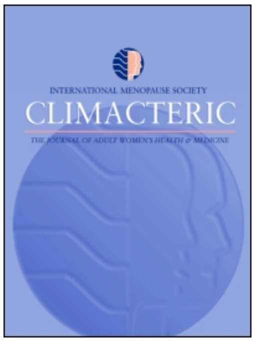

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Sleep disturbance, obesity, physical fitness and quality of life in older women: EXERNET study group

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ORIGINAL ARTICLE

Sleep disturbance, obesity, physical fitness and quality of life in older women: EXERNET study group

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ABSTRACT
Objectives: To investigate the association between physical fitness, obesity, health related quality of life (HRQoL) and sleep disturbance in 463 community-dwelling older Spanish women (66–91 years of age).
Study design: Cross-sectional study.
Method: Sleep disturbance was assessed with the Jenkins Sleep Scale. Active and sedentary behaviors were recorded by standardized questionnaires. HRQoL was assessed with the EuroQoL-5D. Anthropometric measurements were obtained using standardized techniques. Body fat was measured using bioelectrical impedance. Physical fitness was evaluated by a set of eight tests.
Results: Sleep disturbance was reported by 45.1% of women, being associated with higher body mass index ($p < 0.05$) and waist circumference ($p < 0.01$). Presence of insomnia was inversely associated with physical fitness. Women in the upper tertile of fitness index had 92.0% lower risk of sleep disturbance as compared to the lower tertile ($p = 0.08$), while women in the highest tertile of upper body strength had 76.4% lower risk of sleep disturbance as compared to the lower tertile ($p < 0.05$). Women without sleep disturbance showed better HRQoL.
Conclusion: Sleep disturbance was associated with central obesity, lower physical fitness and reduced HRQoL. Interventions involving weight management and improvement of physical fitness may contribute to better sleep quality in older women.

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KEYWORDS
Sleep disturbance; fitness; aging; body fat

Introduction

Sleep disturbance is highly prevalent in middle-aged subjects, especially among women[1], becoming more common with advanced age[2]. During the aging process, there are physical, psychological and social changes; sleep disturbances are the most frequent complaints in older people. Some 30–50% have difficulties in initiating and maintaining sleep[2,3]. Several factors have been associated with insomnia, including clinical or psychiatric illnesses such as depression or anxiety, environmental changes, poor sleep hygiene, use of medications, advanced endogenous circadian clock, reproductive cycles, urinary incontinence and nocturia, obesity, lifestyle changes, and metabolic alterations such as increases in nocturnal cortisol levels[2,4–10]. In addition, subjects with insomnia have increased risk of mortality and other morbid conditions such as mental disorders and cardiovascular and metabolic diseases[11,12]. Therefore, insomnia is important by itself, but also because of its effects on other health-related issues.

Fat re-distribution while aging commonly results in an increase in visceral fat[13]. In postmenopausal women, this central distribution of fat is more marked than in men, which is related to hormonal changes[14]. The visceral fat storage is associated with cardiovascular disease and type 2 diabetes mellitus, being the main determinant for the development of metabolic syndrome such as insulin resistance or glucose intolerance in the elderly[13,14]. Age and body mass index (BMI) are significant risk factors for sleep apnea syndrome[15], which is another factor in sleep disturbance. Older people with sleep apnea have more storage of visceral fat, playing a significant role in the development of sleep-disordered breathing[16]. Central obesity increases sleep disturbance in women[6], whereas people with a high percentage of body fat have a higher prevalence of insomnia or difficulty with sleep[5] and sleep apnea[17].

Even more, in older populations, physical fitness is related to the performance of daily life activities independently and without undue fatigue[18]. Less fit older people present poorer body composition than their very fit peers and regular physical activity plays a key role in preventing and treating this condition[19]. People with sleep disturbances show low values of physical fitness[5] which is particularly relevant in order to preserve normal autonomy and to have a successful old age. Some researchers have found that moderate physical activity is associated with improvements in sleep quality[5,10,20].

