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The Effect of Body Weight on Sleep Quality and Sleep Duration in Adolescents

Adölesanlarda Vücut Ağırlığının Uyku Kalitesi ve Uyku Süresine Etkisi

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Abstract

Aim: The aim of the present study was to determine the effect of body weight on sleep duration and sleep quality in adolescents.

Material and Method: This cross-sectional study was performed on 14-17 year-old adolescents (n=1072) attending public and private high schools. In order to determine the sleep quality, Pittsburgh Sleep Quality Index (PSQI) was filled, and sociodemographic data were collected through a questionnaire. Body weight, height, waist, and hip circumferences were measured and body mass index (BMI), waist to hip ratio were calculated.

Results: In the least sleeping group (<8 hours/day) for both genders, the body weights were the highest ($p<0.05$). In boys, the least sleeping group had the highest BMI ($p<0.05$). The adolescents having good sleep quality had lower body weight and BMI values than the ones having poor sleep quality but the difference is not statistically significant. There was no significant relationship between sleep quality and, smoking habits, family types, self-evaluated school success, and appetite. There was a relationship between age and deterioration in the quality of sleep ($p<0.05$).

Conclusion: Sleep duration may be an important factor for obesity. In order to develop improvements on health; the adolescents, their families, and teachers should be informed more on healthy nutrition, and healthy sleep.

Keywords: Adolescent, obesity, sleep duration, sleep quality

Öz

Amaç: Bu araştırmanın amacı, adölesanlarda vücut ağırlığının uyku süresi ve uyku kalitesi üzerine etkisinin belirlenmesidir.

Gereç ve Yöntem: Kesitsel olarak tasarlanan bu araştırma, özel ve devlet liselerine devam eden 14-17 yaş adölesanlar (n=1072) üzerinde yürütülmüştür. Uyku kalitesini değerlendirmek amacıyla, Pittsburgh Uyku Kalitesi İndeksi (PSQI) kullanılmıştır. Sosyo-demografik veriler anket aracılığıyla toplanmıştır. Vücut ağırlığı, boy uzunluğu, bel ve kalça çevresi ölçülmüş, Beden Kütle İndeksi (BKİ) ve bel kalça oranı hesaplanmıştır.

Bulgular: Her iki cinsiyette de en az uyuyan (<8 saat/gün) adölesanların vücut ağırlıklarının en fazla olduğu belirlenmiştir ($p<0,05$). Erkeklerde, en az uyuyan grubun BKİ'si en yüksektir. İstatistiksel olarak anlamlı olmasa da iyi uyku kalitesine sahip olan adölesanların vücut ağırlığı ve BKİ değerlerinin, kötü uyku kalitesi olanlara göre daha düşük olduğu belirlenmiştir. Uyku kalitesi ile sigara kullanımı, aile tipi, okul başarısı ve iştah arasında bir ilişki saptanmamıştır. Yaş ve kötü uyku kalitesi arasında ilişki saptanmıştır ($p<0.05$).

Sonuç: Uyku süresi obezite için önemli bir faktör olabilir. Sağlığı geliştirmek için; adölesanlar, aileleri ve öğretmenleri sağlıklı beslenme ve sağlıklı uyku konularında daha fazla bilgilendirilmelidir.

Anahtar Kelimeler: Adölesan, obezite, uyku süresi, uyku kalitesi

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INTRODUCTION

Having a regular good night's sleep is one of the essentials of a healthy life for both children, and adults. Many somatic, cognitive, and psychological processes are strongly affected by good sleep and it seems to contribute to health improvement and survival.[1] Despite the fact that the concepts of basal sleep needs are still being studied by scientists, cumulative evidence indicates that an insufficient amount of sleep may have harsh effects on metabolism with a higher risk of obesity, diabetes, and mortality risks among populations.[2] Lately, chronic sleep duration (less than 6 hours) has been believed to be in relation to an increased risk of obesity, hypertension, diabetes, and cardiovascular diseases.[3] Various meta-analyses and reviews have just been assigned to the relation between sleep loss, and obesity or diabetes.[4,5] As accumulative evidence proposes, insufficient sleep may be connected with adverse health effects such as type 2 diabetes, obesity, hypertension and cardiovascular diseases.[6,7] Day by day, modern societies suffer more from reduced sleep duration and poor sleep quality, which are linked to changing socioeconomic environment, and lifestyle.[8]

