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ORIGINAL ARTICLE

Influence of Body Composition on Sleep in People Who Exercise

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ABSTRACT

Study objective: Epidemiological studies have shown an inverse relationship between sleep duration and body mass index. Respiratory sleep problems are also correlated with abdominal adiposity and fat mass indicators. We analyzed if body fat has influence on sleep duration and quality, according to percentiles, gender and exercise.

Methods: An observational, descriptive, retrospective study with 264 subjects from different sports clubs and gyms in the Community of Madrid was conducted. Anthropometric measurements (weight, height, BMI, body fat %, fat free mass, waist circumference, basal metabolic rate) and a questionnaire, including medical history, eating habits, sleep and exercise items, were taken. Different percentiles for body fat % were calculated according to gender and age. Participants were classified into three groups: percentile<45, between 45-55 and percentile>55. Data analysis was performed with SPSS® 20 software. Quantitative variables were presented as mean±standard-deviation; qualitative variables as absolute frequencies and percentages.

Results: Men and women slept the same number of hours and had similar body fat % percentiles. No relationship between body fat and sleep quality was found. Subjects with percentile >55 had longer sleep duration than percentile <45 and 45-55.

Conclusion: Body composition influences on sleep, being worse in individuals with obesity and better in individuals who exercise.

Keywords: Physical activity, obesity, somnolence, health, overweight

INTRODUCTION

There is a close relationship between sleep processes and overall physical and psychological state of health of a person. Sleep is definitely an excellent indicator of health status in both diseased and general population (Miró, Cano-Lozano, & Buela-Casal 2008).

The sleep effects are not limited to the body itself in need of neurological restoration, but affect on normal development and functioning of cognitive and intellectual people capabilities (Miró, Cano-Lozano, & Buela-Casal 2008, Pérez, Díaz, & Garrido, 2007). Sleep quality is not only important as a determinant of health, but also a propitiatory element of good quality of life (Pérez, Díaz, & Garrido, 2007).

Knowing the factors which modulate sleep can be an important way to control or improve the alterations

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thereof. In Spain, these changes affect one third of the population and also lead to a significant public health problem (Concepción, 2014).

In addition, sleep disorders have the major economic, social and health impact. These are reflected in issues such as obesity, vascular problems, development of carcinogenic processes or the influence of neurodegenerative and cerebrovascular diseases (Concepción, 2014).

Some studies relate sleep quality with body composition. In particular, epidemiological studies have shown an inverse relationship between sleep duration and body mass index (BMI) (Hursel, Gonnissen, Rutters, Martens, & Westerterp-Plantenga, 2013). Intra-abdominal (visceral) adipose tissue has an important role in obese male adolescents' sleep (Arboledas, & Roselló, 2007). This has also been observed in overweight and obese pediatric population, where are common and correlate with abdominal adiposity and fat mass indicators (Olivieri, & de Dios, 2007).

In obese adult patients, sleep problems also occur. They usually have adjacent fat deposits to the pharynx and soft palate, which narrows the nasopharyngeal route (Forga, Petrina, & Barbería, 2002). This means that in reduced expiratory reserve volume there is an exponential correlation with increasing BMI (Rabec, de Lucas Ramos, & Veale, 2011). It is known therefore, that regional fat distribution pattern plays an important role in the predisposition of respiratory complications in obese subjects, which affect on sleep quality (Jones, & Nzekwu, 2006).

A recent study has linked chronic sleep restriction from infancy to school age with more general and central adiposity in middle childhood (Taveras, Gillman, PeñaRedline, & Rifas-Shiman, 2014).

There are other factors that influence on quantitative and qualitative sleep in humans. One of the most interesting among them is practice of physical activity. Exercise not only helps to reduce the risk of chronic diseases, but also improves sleep pattern (Monteiro, Neri, & Coelim, 2014). The increase of serotonin, while exercising, in brain areas such as the hippocampus and cortex, is one of the mechanisms involved (Santos, Almada, & Smalley, 2013). Another factor is the increase of basal metabolism with exercise, which improves insulin resistance and lipid profile (El Ferrol, & Coruña, 2006). Regular physical activity, mainly aerobic exercise, decreases body and abdominal fat in obese and overweight people, helping to avoid sleeping problems mentioned above (González, Hernández, Pozo., & García, 2011).