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However, in older women, the number of studies focusing specifically on self-reported problems in sleeping, physical fitness level, and adiposity is somewhat modest. Spanish older women are more sedentary than men and show a lower level of physical activity, which results in a higher predisposition to develop overweight/obesity and central obesity during this period of life[21,22]. To our knowledge, no data on health-related quality of life (HRQoL) and sleep disturbance in relation to the fitness level have been reported in this population. Thus, the aim of this study was to investigate the relationship between sleep disturbance, obesity (including BMI, waist circumference and body fat percentage measurements), physical fitness and HRQoL.

Methods

Study design and participants

The study was carried out within the frame of a multicenter study on physical fitness and body composition evaluation and its relation with healthy lifestyle among community-dwelling older Spanish women (Research Network in Exercise and Health for Special Populations, EXERNET)[22]. Briefly, this cohort is a representative sample of community-dwelling Spanish seniors selected by means of a multistep, simple random sampling, taking into account the locations (six different regions from Spain: Aragón, Castilla-La Mancha, Castilla-León, Madrid, Extremadura and Canarias) that ensure the geographical and cultural diversity of the sample. Subjects were recruited from three different cities in each region: the capital of the region and two other cities, one of 10 000–40 000 inhabitants and other of 40 000–100 000 inhabitants[23].

The information was collected through personal interviews using standard procedures and validated questionnaires that included the Jenkins Sleep Scale (JSS) and other questionnaires, followed by anthropometric and body composition measurements, and physical fitness assessment. Data collection took place from January 2011 to December 2012. The study was approved by the Research Ethics Committee of Aragón (Spain) (18/2008) and performed according to the principles established with the revised Declaration of Helsinki[24]. Written informed consent was obtained from each participant.

The study sample consisted of a sub-cohort of 463 women (aged 66–91 years) from the EXERNET multicenter study who completed all tests and the JSS questionnaire. This sub-sample was obtained in the follow-up of the EXERNET cohort, carried out 2 years after the 1st wave. In this 2nd wave, only four regions (Aragón, Castilla-La Mancha, Madrid and Extremadura) participated, with a total sample size of 630 men and women. A flow chart of the process is presented in Figure 1. To make maximum use of the data, all valid results on physical fitness tests, body composition and questionnaires were included in this report. Consequently, sample

