1874-9445/20

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RESEARCH ARTICLE

Gender-Specific Associations of Different Anthropometric Indices with Sleep Quality and Daytime Sleepiness

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Abstract:

Background:

Sleep is necessary for all living beings and plays a significant role in preventing health complications. Many health risks are associated with overweight and obesity. Association between sleep habits and anthropometric indices were investigated in this study.

Objective:

The objective of this study was to determine gender-specific associations of different anthropometric indices with sleep quality and daytime sleepiness.

Methods:

This cross-sectional study involved 550 males and females. Anthropometric indices measured with the help of a bioelectric impedance device. The Pittsburgh sleeps quality index was used to evaluate sleep quality over a one-month period, and the Epworth sleepiness scale was used to measure the level of daytime sleepiness. Kruskal-Wallis test was applied for comparative analysis, and Spearman correlation was also used to assess the relationship among all variables.

Results:

A negative correlation identified between the percentage of body fat with sleep quality and daytime sleepiness and other anthropometric indices has a low positive correlation, but not significant for sleep quality and daytime sleepiness. While females have a negative correlation for daytime sleepiness and a significant difference among anthropometric indices for sleep quality and daytime sleepiness was evident. A higher percentage of body fat was found among female participants.

Conclusion:

This study has highlighted the prevalence of obesity with multiple anthropometric indices. Such studies could help evaluate the role of anthropometric indices in predicting the quality of sleep and daytime sleepiness in male and female participants.

Keywords: Obesity prevalence, Health risk, Body fat, Visceral fat, Waist circumference, WHR.

Article History	Received: January 07, 2020	Revised: April 22, 2020	Accepted: April 29, 2020

1. BACKGROUND

Sleep is crucial for optimum health. During sleep, our body is able to rest and recharge. Sleep is an excellent indicator of health status in both general and sick populations [1]. Quality of sleep is not only a determinant of health but is also an important component of a good quality of life [2]. American sleeping habits have been significantly affected in recent years, with 15.6% of young adults sleeping less than 7 hours/day in 1960, rising to 43% in 2009 (National Sleep Foundation of America). Furthermore, poor sleep habits lead to social, economic, and health problems. Specific health problems include issues such as vascular problems, cerebrovascular diseases, development of neurodegenerative, and obesity. American adults reported around 27.5% to 29. 1% short sleep duration [3]. Various studies have examined relationships between sleep and obesity risk in adults [4].

Noticeable body composition difference has been reported between males and females around the world regardless of

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DOI: 10.2174/1874944502013010273, 2020, *13*, 273-280

ethnicity, region, religion, culture, environment, lifestyle, age, and body size. Females have comparatively higher percentage (25%) of body fat than males (15%), and males tend to have a higher percentage (43%) of muscle mass than females (36%) [5]. Males have greater lean mass and a more central fat pattern while females have peripheral fat distribution, identified as fat accumulated in hips and limbs, predominantly into the lower body [6].

Males and females experience sleep differently throughout their life. They face different challenges to sleep. Females are more prone to insomnia, while males are more likely to suffer from a sleep disorder like sleep apnea and snoring [7]. Galland *et al*. found that 56% of adolescents had poor sleep quality with a higher prevalence among females (63.1% *vs*. 44.5% among males), and sleep hygiene was significantly worse in females [8]. The insomnia (sleeplessness) enhanced from 3.4% to 12.2% in females and from 4.3% to 9.1% in males [9]. Ohayon and Zulley reported that the prevalence of global dissatisfaction of sleep increased with age and was higher in females [10]. A significant age difference was found to be related to sleep disturbance and habitual sleep patterns in 15 years of age or older adolescents. A number of studies have found that sleep duration is inversely related to BMI [11]. The studies on sleep and body composition in Saudi Arabia on adolescents found an inverse association between poor sleep duration (less than seven hours per day) and obesity/overweight [12, 13]. Inadequate sleep also reduces the burning of calories throughout the day, leading to weight gain and an unhealthier body. Earlier research assessing the relationship between obesity and sleep duration used BMI or weight gain as outcomes, and limited research measured body fat or abdominal obesity [14, 15]. Mahfouz *et al*., conducted a cross-sectional study in Saudi Arabia revealed that female university students have poor sleep quality (69.1%) as they slept a mean of 4.77 hours/night [16]. Epidemiological studies had shown a contrary correlation between BMI and sleep duration [17]. Sleep medicine in Saudi Arabia emphasizes the need for further sleep investigation to address the prevalence of various sleep disorders amongst the Saudi population according to their lifestyle and body composition [18].

