a psychoneuro- immunology perspective. Annu RevPsychol. 2015;66:143–172.*
2. *Ohayon M, Wickwire EM, Hirshkowitz M, et al. National Sleep*
3. *Foundation's sleep quality recommendations: first report. Sleep Health. 2017;3:6–19.*
4. *Harvey AG, Stinson K, Whitaker KL, et al. The subjective meaning*
5. *of sleep quality: a comparison of individuals with and without insomnia. Sleep. 2008;31:383–393.*
6. *National Sleep Foundation. What is good quality sleep? [cited*

7. 2019 May 28]. Available from: https://www.sleepfoundation.org/ press-release/what-good-quality-sleep
8. CDC. General physical activities definition by level of intensity.
9. [cited 2019 May 28]. Available from: https://www.cdc.gov/nccdphp/dnpa/physical/pdf/PA_Intensity_table_2_1.pdf
10. Yang PY, Ho KH, Chen HC, et al. Exercise training improves sleep
11. quality in middle-aged and older adults with sleep problems: a systematic review. J Physiother.2012;58:157–163.
12. Park S. Associations of physical activity with sleep satisfaction,
13. perceived stress, and problematic Internet use in Korean adoles- cents. BMC Public Health.2014;14:1143.
14. King A, Pruitt L, Woo S, et al. Effects of moderate-intensity exer-
15. cise on polysomnographic and subjective sleep quality in older adults with mild to moderate sleepcomplaints. J Gerontol A: Biol Sci Med Sci. 2008;63:997–1004.
16. Stutz J, Eiholzer R, Spengler CM. Effects of evening exercise
17. on sleep in healthy participants: a systematic review and meta- analysis. Sports Med. 2018;49:1–19.
18. Ferrie JE, Kumari M, Salo P, et al. Sleep epidemiology—a rapidly
19. growing field. Int J Epidemiol. 2011;40:1431–1437.
20. Lund H, Reider B, Whiting A, et al. Sleep patterns and predictors of disturbed sleep in a largepopulation of college students. J Adolesc Health. 2010;46:124–132.
21. Curcio G, Ferrara M, Degennaro L. Sleep loss, learning capacity
22. and academic performance. Sleep Med Rev. 2006;10:323–337.
23. Wolfson A, Carskadon M. Understanding adolescent's sleep pat- terns and school performance: acritical appraisal. Sleep Med Rev. 2003;7:491–506.
24. Ahrberg K, Dresler M, Niedermaier S, et al. The interaction
25. between sleep quality and academic performance. J Psychiatr Res. 2012;46:1618–1622.
26. Youngstedt SD. Effects of exercise on sleep. Clin Sports Med.27. 2005;24:355–365.
28. Tremblay MS, Esliger DW, Tremblay A, et al. Incidental movement, lifestyle-embedded activity andsleep: new frontiers in physical activity assessment. Appl Physiol Nutr Metab. 2007;32:S208–S217.
29. Benloucif S, Orbeta L, Ortiz R, et al. Morning or evening activity
30. improves neuropsychological performance and subjective sleep quality in older adults. Sleep.2004;27:1542–1551.
31. Oda S, Shirakawa K. Sleep onset is disrupted following pre-sleep
32. exercise that causes large physiological excitement at bedtime. Eur J Appl Physiol. 2014;114:1789–1799.
33. Rennie K, McCarthy N, Yazdgerdi S, et al. Association of the meta-
34. bolic syndrome with both vigorous and moderate physical activ- ity. Int J Epidemiol. 2003;32:600–

606.

35. Li F, Fisher K, Harmer P, et al. Tai Chi and self-rated quality of sleep and daytime sleepiness in older adults: a randomized con- trolled trial. J Am Geriatr Soc. 2004;52:892–900.

36. Dam T, Ewing S, Ancoli-Israel S, et al. Association between sleep and physical function in older men: the osteoporotic fractures in men sleep study. J Am Geriatr Soc. 2008;56:1665–1673.

37. Kohl H. Physical activity and cardiovascular disease: evidence for a dose response. Med Sci Sports Exerc. 2001;33:S472–S483.

38. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta- analyses: the PRISMA statement. J Clin Epidemiol. 2009;62:1006–1012.

39. Pluye P, Robert E, Cargo M, et al. Proposal: a mixed methods appraisal tool for systematic mixed studies reviews; 2011. [cited 2019 May 28]. Available from: http://mixedmethodsappraisaltool-public.pbworks.com

40. Pace R, Pluye P, Bartlett G, et al. Testing the reliability and effi- ciency of the pilot Mixed Methods Appraisal Tool (MMAT) for sys- tematic mixed studies review. Int J Nurs Stud. 2012;49:47–53.

41. Nguyen M, Kruse A. A randomized controlled trial of Tai chi for balance, sleep quality and cognitive performance in elderly Vietnamese. Clin Interv Aging. 2012;7:185–190.

42. Brandao G, Callou A, Brand~ao G, et al. The effect of home-based

43. exercise in sleep quality and excessive daytime sleepiness in eld- erly people: a protocol of randomized controlled clinical trial. Man Ther Posturol Rehabil J. 2018;16. http://dx.doi.org/10.17784/ mtprehabjournal.2018.16.577.

44. Hori H, Ikenouchi-Sugita A, Yoshimura R, et al. Does subjective sleep quality improve by a walking intervention? A real-world study in a Japanese workplace. BMJ Open. 2016;6:e011055.

45. Myllymaki T, Kyrolainen H, Savolainen K, et al. Effects of vigorous late-night exercise on sleep qualityand cardiac autonomic activ- ity. J Sleep Res. 2011;20:146–153.

46. Hurdiel R, Watier T, Honn K, et al. Effects of a 12-week physical activities programme on sleep in female university students. Res Sports Med. 2017;25:191–196.

47. Baldursdottir B, Taehtinen R, Sigfusdottir I, et al. Impact of a physical activity intervention on adolescents' subjective sleep quality: a pilot study. Glob Health Promot. 2017;24:14–22.