Most studies conducted on college students put forward that they have chronic sleep deprivation. They state that their average sleep duration is around 7 hours, which is less than the recommended amount (9-10 hours) for adolescents and children.[9] In addition, adolescents may be more sensitive to the adverse effects of sleep deficit. Sleep has a crucial role in brain development. Hypothalamic mechanisms regulating appetite and energy expenditure may be modified by sleep loss at young ages. The effect of age can be expressed with another possibility. The effect of sleep duration on weight gain can change in time such that individuals with short sleep duration may not continue to gain weight linearly.[10] As observational studies show, sleep loss affect children more strongly than adults. Randomized prospective interventional trials are necessary for the clarification of the sleep duration effects on the risk of weight gain. Since depriving subjects of sleep for prolonged time periods can be unethical, extending sleeping hours of individuals with short sleep duration and obesity can be used as another way to shed a light on the relationships.[10] Sleep deprivation is linked with weight gain and obesity; however, how sleep extension could improve weight regulation is still unclear. Children and adolescents have an important issue. To observe overweight and sleep-deprived children prospectively who are encouraged to get more sleep for an adequate time period would be crucial.[10] Therefore, the aim of this study was to determine sleep duration, sleep quality, and their relations with obesity among adolescents.

MATERIAL AND METHOD

Study Design and Sample

This cross-sectional study was performed on 14-17 year old adolescents attending public and private high schools. Based on the chi-square test done for the obesity status of age variable, it was calculated by the bio-statistic expert that 1200 students needed to be involved in the study for α=0.05, power=0.80, degree of freedom (df)=8, and effect size=0.32. According to the data obtained from The Kayseri Provincial Directorate for National Education, 67 high schools located in the Kayseri city center are accepted. Five hundred twenty-six students attending 9th grade, 281 students attending 10th grade, 265 students attending 11th grade were included from every nine schools that were selected amongst the 67 high schools using the random cluster sampling method.

A total of 1072 adolescents aged 14-17 years were enrolled in the study. The objective of the research was explained, then survey forms and informed volunteer consent forms for parent permission were handed out to the students who accepted to participate in the study, and these forms were collected the following day. The study was approved by the Ethics Committee of the Faculty of Medicine, Erciyes University, Kayseri, Turkey (Approval number 2009/151). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Anthropometric Measurements

Body weight was measured using a digital scale (Tefal Premio) with an accuracy of ± 100 g. All subjects were weighed without shoes and in light clothes. Height was measured using a tape measure with the subjects standing barefoot, keeping their shoulders in a relaxed position, arms hanging freely, and held in the Frankfort horizontal plane.

Age and sex specific BMI percentiles were calculated and adolescents were classified as normal weight (≥15th-<85th percentile), overweight (≥85th-<97th percentile), and obese (≥97th percentile) according to the International Obesity Task Force (IOTF) criteria.[11] Waist circumference (WC) was obtained from the narrowest point between the lower edge of the cage framework, and the iliac crest using a flexible tape measure, but not an elastic one. Hip circumference was determined from the highest point of the side of the hip.[12] The waist/hip ratio was calculated from the values of waist and hip circumferences.

Pittsburgh Sleep Quality Index (PSQI)

The PSQI is a widely used, self-rated, standardized questionnaire assessing sleep quality in the previous month.[13] The 19 questions are grouped in seven component scores, each exploring a different sleep feature; the sum yields a global PSQI score used to define poor sleep quality when >5. On the basis of the sleep duration component of the PSQI score, self-reported short sleep duration was defined as <6 h of sleep per night. The following PSQI derived data also were analyzed: increased sleep latency (>30 min), reduced sleep efficiency (<85%), sleep disturbance (sleep disturbances component score >1), and daytime dysfunction due to sleepiness (daytime dysfunction component score >1).[13]

Statistical Analysis

All of the data obtained during the study were assessed using SPSS 25.0 (Statistical Package for the Social Sciences, SPSS Inc. Chicago, USA) software. Frequency tables and descriptive statistics were used to interpret the results. Chi-square analysis was used to compare the difference of qualitative variables between groups. The student's t-test was used to compare two independent groups in terms of quantitative variables. The one-way ANOVA was used to compare the means of more than two groups.