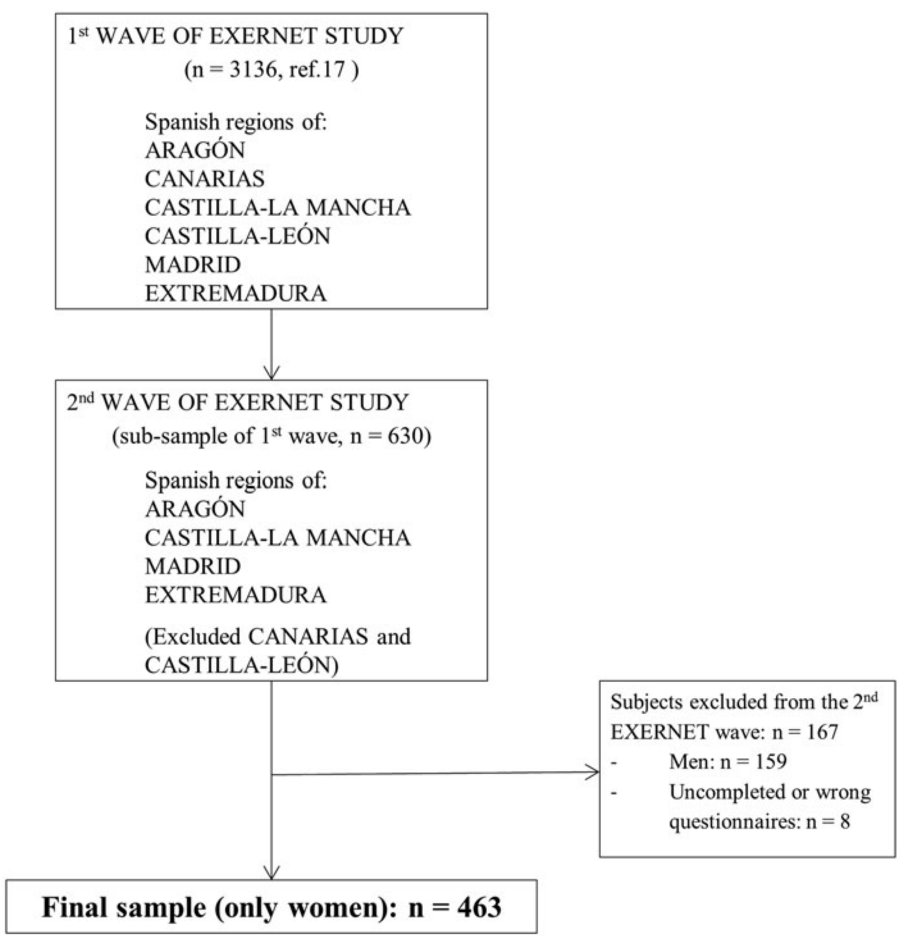

Figure 1. Flow chart reflecting the sampling for the EXERNET study.

sizes vary for different variables. The complete methodology of the study has been described elsewhere[22,23]. The exclusion criteria were: (1) women under 65 years; (2) those suffering from cancer and/or dementia; (3) those who were living in nursing homes and/or were not independent or able to take care of themselves; and (4) those women using walking aids. After finishing the field study, the participants who did not fulfill the inclusion criteria were excluded.

Anthropometric and body composition measurements

The measurements for anthropometric and body composition variables have been described elsewhere[22,25]. Height was measured by a stadiometer (SECA, Hamburg, Germany) with 2.10 m maximum capacity and a 0.001 m error margin. The prevalence (%) of overweight and obesity was calculated following the World Health Organization guidelines[26], establishing overweight as a BMI of 25.0–29.9 kg/m^2 and obesity as a BMI of $\geq$30 kg/m^2. Waist circumference was measured according to the International Society for the Advancement of Kinanthropometry[27]. Central obesity was defined by a threshold waist circumference value of $\geq$88 cm for women[28].

A bioelectrical impedance analyzer Tanita BC 418-MA (Tanita Corp., Tokyo, Japan) was used to measure the weight and estimate body fat percentage. For this variable, values $\geq$38% were considered as overweight, and $\geq$43% were considered as obesity[29].

The anthropometric and body composition variables were measured in 93.3% (height and waist circumference), 93% (weight) and 89.6% (fat mass) of the study participants.

Physical fitness assessment

Physical fitness tests and their reliability have been described elsewhere[25]. In short, the tests assessed the following physical fitness components: static balance by the one-leg test[30], lower and upper body strength by the chair stand test and arm curl test, respectively[18], lower and upper body flexibility by the chair sit-and-reach test and back scratch test, respectively[18], agility/dynamic balance by the 8-foot up-and-go test[18], speed by the 30-m walk[31] and aerobic endurance by the 6-min walk test[18]. These tests were adapted from the Senior Fitness Test Battery[18] and Eurofit Testing Battery[32]. All the tests were performed once, except the one-leg test, which was performed twice with each leg, the 8-foot up-and-go test and the 30-m walk test, which were also performed twice. Reliabilities for the physical fitness tests in this study have been reported by Pedrero-Chamizo and colleagues[25]. All were higher than 90% except for the 8-foot up-and-go. A fitness index of all tests was calculated according to physical fitness percentile values in Spanish elderly[25], bearing in mind the effect of age on the outcome of the physical fitness tests. Additionally, fitness index was categorized into quartiles, having the 1st quartile (Q1) as the lowest physical fitness results.

Questionnaires

Sleep disturbance risk was assessed using the 4-item Jenkins Sleep Scale[33] to indicate whether the participants had experienced disordered sleep over the preceding 4 weeks. The items concern 'difficulty falling asleep' (SQ1), 'difficulty staying asleep' (SQ2), 'waking up several times per night' (SQ3) and 'waking up feeling tired and worn out after the usual amount of sleep' (SQ4). Each item was scored on a Likert response scale from 1 to 6 (1 = 'not at all', 2 = '1–3 days', 3 = '4–7 days', 4 = '8–14 days', 5 = '15–21 days', 6 = '22–28 days')[34]. The sleep disturbance variable was graded as 0 = no presence of this condition, if the participants reported that any of sleep complaints happened less than 15 nights during the past 4 weeks or 1 = presence of sleep disturbance, if they experienced sleep problems in 15 or more nights during the past 4 weeks. The cut-off point for presence of sleep disturbance was based on the Diagnostic and Statistical Manual of Mental Disorder, Fourth Edition, Text Revision (DSM-IV-TR)[35] stipulating that difficulty initiating/maintaining sleep or non-restorative sleep should be present for three or more nights per week for at least 1 month[34,35]. Furthermore, we evaluated presence of sleep disturbance in another way, being present if women reported $\geq$12 days of sleep complaints[8]. A variable with the sum of the scores of the four variables (SQ1, SQ2, SQ3, SQ4) was also reported (SQv), following the recommendations of Jenkins and colleagues[33]. This questionnaire has been validated in Spanish and for different age groups[36].