Research findings regarding gender differences have been inconsistent. Genders not only diverge in height and weight but also multiple anthropometric indices and sleep habits. An increasing body of evidence from various populations demonstrates that there are adverse associations between anthropometric indices and sleep habits. Therefore, this investigation set up to evaluate the association between multiple anthropometric indices and sleep habits for males and females students. We also hypothesized that sleep and multiple anthropometric indices are significantly associated with both genders.

2. METHODS

2.1. Design

We conducted a cross-sectional study of 550 participants. Approval to undertake this study was granted by the deanship of research, Imam Abdulrahman Bin Faisal University, Dammam. All participants voluntarily participated in this study, and the researchers received consent from the participants before the start of the investigation.

2.2. Participants

Data collected from 550 participants, males (n=250), and females (n=300) from the college of Applied Medical Sciences, Imam Abdulrahman Bin Faisal University, Dammam. The sample size was considered appropriate to identify the relationship between sleep habits and multiple anthropometric indices with 95% confidence and a precision rate of 5%. Convenience sampling technique was used for data collection, *i.e*., students were invited through advertisement on the university campus to take part in the study. The data between 2017 and 2018 was collected. The exclusion criteria for this study were individuals who have any chronic illness, cardiac problems, mental or physical disabilities, and pregnancy.

2.3. Demographic Data

Researchers handled the collection of anthropometric measurements of every participant. Anthropometric characteristics of male and female students are available in the Table **1** below.

Table **1** showed the mean and standard deviation of anthropometric variables of both genders. Females were older than males 20.8(5.23) and 19.44 (3.33), respectively. Males were taller and heavier than females (166.8(8.6) *vs*. 157.1 (5.78) cm, 76.1 kg(27.14) *vs*. 57 kg.11.8), and 27.(8.1) *vs*. 22.9 BMI units (4.4).

2.4. Measuring Instruments

2.4.1. Weighing Scale

Portable electronic calibrated weight scale (Detecto Scale – model 750, U.S.A.) was used for height and weight measurement. Participants were asked to wear light clothing and take off their shoes for accurate measurement.

Table 1. Descriptive statistics of male and female students.

-	Male		Female		Both Gender		p-value
	Mean	SD	Mean	SD	Mean	SD	
Age (Years)	19.44	3.33	20.82	5.23	20.19	4.52	<.05
Height (cm.)	166.86	8.63	157.07	5.78	161.52	8.70	<.05
Weight (kg.)	76.05	27.14	56.96	11.81	65.64	22.37	<.05
BMI (kg/cm^2)	27.06	8.12	22.95	4.45	24.82	6.69	<.05

2.4.2. Bioelectric Impedance (BIA)

A bioelectric impedance device was used to measure multiple anthropometric indices. As described by Lukaski *et al.* [19] ,the measurement followed the manufacturer's instruction of the Bioelectrical Analysis (BIA) (iOi 253, Jawon Medical, South Koria). The multiple anthropometric indices were determined was Body Mass Index (BMI), Visceral Fat Area (VFA), Percentage of Body Fat (PBF) Waist Circumference (WC), and Waist-Hip Ratio (WHR). The multiple anthropometric indices measured at normal body hydration in similar external temperatures [20]. The bioelectrical impedance method shows a high correlation (R=0.88) with dual X-ray absorptiometry [21]. The Hip Circumference (HC) was measured manually with the help of measuring tape. The Waist-Height Ratio calculated as waist measurement divided by height.

2.4.3. The Pittsburgh Sleep Quality Index (PSQI)

The PSQI (Arabic version) self-reported questionnaire, was used to evaluate sleep quality during the past month. The PSQI included seven component scores (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction). The components range from 0 (no difficulty) to 3 (severe difficulty), and when summed, generate a sum score ranging from 0 to 21, a score > 5 indicates "poor" sleepers and ≤5 indicate "good" sleepers. Good psychometric properties have been established [21]. The PSQI has been validated previously as Cronbach alpha was 0.83 [22, 23].

2.4.4. Epworth Sleepiness Scale (ESS)

The ESS (Arabic version) was used, which is a self-reported measure designed to estimate the level of the daytime sleepiness in recent times. The measure consists of eight items on a four-point Likert scale on which respondents rate their response about the chance of dozing in each situation, from 0 (would never) to 3 (high chance). Total scores range from 0 to 24, with higher scores indicating more significant sleepiness. Acceptable validity and test-retest reliability for the ESS have been reported [24]. Scores over 10 suggest significant daytime sleepiness, and scores over 15 suggest pathological sleepiness associated with conditions like sleep-related breathing disorders or narcolepsy.