Furthermore, leptin, which is increased in obesity and correlates with increased susceptibility to accumulate abdominal fat, improves on exercise. Results obtained in different studies show that metabolic parameters and estimated adiposity are associated with leptin depending on sport, especially subcutaneous fat in endurance athletes and weight trainers (González, Hernández, Pozo., & García, 2011, Fernández-Real, Vayreda, Casamitjana, Gonzalez-Huix, & Ricart, 2000).

A better get to sleep is one of the benefits perceived by adults when they initiate exercise (Barrios Duarte, Borges Mojaiber, & Cardoso Pérez, 2003). Physical activity, sedentary time and sleep duration should all be directed to improve cardio-metabolic risk markers, and quality of life in general (Barrios Duarte, Borges Mojaiber, & Cardoso Pérez, 2003).

Due to the relationship between body composition-metabolism-sleep, the effect of body composition is expected to be a modulator of sleep.

The proposed objective to achieve was to analyze the influence of body fat (BF) on sleep, according to percentiles of BF, gender and exercise.

MATERIAL AND METHODS

It is an observational, descriptive and retrospective study.

The study population was constituted by 264 subjects, all belonging to different sports clubs, gyms and sports centers in the Community of Madrid (Spain). Mean age (±standard deviation) was 35.9±11.07 years old.

Weight, height, BMI, BF percentage, fat free mass (kg), waist circumference and basal metabolic rate (BMR) of each participant was measured. Weight, BMI and body composition were determined through an electrical bioimpedance, tetra-pole, multi-frequency (20 and 100kHz), InBody 230 Model, and a flexible non-elastic, metallic measuring tape, ranged from 0.1mm to 150cm.

After analyzing BF %, various percentiles were calculated by gender and age. Subsequently, participants were classified into three groups: those who had a percentile <45 BF %, between 45% and 55%, and those with a percentile >55 BF%.

Several questions about sleeping habits including: bedtime, time to get up, number of times they woke up at night and reasons, total sleep hours, sleep quality, feeling tired upon awakening and hours of sleep different than at night (nap), were conducted. All calculated daily and at weekends, and also together.

Finally, an ad hoc survey which included the medical history, eating (Serra, Ribas, L., Ngo, J., Ortega, R. M., Pérez, C., & Aranceta, 2002) and exercise habits (Booth, 2000) was fulfilled. Subjects' exercise routine was analyzed by questions such as what type of exercise do you practice?, how many times a week?, for how long each day?, what stimulates you to practice exercise?.

All participants were informed, written and orally, about the purpose of the study, and were invited to participate and to sign the informed consent sheet. The protocol recommended for measurements with electrical bioimpedance was also transmitted to users in order to avoid a lower reliability of the results. Data were collected by trained and formed nutritionists and dieticians, standardizing the data collection protocol and monitoring the study.

Data analysis was performed with version 20 of SPSS® software. Quantitative variables were presented as mean ± standard deviation, whereas qualitative variables were presented as absolute frequencies and percentages.

To study differences in sleep quality depending on BF, nonparametric Kruskal-Wallis test was used for independent samples, comparing it as stated in the classification of subjects according to their percentile BF into three groups: <45 (n= 82; 31%), 45-55 (n= 55; 21%) and >55 (n= 100; 38%). Correlations and linear regressions between the different dimensions and BF percentiles were carried out.

Nonparametric Mann-Whitney test was also used to assess the relationship between gender and sleep and BF, as well as differences per groups (for two independent samples).

RESULTS

Information about the sample in terms of descriptive statistics is shown in Table 1.

The nonparametric Mann-Whitney test for two independent samples indicated that men and women

Table 1: Personal, anthropometric and lifestyle details

	Total (n=264) Mean±SD	Males (n=156, 59.1%) Mean±SD	Females (n=108, 40.9%) Mean±SD
Age (years)	35.9±11.07	35.61±11.37	36.41±10.66
Weight (Kg)	70.12±12.42	70.44±12.68	69.61±12.05
Height (m)	171.25±9.15	171.7±9.32	170.53±8.87
BMI (Kg/m^2)	23.78±3.1	23.76±3.27	23.81±2.84
Body fat (%)	20.76±8.67	20.27±9.01	21.51±8.1
Muscle (kg)	31.03±7.26	31.43±7.48	30.4±6.88
Waist circumference (cm)	79.58±10.38	79.25±10.49	80.12±10.24
Physical exercise (hours/week)	7.24±4.21	7.82±4.1	6.42±4.25
Sleep (hours/day)	7.14±0.94	7.12±0.95	7.17±0.92

Table 2: Relationship between gender, hours of sleep and body fat percentage.