Quality of life was assessed using the validated questionnaire EuroQol-5D (EQ-5D)[37] which has been previously used in elderly people[38]. The EQ-5D essentially consists of two parts, the EQ-5D descriptive system and the EQ visual analog scale (EQ-VAS). The EQ-VAS records the respondent's self-rated health on a vertical, visual analog scale where the endpoints are labeled 'Best imaginable health state' (100 points) and 'Worst imaginable health state' (0 points). This information can be used as a quantitative measure of health status as judged by the individual respondents. The EQ-VAS was used to assess the perceived health of each subject at that moment, establishing values equal to or more than 80 points as a good indicator of perceived health[37,38].

A validated questionnaire for an elderly population was used to record sitting and walking time of the participants[39]. Data for sitting time were collected through the question: 'How many hours do you usually spend sitting per day?'[21]. This question covered any activity in which the participant had to be sitting (e.g. watching television, reading, sewing) and it referred to the present time. For the walking time variable, the participants had to answer the question: 'How many hours do you usually spend walking per day?'[21]. For both questions, each participant had to choose one of the following options: <1 h/day, 1–2 h/day, 2–3 h/day, 3–4 h/day, 4–5 h/day or $\geq$5 h/day.

Statistical analysis

Data are presented as mean value ± standard deviation. Kolmogorov–Smirnov tests showed normal distribution of the studied variables. Differences were determined using paired Student's *t*-tests. Pearson correlation analysis was applied to identify the relationship between sleep disturbance and body composition and fitness variables. Binary logistic regression was used to test the association among physical fitness tests, obesity and the dependent variable (sleep disturbance). Odds ratios with 95% confidence intervals (CI) are reported for the studied models. Data were analyzed with the Statistical Package for the Social Sciences (SPSS, Inc., Chicago, USA) Windows software, version 20.0. Statistical significance was set as $p < 0.05$.

Results

Sleep disturbance and body composition

Age and gender-adjusted data for anthropometrics and body composition are displayed in Table 1. Women with central obesity according to waist circumference had worse scores than normal women in SQ2 ($p < 0.01$), SQ3 ($p < 0.05$), SQ4 ($p < 0.01$), and SQv ($p < 0.01$) (Figure 2). The group with sleep disorders showed significantly greater values of BMI (30.0 ± 4.4 kg/m^2 vs. 28.9 ± 4.2 kg/m^2, $p < 0.05$, with and without sleep disorders, respectively), and waist circumference (94.1 ± 11.5 cm vs. 91.3 ± 10.3 cm, $p < 0.01$, with and without sleep disorders, respectively) than those with proper sleep (Figure 2). Body fat percentage was not significantly different in women with or without sleep disturbance (39.9 ± 4.8% vs. 39.4 ± 4.9%, $p = 0.32$, with and without sleep disorders, respectively). There were low, but significant correlations between the disordered sleep score (SQv) and body composition parameters such as body weight ($r = 0.12$, $p < 0.05$), BMI ($r = 0.12$, $p < 0.05$) and waist circumference ($r = 0.13$, $p < 0.01$).

Sleep disturbance and fitness score

Differences between the 1st and the rest of the quartiles of fitness index were significant for SQ4 ($p < 0.001$) and SQv ($p < 0.05$, Table 2). *Post hoc* tests showed that the 1st quartile

Table 1. Descriptive characteristics and body composition parameters. Data are given as mean ± standard deviation or %.