2.5. Procedure

A total of 617 participants consented to taken part in the study. Only 250 males and 300 female students selected due to incomplete information on filled questionnaires. Before the administration of the test, all the important instructions explained to the participants relating to providing their response on the PSQI, ESS, and during multiple anthropometric indices test through BIA. Students completed multiple anthropometric measurement tests in a laboratory setting. Hip Circumference (HC) was measured at the maximum circumference of the hips while the participant stands in an upright position. Participants took 5-6 minutes to complete both questionnaires. To measure multiple anthropometric measurements, participants were requested to stand barefoot on the electrodes of the BIA. Demographic information entered to the device, and the participant was requested to grip hand-hold electrodes and push the button attached. The participants were required to stand in a stationary position while the measurement been taken. Within 2-3 minutes, results were printed by the device.

2.6. Statistical Analysis

The Kolmogorov-Smirnov test was applied to determine the normal distribution of variables. The test found that anthropometric indices and sleep habits variables were not distributed normally. Descriptive statistics as mean and Standard Deviation (SD) were calculated for participants' age, weight, height, and BMI. For the comparative analysis between genders, the Kruskal-Wallis test was applied. A P-value ≤.05 was taken as statistically significant. Spearman correlation test used to estimate the relationship between variables. The Statistical Package for Social Science V-21 (SPSS inc, USA) was used to analyze the data.

3. RESULTS

Table **2** details the mean and standard deviation of all variables by gender. The percentage of body fat is higher in females 30.01(6.49) than males 27.93(9.21). The visceral fat area is lower in female 57.38(31.27) than in male 102.51(7) participants. Males 93.19(21.51) have a wider waist circumference than female 76.65(8.82) participants. The hip circumference of males 108.02(11.43) is wider than the females 97.53(4.74). The waist-hip ratio is higher 0.85(.11) in males than the females 0.78(.06). The waist-height ratio is also greater in males 0.56(.12) than females 0. 49(.06). All the multiple anthropometric variables are significant at 0.05.

Table 2. Descriptive analysis of male and female students for anthropometric indices.

-	Male		Female		Both Gender		p-value
	Mean	SD	Mean	SD	Mean	SD	
PBF	27.93	9.21	30.01	6.49	29.06	7.91	<.05
VFA	102.51	70.00	57.38	31.27	77.89	57.10	<.05
WC	93.19	21.51	76.65	8.82	84.16	17.89	<.05
HC	108.02	11.43	97.53	4.74	102.30	9.94	<.05
WHR	.85	.11	.78	.061	.81	.092	< 0.05
WHtR	.56	.12	.49	.06	.52	.096	< 0.05

Table 3. The comparison between male and female for different anthropometric indices by Kruskal-Wallis Test.

-	Gender	Mean Rank	sig
PBF	Male	255.65	.007
	Female	292.04	
BMI	Male	320.20	.000
	Female	238.25	
VFA	Male	342.68	.000
	Female	219.51	
WC	Male	354.88	.000
	Female	209.35	
HC	Male	369.88	.000
	Female	196.85	
WHR	Male	336.06	.000
	Female	225.03	
WHtR	Male	328.97	.000
	Female	230.94	
Sleep Quality	Male	292.43	.021
	Female	261.39	
Daytime Sleepiness	Male	297.19	.003
	Female	257.43	

Table **3** shows the mean rank between males and females for multiple anthropometric indices and sleep habits (PSQI & ESS). The results show that all variables are significant. The significant differences existed at 0.05 levels among males and female participants.

Table **4** shows the correlation (Spearman-correlation (2-tails) among multiple anthropometric indices and sleep habits. There was a negative relationship found between sleep habits and PBF. No significant relationship has been found among any anthropometric indices for sleep quality, and daytime sleepiness also showed an insignificant.

Table **5** reveals that there is a very low positive correlation (Spearman-correlation (2-tails) among multiple anthropometric indices and sleep quality and daytime sleepiness for male and female participants. Whereas, daytime sleepiness for female participants shows low negative correlation among multiple anthropometric indices except for hip circumference. The relationship is insignificant for multiple variables.

Table 4. Correlation of multiple anthropometric indices and sleep habits.