RESULTS

43.9% (n= 471) of the 1072 students participating the study were boys and 56.1% (n= 601) of them were girls. The mean age was 15.54±1.08. The mean body weight of the male students was 64.55±12.59 and their BMI mean was 21.5±3.58 kg/m². The mean body weight of the female students was 55.0±10.11 kg and their BMI mean was 20.80±3.52 kg/m². The mean waist circumference of the boys was 76.08±9.73 cm whereas that of the girls was 70.0±8.82. The waist/hip ratio was 0.81±0.08 in boys while it was 0.77±0.07 in girls. Body weight, height, waist circumference, hip circumference, and waist/hip ratio ($p<0.001$) among the anthropometric measurements were found to be significantly higher in boys than girls (**Table 1**).

Table 1. Anthropometric measurements of adolescents

	Boy (n=471) X±SD	Girl (n=601) X±SD	p
Weight (kg)	64.55±12.59	55.00±10.11	0.000*
Height (cm)	1.72±0.07	1.62±0.06	0.000*
BMI (kg/m²)	21.50±3.58	20.80±3.52	0.870
Waist circumference (cm)	76.08±9.73	70.00±8.82	0.000*
Hip circumference (cm)	93.22±9.04	90.00±8.17	0.000*
Waist/hip ratio	0.81±0.08	0.77±0.07	0.000*

*p<0.001, **p<0.05

PSQI score distributions of the adolescents are demonstrated in **Table 2**. The mean PSQI total score of the adolescents participating the study was 5.05±1.82 in boys and 5.25±1.81 in girls. PSQI subcomponent score averages were detected to be 2.11±0.67 and 2.02±0.70 in boys and girls respectively for subjective sleep quality; 19.86±14.56 and 21.15±15.42 for sleep latency; 7.35±1.54 and 7.36±1.37 for sleep duration; 93.11±6.38 and 93.92±5.01 for habitual sleep efficiency; 4.42±3.51 and 4.97±3.65 for sleep disturbance; 0.86±1.21 and 1.26±1.55 for daytime dysfunction. Subjective sleep quality was observed to be higher in boys according to their self-assesments ($p<0.05$). However, girls were detected to have higher levels of habitual sleep efficiency, sleep disturbance ($p<0.05$) and daytime dysfunction ($p<0.001$) compared to the boys.

Table 2. Sleep features of the adolescents according to the PSQI

PSQI	Boy (n=471) X±SD	Girl (n=601) X±SD	p
Subjective sleep quality	2.11 ±0.67	2.02±0.70	0.023*
Sleep latency	19.86±14.56	21.15±15.42	0.160
Sleep duration	7.35±1.54	7.36±1.37	0.903
Habitual sleep efficiency	93.11±6.38	93.92±5.01	0.020*
Sleep disturbance	4.42±3.51	4.97±3.65	0.013*
Day dysfunction due to sleepiness	0.86±1.21	1.26±1.55	0.000**
PSQI score	5.05±1.82	5.25±1.81	0.073

*p<0.05, **p<0.001

Table 3 indicates sleep quality evaluations of some students in the study with regards to their certain features. Age 14 group, in which older age and poor sleep quality increase in direct proportion, was observed to have the best sleep quality rate (47.0%) ($p<0.05$). Smokers were observed to have poorer sleep quality than non-smokers (72.0% and 59.7%, respectively). Students who are the core family members were detected to have the highest rate of good sleep quality (40.9%). On the other hand, students who have broken families were found to have the poorest sleep quality (78.4%). The relationship among the students' smoking habits, family types, school success and appetites was not statistically significant.