Age (years)	74.59 ± 5.20
Height (cm)	151.6 ± 5.48
Weight (kg)	67.49 ± 10.47
Sitting time (h/day)	4.25 ± 1.35
Walking time (h/day)	1.79 ± 0.89
Body mass index (kg/m^2)	29.37 ± 4.33
overweight (%)	45.48
obesity (%)	40.14
Waist circumference (cm)	92.51 ± 10.91
central obesity (%)	63.67
Lean mass (kg)	40.38 ± 4.17
Fat mass (%)	39.59 ± 4.86
overweight (%)	46.02
obesity (%)	29.64
Fitness index	55.16 ± 17.9

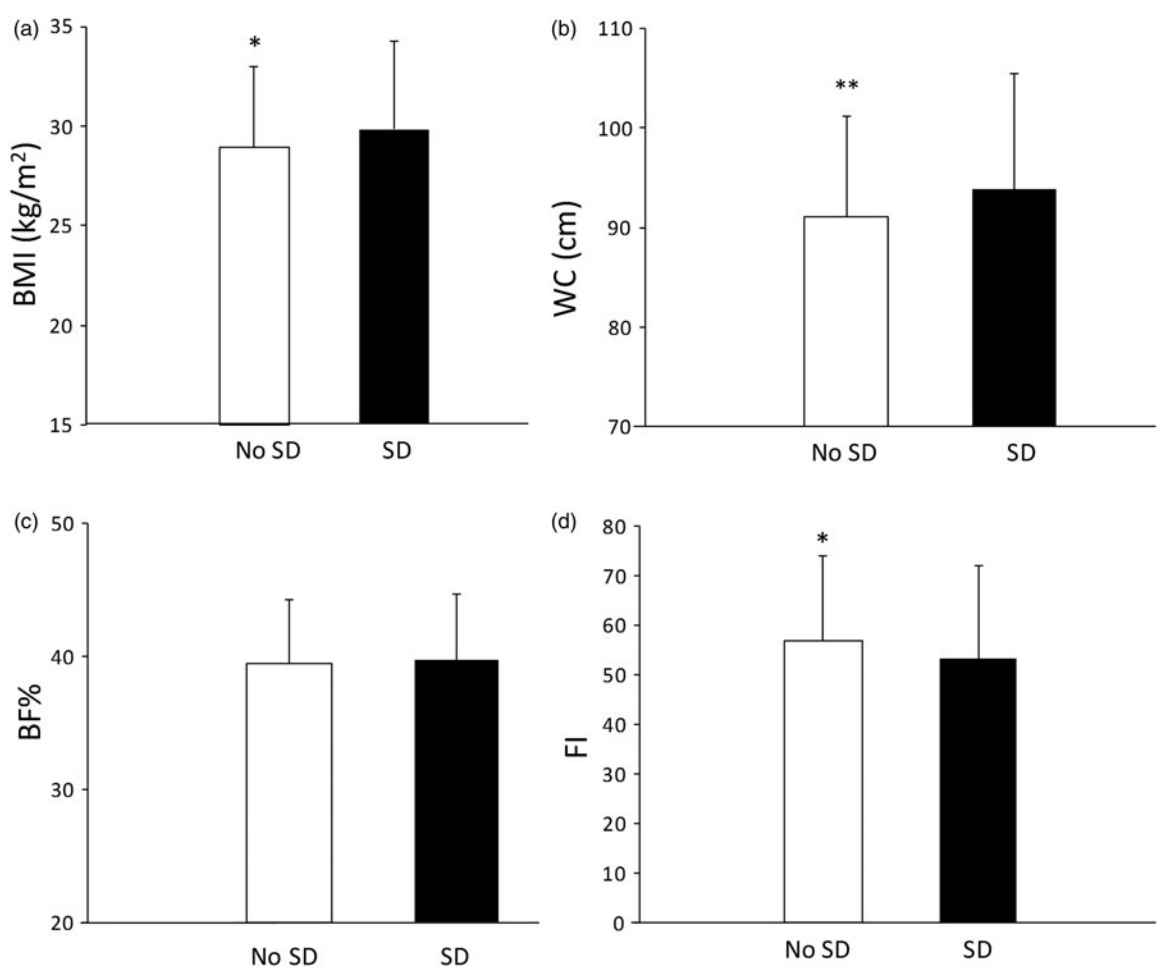

Figure 2. (a) Body mass index (BMI), (b) waist circumference (WC), (c) body fat percentage (BF%) and (d) fitness index (FI) in women with and without sleep disorders (SD). *, $p < 0.05$ with vs. without sleep disorders; **, $p < 0.01$ with vs. without sleep disorders.