-		PBF	BMI	VFA	WC	HC	WHR	WHtR	PSQI
Sleep Quality	Correlation Coefficient	-.023	.037	.038	.067	.100*	.039	.041	-
	Sig. (2-tailed)	.589	.390	.368	.118	.019	.362	.336	-
Daytime Sleepiness	Correlation Coefficient	-.002	.039	.033	.058	.110	.030	.043	.008
	Sig. (2-tailed)	.971	.356	.444	.176	.010	.483	.320	.852

*Correlation is significant at the 0.05 level (2-tailed).

Table 5. Gender-wise correlation of multiple anthropometric indices among sleep quality and daytime sleepiness.

-	Gender	Sleep Quality		Daytime Sleepiness	
		Spearman	***P*-value**	**Spearman**	***P*-value**
BMI	Male	.016	.807	.042	.510
	Female	.014	.814	-.014	.806
PBF	Male	-.012	.846	.025	.697
	Female	-.004	.949	-.011	.583
VFA	Male	.014	.822	.015	.813
	Female	.004	.944	-.039	.501
WC	Male	.023	.719	.026	.682
	Female	.046	.432	-.021	.712
HC	Male	.047	.463	.048	.453
	Female	.101	.079	.054	.347

-	Gender	Sleep Quality		Daytime Sleepiness	
		Spearman	*P*-value	Spearman	*P*-value
WHR	Male	.032	.610	.026	.682
	Female	.001	.993	-.040	.488
WHtR	Male	.040	.531	.036	.570
	Female	.001	.985	-.017	.774
Sleep Quality	Male	1.00	.	.044	.485
	Female	1.00	.	-.037	.520
Daytime Sleepiness	Male	.044	.485	1.00	.
	Female	-.040	.491	1.00	.

*Correlation is significant at the .05 level (2-tailed).

4. DISCUSSION

This research examines the relationship between selected anthropometric indices and sleep habits among male and female subjects. The results of this research demonstrated that there was a significant difference between male and female participants for multiple anthropometric variables, but no significant correlation among any anthropometric indices with sleep habits. Only the percentage of body fat was higher in females than males.

Regarding the gender differences for anthropometric indices, sleep habits, and daytime sleepiness, a prevalence of excess BMI, VFA, WC, HC, WHR, WHtR was observed among males, whereas females had an excess percentage of body fat. Öztürk and Yabanc Ayhan did not find any association between body fat, body fat percentage, BMI, WC, and sleep quality, in a cross-sectional study of Turkish women [25]. In another Turkish study, no association between BMI and sleep quality was found [26]. Similarly, it was noticed in China that sleep quality and BMI do not have a significant association in older people [27]. In this study, males represented 45% of the sample and had a higher BMI 27.06(8.11) and better sleep habits 8.14(2.24) and daytime alertness 10.92(3.62) than females. Females were more likely than males to report both poor sleep habits 7.75(2.45) and daytime sleepiness 9.84(4.05). These findings are different from the Chinese study where obese adults are more likely to have a short sleep duration than their non-obese counterparts [28]. Most of the females have less daytime sleepiness and poorer sleep habits during the night due to biological and psychological factors such as hormonal makeup, enhanced risk of depression, rearing demands, and overall greater ease of disclosing sleep-related intricacies [29].

In the present study, females represent 55% of the sample and exhibited more percentage of body fat 30.01(6.49) than males 27.93(9.21). There was a significant difference, but no significant association was observed between the percentage of body fat and sleep habits in either males or females, but females had a negative correlation. These findings are similar to Rontoyanni *et al*. [30]. They reported a negative correlation between sleep duration and fat percentage in healthy females, supporting the idea that sleep duration significantly correlated with body fat. Daytime sleepiness is the lowest in underweight people, whereas the highest in obese participants. In a study Wang *et al*. that engaged 5518 children aged 9-12,found that girls had significantly lower weight, BMI, and WHtR, but a higher percentage of body fat than boys. Yen *et al*. observed a negative and insignificant association between self-reported short sleep duration and the percentage of body fat among Chinese men and women [31]. Ozturk and Yabanc Ayhan [25] also did not find any relationship between sleep quality and body fat percentage in a cross-sectional study on Turkish women.