Table 3. Some socio-demographic characteristics of adolescents according to PSQI

	PSQI				Total		
	<5 Good sleep quality		≥5 Bad sleep quality				
	n	%	n	%	n	%	p
Age							0.030*
14	102	47.0	115	53.0	217	100.0	
15	141	41.5	199	58.5	340	100.0	
16	88	38.1	143	61.9	231	100.0	
17	98	34.5	186	65.5	284	100.0	
Smoking							0.290
Smoker	7	28.0	19	72.0	26	100.0	
Non-smoker	422	40.3	624	59.7	1046	100.0	
Family type							0.060
Core family	372	40.9	538	59.1	910	100.0	
Broken families	8	21.6	29	78.4	37	100.0	
Large families	49	39.2	76	60.8	125	100.0	
Self-evaluated school success							1.000
Unsuccessful	17	40.5	412	59.5	42	100.0	
Successful	25	40.0	618	60.0	1030	100.0	
Appetite							0.424
Very poor	3	20.0	12	80.0	15	100.0	
Poor	31	40.3	46	59.7	77	100.0	
Normal	163	39.8	247	60.2	410	100.0	
Good	139	38.9	218	61.1	357	100.0	
Very good	93	43.7	120	56.3	213	100.0	
Total	429	40.0	643	60.0	1072	100.0	

Table 4 displays the PSQI score distribution of the adolescents in terms of anthropometric features. The mean body weight of the students who have good sleep quality was 60.03±11.96 kg while that of the students who have poor sleep quality was 60.14±11.92 kg. The mean BMI was 21.46±3.61 kg/m² and 21.50±3.50 kg/m² respectively. Although poor sleep quality group was observed to have higher body weight, BMI and hip circumference averages, the difference in between was not statistically significant.

Table 4. Anthropometric measurements of adolescents according to the PSQI

	PSQI		
	<5 (Good sleep quality)	≥5 (Bad sleep quality)	p
Anthropometric measurements			
Weight (kg)	60.03±11.96	60.14±11.92	0.883
Height (cm)	1.67±0.08	1.66±0.08	0.936
BMI (kg/m²)	21.46±3.61	21.50±3.50	0.843
Waist circumference (cm)	73.03±9.62	72.64±9.72	0.513
Hip circumference (cm)	91.88±8.71	92.14±8.57	0.625
WHtR	43.73±5.33	43.52±5.51	0.544
WHR	0.79±0.07	0.78±0.08	0.195

BMI= Body mass index, WHtR= Waist to height ratio, WHR=Waist to hip ratio

The mean values of anthropometric measurements of adolescents according to their sleep duration were shown in **Table 5**. The mean body weight of boys who sleep for 8 hours or less was the highest. It was determined that the mean body weight increased as the sleep duration decreased. The difference between sleep duration groups in terms of body weight was found to be statistically significant (p<0.01). The group with the highest mean body weight in girls was determined in those who slept 8 hours or less, and the difference was statistically significant (p<0.05). The difference between height and sleep duration is statistically significant in boys (p<0.05). The group with the highest mean BMI in boys is the group that sleeps 8 hours or less. It was determined that as sleep duration increased, the mean BMI decreased, and the difference was statistically significant (p<0.05).

DISCUSSION

The major contributions of this study to the current literature were both determining the relationship between sleep deprivation, sleep quality and obesity. Sleep deprivation or short sleep occurs if sleep time lasts less than 9 hours which is the average basal level per night for adolescents. National Sleep Foundation has recently updated its guidelines to 8-10 hours for adolescents between the ages of 14 and 17.[14] Similar to a number of countries around the world, adolescents do not get enough amount of nocturnal sleep according to the studies.[15-17] This latter review concluded that in Asian studies adolescents slept for 7.64 hours, in European studies for 8.44 hours and in North American studies for 7.46 hours.[15] According to the reports of as many as one-fourth of adolescents, they sleep for 6 hours or less per night.[16] In its survey in 2006, The National Sleep Foundation stated that only 1 in 5 adolescents has 9 hours of sleep on school nights whereas 45% of them have 8 hours or less sleep. And a regular high school senior gets only 6.9 hours' sleep on such nights.[15,18] Similar to Asian and North American studies, Yılmaz et al. (2011) reported 7.42±1.48 hours sleep on school nights among adolescents in Turkey.[15,17]

Evidence strongly proposed a compatible relationship between restricted sleep and overweight/obesity in children. The shorter the sleep duration the greater the odds of overweight/obesity or weight gain.[19-23] This applies especially to preschool children. In fact, the evidence puts forward an evident dose-response association. That is to say, each unit decrease in sleep duration triggers an increase in weight or weight gain.[23] Yet, when it comes to adolescents, the