Table 2. Sleep quality variables (mean ± standard deviation) according to quartiles of fitness index and upper body strength.

Fitness index	Q1 (n = 35)	Q2 (n = 139)	Q3 (n = 189)	Q4 (n = 54)
SQ1	2.63 ± 2.8	1.88 ± 2.14	1.70 ± 2.07	1.98 ± 2.09
SQ2	2.00 ± 2.33	1.67 ± 2.18	1.53 ± 2.1	1.52 ± 2.10
SQ3	2.37 ± 2.30	2.14 ± 2.27	1.76 ± 2.19	1.87 ± 2.22
SQ4	1.83 ± 2.23	1.14 ± 1.96	0.59 ± 1.42[b,d]	0.70 ± 1.53[a]
SQv	8.83 ± 7.39	6.82 ± 6.73	5.52 ± 6.48[a]	6.07 ± 5.85
Upper body strength	**Q1 (n = 51)**	**Q2 (n = 106)**	**Q3 (n = 100)**	**Q4 (n = 186)**
SQ1	2.31 ± 2.3	2.11 ± 2.16	1.93 ± 2.20	1.63 ± 1.98
SQ2	2.39 ± 2.27	1.49 ± 2.11	1.86 ± 2.26	1.25 ± 1.95[b]
SQ3	3.00 ± 2.14	1.98 ± 2.24[a]	2.04 ± 2.31	1.59 ± 2.08[c]
SQ4	1.39 ± 2.07	1.13 ± 1.91	0.78 ± 1.73	0.65 ± 1.47[a]
SQv	9.10 ± 7.09	6.71 ± 6.56	6.61 ± 6.94	5.11 ± 6.00[c]

Q1, first quartile; Q2, second quartile; Q3, third quartile; Q4, fourth quartile; SQ1, difficulty falling asleep; SQ2, difficulty staying asleep; SQ3, waking up several times per night; SQ4, waking up feeling tired and worn out after the usual amount of sleep; SQv, sum of the scores SQ1–SQ4
[a], $p < 0.05$ compared to Q1 values; [b], $p < 0.01$ compared to Q1 values; [c], $p < 0.001$ compared to Q1 values; [d], $p < 0.05$ compared to Q2 values

of fitness level had significantly higher scores in the SQv, compared to the 3rd quartile ($p < 0.05$). In addition, 53.7% of women in the upper quartile (29 out of 54) suffered from sleep disturbance compared to 65.7% in the lower quartile (23 out of 35). Sitting and walking times per day were not significantly different in women with and without sleep disturbance.

When comparing women with and without sleep disturbance for each individual physical fitness test, better performances were found for women without sleep disturbance for the variables of lower body strength (13.9 ± 4.0 vs. 14.7 ± 3.5 repetitions, $p < 0.05$), upper body strength (18.5 ± 4.1 vs. 17.2 ± 4.0 repetitions, $p < 0.001$), agility (6.4 ± 2.4 vs. 6.1 ± 2.0 s, $p < 0.01$) and walking speed (19.0 ± 5.5 vs. 17.2 ± 4.0 s, $p < 0.05$), in all of them, with and without sleep disturbance, respectively.

When considering each physical test individually as an independent factor, some of them did not present significant differences among quartiles (i.e. static balance, lower body flexibility, upper body, flexibility, lower body strength and endurance) while subjects in the 1st quartile of upper body strength showed higher scores in SQv variable compared to those in the 4th ($p < 0.001$). When comparing women with and without sleep disturbance, results were higher for women without this condition for the variables of lower body strength ($p < 0.05$), upper body strength ($p < 0.001$), agility ($p < 0.05$) and walking speed ($p < 0.05$) (Table 2). Additionally, inverse correlations between SQv and fitness index ($r = -0.11$, $p < 0.05$), and SQv and upper body strength ($r = -0.18$, $p < 0.001$) were found.