In the present study, males exhibited more Visceral Fat Area (VFA) 102.51(70) than females 57.38(31.27). There was a significant difference, but insignificant association was noted between VFA and sleep habits in both genders, but females had a negative correlation for daytime sleepiness. Visceral fat area corresponds to 10-20% of total body fat in men, and 5-8% of total body fat in women, increasing after menopause [32]. It has been seen that the number of obesity-related risk factors increases with the visceral fat area [33]. A six-year longitudinal analysis on sleep and visceral adiposity revealed that the change in sleep duration was not associated with visceral adiposity changes in adults [34]. A study revealed gender differences for VFA and Obstructive Sleep Apnea (OSA), found there is an independent association with VFA only in men, but not women [35].

In the present study, males measured larger Waist Circumference (WC) 93.19(21.51) than females 76.65(8.83). There was a significant difference, but no significant association was seen between WC and sleep habits in either male or female. Waist circumference is highly dependent on the quantity of visceral adipose tissue [36]. The results are in line with some earlier findings in that they did not notice an association between sleep duration and any of obesity indicators among male and female throughout any distribution of BMI and WC [37, 25]. In contrast, Mathews *et al*. identified a significant association between high waist circumference and poor sleep quality for university students [38]. Rahe *et al*. also observed a significant correlation between high waist circumference and poor sleep quality [39]. Davidson *et al*. have revealed that WC correlates most significantly with sleep duration for both women and men in a cohort of 414 patients [40].

In this study, males showed wider hip circumference 108.02(11.4) than females 97.53(4.74). There was a significant difference, but no noteworthy association was seen between the hip circumference and sleep habits in either males or females. Mathiyalagen *et al*. performed a cross-sectional study in a Non-communicable disease clinic of a rural health training center in South India. In their study, they found that there was a significant difference in the hip circumference between the group considered to be at low risk and high risk of developing OSA [41]. A cohort study examines anthropomorphic measures concerning obstructive sleep apnea for men (47%) and women (53%). The stepwise linear regression analysis showed explanatory variable of hip circumference was not significant (P=.064) [42]. A cross-sectional study conducted on105 women aged ranged 20-25 years at a public institution found that HC was not different between groups (P <.05). (25). A study was conducted by analyzing the medical records of 952 adults from hospitals. They found that hip circumference was most positively correlated (CC: .403) with apnea-hypopnea index for men and women, (CC:0.420, P < .001) and (CC:.188, P < .001) respectively [43].

In this study, males showed a greater waist-hip ratio .85(.11) than female .78(.06). There was a significant difference, but no significant association was seen between waist-hip ratio and sleep habits in either males or females. WHR is a feasible and straight forward measure to estimate abdominal fat. A study conducted on Taif University students showed a significant positive correlation of sleep disturbance scale and daytime sleepiness with waist-to-hip ratio, and the daytime sleepiness was more prevalent in females than males [44]. A study conducted in Turkey showed no statistically significant differences for WHR with poor sleep quality and good sleep quality in women; they also have a waist-hip ratio within normal limits [25]. Andreeva *et al*. revealed that there was no significant association was observed with WHR for men, but for women, a significant association existed between WHR and chronic insomnia [45]. Turkish adults do not indicate any significant relationship between anthropometric indices and WHR, either males or females too. The lack of relationship between sleep and WHR may be the result of a significant association between any anthropometric indices.

In this study, males indicated a greater waist-height ratio .56(.12) than females .49(.06). There was a significant difference, but no significant association seen between the waist-height ratio (WHtR) for sleep habits in either males or females. Earlier research by Hazzaz illustrated that sleep duration was more affected by the joint, abdominal obesity, and general obesity rather than low WHtR and High BMI or High WHtR and low BMI of adolescents [46]. In other research, the waist-height ratio measured to be higher in obstructive sleep apnea syndrome patients. Correlation analysis of anthropometric measurement (WHtR) did not reveal any difference in either of the gender [47]. A cross-sectional study of South Korean adolescents indicated that there was no significant association between sleep duration and WHtR for girls. Whereas a decreased sleep duration was associated significantly with increased WHtR for boys [48]. These findings are in contrast with earlier researches indicating a negative relationship between WHtR and sleep duration [49].

CONCLUSION

The study concludes on analysis for the anthropometric indices, sleep quality, and daytime sleepiness in regard to gender. All are positively associated with each other, but there is an insignificant difference. Such studies could be helpful in evaluating the role of anthropometric measurement in predicting the quality of sleep and daytime sleepiness between male and female participants.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Deanship of scientific research and Imam Abdulrahman bin Faisal University, Saudi Arabia with approval no. IRB-2017-03-165.

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

The researchers received consent from the participants before the start of the investigation.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

Declared none.

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