	Male			Female			Mann-Whitney test	
	N	M (DE)	IC 95%	N	M (DE)	IC 95%	z	p
Sleep (hours/day)	148	7,82 (4,10)	7,16-8,48	103	6,42 (4,25)	5,60-7,24	-0,755	0,450
Body fat (%)	156	20,27 (9,01)	18,86-21,68	100	21,51 (8,10)	19,93-23,10	-1,168	0,243

Note. N: sample; M: mean; SD: standard deviation; CI: confidence interval. Summary of the mean and standard deviation, confidence interval, and the values of the Mann-Whitney test for sleep parameters (hours/day) and body fat %, according to gender.

slept the same number of hours (directly asked to participants) and had the similar BF percentage (Table 2).

Having asked participants about their self-perception of their sleep quality, by a good-mediocre- poor scale, no relationship was found between BF and sleep quality [chi-square (4)= 3.677; p= 0.45] (Table 3).

Table 3: Relation between body fat, according to percentiles, and sleep quality.

Percentile	Good N (%)	Regular N (%)	Bad N (%)
<45	45 (30,4)	33 (42,9)	2 (28,8)
45-55	37 (25,0)	15 (19,5)	2 (28,3)
>55	66 (44,6)	29 (37,6)	3 (42,9)

Note. N: sample; %: percentage. Summary of evidence linking sleep quality with various percentiles of body fat, expressed in sample population and percentage.

subjects with "good sleep quality" than in the other two.

Finally, the relation between BF and the number of sleep hours was studied (Table 4). The nonparametric Kruskal-Wallis test indicated an association between the two variables [$\chi^2(2)$= 7.909; p= 0.019]. Subjects in groups <45 and 45-55 were similar in their sleep hours (z= -0.049; p= 0.961). However, subjects with percentile >55 sleep more hours than subjects in groups <45 (z= -2.528; p= 0.011) and 45-55 (z= -2.127, p= 0.033).

DISCUSSION

Different studies have been published, in which is shown how body composition largely influences on the quality of sleep:

Table 4: Sleep hours depending on body fat percentile.

Percentile <45			Percentile 45-55			Percentile >55		
N	M (DE)	IC 95%	N	M (DE)	IC 95%	N	M (DE)	IC 95%
77	7,02 (0,78)	6,85-7,19	54	6,99 (1,06)	6,71-7,27	99	7,34 (0,99)	7,14-7,53

Note. N: sample, M: mean, SD: standard deviation, CI: confidence interval.

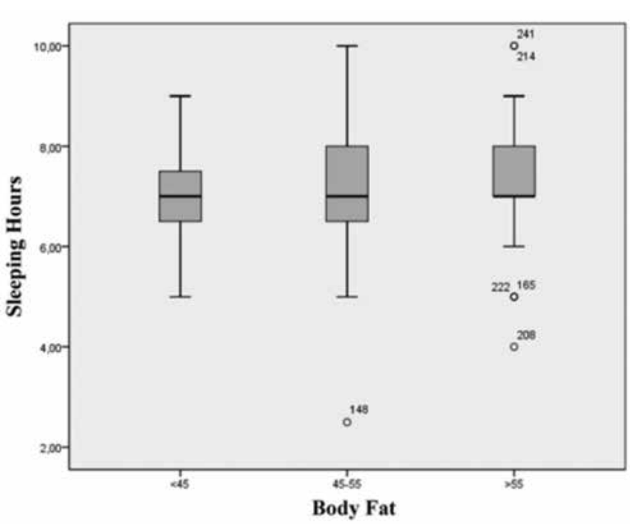

Figure 1: Sleeping hours vs. Body fat
Note. The figure shows how the group who sleeps more hours has a higher body fat percentage.

It is seen that there are more patients with "poor sleep quality" in percentile >55 group by comparison with the other two groups. However, this group also has more

Kamath et al. (2014) argued that sleep duration influences on the metabolism and regulates body weight. Eighty nine Malaysian students of both genders and with the mean age of 21.2 years were included. The subjects were interviewed regarding the average hours of sleep/day (categorized as <6 hours/day (short sleep), 6-7 hours/day and >7 hours/day). Their BMI, and waist and hip circumferences were measured. The sleep duration was compared with BMI and waist-hip ratio using one way ANOVA. They found no statistical significance when sleep duration was associated with BMI (p= 0.65) and waist-hip ratio (p= 0.95). Therefore, in this case, sleep duration did not affect BMI and waist-hip ratio. The age and healthy lifestyle of the subjects in this study may have been a reason for no significant influence of short sleep duration on the BMI and waist-hip ratio.