Sleep disturbance and HRQoL

Women without sleep disturbance reported better HRQoL as compared to those with it (73.3 ± 1.7 vs. 65.7 ± 1.9, $p < 0.05$, respectively). In addition, a mild inverse correlation between the presence of sleep disturbance and HRQoL ($r = -0.20$, $p < 0.05$), and a positive correlation between sleep disturbance and fitness index ($r = 0.22$, $p < 0.05$) were found. Finally, inverse correlations between sleep disturbance, HRQoL ($r = -0.20$, $p < 0.05$) and fitness index ($r = -0.11$, $p < 0.05$) were found.

Sleep disturbance risk and physical fitness index

Women with better physical condition (upper tertile of fitness index) had lower risk of suffering from sleep disturbance by 92% (odds ratio, OR = 0.52, 95% CI 0.251–1.083) compared to women with lower physical condition (lower tertile of fitness index) ($p = 0.08$). Specifically, women with better upper body strength reduced their risk by 76.4% compared to women with lower scores in this test (OR = 0.57, 95% CI 0.361–0.888, $p < 0.05$) while women with better agility reduced their risk of suffering from sleep disturbance by 51.5% (OR = 0.66, 95% CI 0.425–1.033, $p = 0.07$).

Discussion

The major findings of this study are: (1) older women with central obesity showed more sleep disturbance in most of the variables in the JSS; (2) women with sleep disturbance had greater BMI and waist circumference (central obesity) than those without it; (3) the presence of sleep disturbance was negatively associated with physical fitness, especially with low upper body strength; and (4) low physical fitness level in older women was associated with higher risk of suffering sleep disturbance and reduced HRQoL. The JSS is a validated simple instrument to detect sleep disturbance and has been used in both cross-sectional and longitudinal studies, and in different clinical settings, including postmenopausal women[8,40–42].

Sleep quality has been previously studied in young peri- and postmenopausal women (upper age limit: 60–65 years) in different populations using different sleep assessment tools[8,43–46]. Cuadros and colleagues[45] reported a prevalence of insomnia of 36.6% using the Insomnia Severity Index in women aged 40–65 years, while Ornat and colleagues[8] reported a prevalence of sleep disturbance of 37.5% using the JSS in women aged 40–59 years. The elderly population is commonly reported to suffer from some kind of insomnia with a higher incidence when compared to younger counterparts[9], and thus older women (more than 65 years) are at particular risk of having sleep disturbance. In the present study, 45.1% of women reported trouble with sleeping, as measured with the JSS. The main possible contributing factors placing older women at increased risk for sleep difficulties are clinical or psychiatric illnesses such as depression or anxiety[2,47], obesity, musculoskeletal symptoms, urinary incontinence and nocturia[2,47,48]. In fact, in a recent paper published by our group, with the same sample, overweight and obese women showed a greater incidence of nocturia than their normal-weight counterparts[23].

Regarding the increases in visceral fat with aging, low sleep quality promotes chronic elevations of glucocorticoids, such as cortisol and glucose, in order to secure brain and physical function[5,9]. These changes could lead to a decrease in peripheral insulin sensitivity, an increase in the intake of high sugar and fat foods, as well as in the deposition of fat in the abdominal region[5,9]. Eventually, type 2 diabetes and excess weight might occur[9].

All these previously reported factors might explain why, in our study sample, women with central obesity marked most items concerning sleep disturbance. Furthermore, those with insomnia had higher BMI and WC, and therefore probably more fat in the trunk region compared to those without sleep disturbance. On the other hand, sleep interruptions or disordered sleep appear to contribute to the development of, or exacerbation of, body adiposity or vice versa[5]. In the present study, central obesity could be considered as one of the dominant predictor factors to develop insomnia.

A non-pharmacological, effective, feasible and easily available treatment that has been traditionally thought to improve sleep is exercise. In epidemiological research, physical exercise has frequently been associated with better sleep[49]. Physical fitness is a set of attributes that people have or achieve related to physical activity[50] and diminishes with age as a result of lower physical activity levels and more sedentary habits[21,25,51], especially in older women[51]. Maintaining appropriate levels of physical fitness is particularly important in older adults in order to assure physical independence in everyday functioning tasks and preserve autonomy in daily life[18]. Concerning sleep disturbance in the older population, poor sleep has been associated with suffering more subsequent falls[47], daytime sleepiness, fatigue, and decreased physical functioning[5,6]. Specifically in women, poor sleep has been associated with irritability, higher waist/hip ratios and increased probability of development of cardiovascular events. In this regard, it is crucial to maintain the level of daily physical activity as high as possible in order to promote better physical fitness since any kind of exercise is better than inactivity in the elderly population.