The study by Hayley et al. (2014) assessed 1066 women aged 21-94 years (median= 51 years) and 911 men aged 24-92 years (median= 60 years). In women, excessive daytime sleepiness (EDS) was associated with greater waist circumference and BMI. EDS was also associated with 1.5-1.6-fold increased odds of being overweight or obese. In men, EDS was associated with greater BMI. The EDS was also associated with 1.5 times more likely to be obese. No differences in lean mass, % BF or % lean mass were detected between those with and without EDS for men or women.

Jürgens (2006) conducted the study conformed by 71 women and 62 men with a mean age of 23 years. The sample was divided into sedentary, recreational and competitive individuals. He compared the quality of life among athletes and sedentary subjects, and the data analysis revealed that there were significant differences in overall quality of life and health among athletes and sedentary individuals, especially in social, environmental and psychological functioning domains. The World Health Organization Quality of Life (WHOQOL-100) was applied and five different domains of quality of life were measured; physical domain was one of them, where sleep and rest was assessed. He concluded that physical exercise not only modifies the internal configuration of the subject, but so does the external configuration with weight loss, decreased BF and increased muscle mass, which helps improve sleep quality.

If we relate the above research with our sample, we also observed that sleep quality was worse in individuals with a percentile >55 of BF and that the higher BF percentage, the more sleep they got.

It should be noted that sleepiness may be present in the absence of respiratory sleeping problems in up to 35% of obese subjects, which puts the probable role of obesity per se in the genesis of daytime vigilance disorders present in this population (Rabec, C., de Lucas Ramos, P., & Veale, 2011). The prevalence of undiagnosed sleep-disordered breathing is high among men, but much higher than previously suspected in women (Young, Palta, Dempsey, Skatrud, Weber, & Badr, 1993).

It has also been observed, in other population groups and ages, that there are associations between body composition and sleep. Arboledas and Lluch-Roselló (2007) conducted a case-control study between obese and non-obese children. The cohort consisted of 26 children with the BMI above the 90^{th} percentile for their age, with the mean age of 10.3 years, but no other clinically detectable medical problems. The control group consisted of 30 non-obese children of the same age and gender. Breathing problems during sleep were significantly related to the tonsil size and the BMI.

It has also been observed that, in adolescents, the percentage of BF influences the hours of sleep, and that higher adiposity favors the appearance of breathing problems during sleep (Olivieri, & de Dios, 2007). Ninety adolescents were included into the study of Ruiz et al. (2014). Under the hypothesis that sleep modulates neuroendocrine function and metabolism, and therefore, changes in sleep duration may lead to developing obesity during adolescence, they found that compared to the group with normal weight, adolescents with overweight had, in average, fewer sleep hours Sundays through Thursdays ($p<0.05$) and a higher rate of sleep deficit and sleep debt ($p<0.05$). Among adolescents with sleep debt, the risk of being overweight was 2.7 times higher (95% CI= 1.09 to 6.72; p= 0.032). The authors concluded that nocturnal sleep deficit and sleep debt were significantly associated with overweight and metabolic alterations related to a high cardiometabolic risk.

The diagnosis and treatment of respiratory complications during sleep of the obese subject represents, nowadays, a new challenge for health systems. A national survey conducted in Spain, published in 2000, showed that 15% of patients in non-invasive ventilation were diagnosed with obesity-hypoventilation syndrome (de Lucas, Rodríguez, Paz, Santa-Cruz, & Cubillo, 2000).

CONCLUSION

Results obtained show that, body composition influences on sleep and its quality, which in turn interferes with quality of life, given that sleep is a health indicator.

Self-reported sleep quality is worse in individuals with obesity, since it is correlated with the individuals BMI and adiposity. In addition, more sleep duration was observed in increasing BF.

Physical activity helps to improve sleep quality. Thus we observe that those individuals who exercise have better quality and better sleep duration, with no significant differences in gender.

Physical activity, sedentary time and sleep duration should all be targeted to improve cardio-metabolic risk and quality of life markers.

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Conflict of Interest

Authors declare they have no conflict of interest.

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