There are several hypotheses frequently cited in the literature to explain the relation between exercise and sleep quality, including body restoration (brain and physical functions), energy conservation, and a thermogenic effect[52] as well as increased exposure to outdoor light[10,53], weight loss and increases in physical fitness levels[53,54]. Physical exercise programs for older women are effective against obesity, via improving body composition, controlling high body weight and reducing trunk adiposity[55]. All of these are factors related to insomnia in older women, and therefore, they could explain why, in our results, women with lower physical fitness presented a higher risk of suffering from sleep disturbance. Furthermore, research studies suggest that physical exercise programs improve sleep quality in postmenopausal and older women[10,56].

In our study, performance in the upper body strength test has been related to proper neuromuscular function. This is influenced, among other factors, by upper body composition and voluntary activation. High levels of upper body strength were associated with lower reported disordered sleep. It seems plausible that muscle strength, particularly concerning the upper body, might play a role in sleep quality. In fact, in the pilot study with older adults by Ferris and colleagues[57], improvements in total body strength after a 6-month resistance training, particularly in upper body strength, lead to an improvement of 38% in sleep quality.

Additionally, superior perceived health has been associated with better physical fitness performance in elderly women[58]. In agreement, in our study, women without sleep disturbance showed better HRQoL and better fitness levels compared with women with this condition. The latter was confirmed by the inverse correlation of sleep disturbance with HRQoL and the positive correlation of sleep disturbance with the fitness index. Even more, sleep disturbance has been associated with seven- to ten-fold increase in the risk of impaired quality of life[43], and reduced sleep quality is common and associated with reduced HRQoL (measured by the EQ-5D) both in general[59] and pathological populations[60,61].

The present study is not free of limitations. First, only self-reported sleep quality and activity levels were assessed, and thus objective measurements with either actigraphy or polysomnography were not conducted. However, in the clinical area, self-reported questionnaires are widely used for diagnosis of sleep quality and insomnia treatment, providing sufficient evidence to warrant adequate advice to improve sleep, health and well-being[53]. Similarly, although the questionnaire for the assessment of physical activity levels has been validated[39], objective physical activity measurements were not included in the present study. Second, the definition of insomnia is widespread in the population and between one-quarter and one-third of adults complain of insufficient or disrupted sleep. Also, investigation of the prevalence of sleep apnea/hypopnea requires specific tools[62], which were not used in the present study. Third, the cross-sectional design used does not make it possible to determine whether fitness improves sleep quality and diminishes fatigue, allowing participants to be more eager to engage in regular exercise and perform better during the fitness tests[49,53]. However, in this regard, the data are in line with several studies reporting that better physical fitness is related to better sleep quality in older subjects[10,20,49,52,53] and physical exercise is the critical factor to increase fitness levels. In the elderly population, physical exercise has an overall beneficial impact on sleep, mood, well-being and quality of life[53]. Thus, it is fundamental with this population to prescribe physical exercise programs on an individual basis to warrant safety and facilitate self-efficiency, with the objective to overcome common barriers and maximize adherence[53]. Fourth, potential confounders, like prevalence of type 1 and type 2 diabetes, inactivity due to physical-related disabilities or other health issues, and other factors, like care-taking responsibilities, use of non-prescription drugs and/or sleep aids were not recorded. Nonetheless, all the participants in the present study were able to complete the physical fitness tests, and thus the influence of physical disabilities in our results was probably very limited. Finally, between-subject differences in ambient light exposure during the day, evening and night could have influenced both the sleep quality and the level of obesity, by modifying melatonin levels and therefore circadian alignment[63]. Individual light exposure could not be controlled in the present study, and therefore we cannot account for its influence on our results.

Conclusion

Central obesity is associated with the presence of sleep disturbance in older women. Additionally, sleep quality is positively associated with increased health-related quality of life and physical fitness, and especially with high levels of upper body strength. Therefore, interventions involving reduction of fat mass and increased physical activity levels (especially using the upper body limbs) in elderly women could be an effective method to reduce the presence of disordered sleep in this population.

Conflict of interest The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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