Table 5. Anthropometric measurements of adolescents according to sleep duration

Sleep duration (hour)		≤8 (n=326)	8.1-8.9 (n=58)	9.0-9.9 (n=53)	≥10 (n=34)	p
Anthropometric measurements						
Boys (n=471)	Weight (kg)	65.84±12.97	63.70±12.49	61.06±9.85	59.09±10.48	0.003**
	Height (cm)	1.73±0.07	1.72±0.07	1.70±0.07	1.70±0.08	0.028*
	BMI (kg/m²)	21.77±3.66	21.33±3.71	20.90±3.05	20.19±3.08	0.047*
	WC (cm)	75.96±9.85	75.56±8.38	76.11±9.62	78.05±11.02	0.658
	HC (cm)	93.21±9.10	94.25±8.64	92.15±8.52	93.29±10.08	0.682
	WHR	0.81±0.08	0.80±0.55	0.82±0.08	0.84±0.12	0.154
Girls (n=601)		(n=431)	(n=85)	(n=53)	(n=32)	
	Weight (kg)	57.30±10.33	55.75±9.07	53.70±7.74	54.39±12.13	0.036*
	Height (cm)	1.62±0.06	1.62±0.06	1.61±0.07	1.61±0.06	0.351
	BMI (kg/m²)	21.69±3.60	21.04±3.25	20.72±3.03	20.78±3.55	0.084
	WC (cm)	70.12±9.00	69.29±7.96	71.00±8.30	72.78±9.29	0.252
	HC (cm)	91.05±8.14	90.68±7.40	91.69±7.17	92.00±11.69	0.825
	WHR	0.77±0.07	0.76±0.08	0.77±0.05	0.79±0.05	0.307

*p<0.05, **p<0.01; BMI= Body mass index, WC= Waist circumference, HC= Hip circumference, WHR=Waist to hip ratio

evidence is unclear. One reason for this is that researches conducted on them are inadequate. Cuypers et al. (2012) have stated that inadequate amount of sleep is linked to obesity only if there is an unusual sleep range (5 or less hours of sleep).[24] Therefore, there is a stronger evidence for an inverse relationship between restricted sleep and overweight/obesity among children and adolescents than the latter age group.

Von Kries et al. (2002) state in their research on 5-6 year olds that children who sleep for 11.5 or more hours have half the risk of obesity compared to ones who sleep for 10 or less hours.[25] Similarly, Touchette et al. (2008) reported that continual short sleep in early childhood increases the risk of overweight or obesity in childhood.[26] In the research on 8234 children in England, it is found that sleeping for 10.5 or less hours at the age of 3 increases the risk of obesity by 45% in 7-year -old children.[27] According to the findings obtained from France, Tunisia, Japan, Germany, USA, Brazil, Portugal, Great Britain, Canada, Taiwan and China along with the research on 29502 children, a significant association between short sleep duration and obesity exists.[28] Another research conducted in accordance with NHANES I findings support the existence of the association between insufficient sleep duration and obesity.[29]

In the study conducted on 5358 Turkish adolescents between the ages of 6 and 17, Ozturk et al. (2009) detected that sleep duration of both sexes increases as their BMIs decrease.[30] Girls who sleep for 10 or more hours have significantly higher BMIs than the ones sleeping for 8 or less hours. On the other hand, boys who sleep for 8 or less hours have significantly higher BMIs and waist circumferences compared to the ones sleeping for 10 or more hours. The risk of overweight/obesity is lower in children who sleep for 10 or more hours than the other groups. According to research results, a decrease in sleep duration triggers the risk of overweight/obesity (statistically insignificant in girls). Consistent with Ozturk et al. (2009), in the present study, boys who sleep for 8 or less hours have the highest mean body weight. As the sleep duration decreases, mean body weight increases. Also, the difference between sleep duration groups is statistically significant with regards to body weight. Among the girls, the one belonging to the girls who sleep for 8 or less hours has the highest mean body weight. Similarly, the difference between them is statistically significant. Additionally, the difference between boys' sleep duration and height is statistically significant. The group of boys who sleep for 8 or less hours has the highest BMI average. As the sleep duration increases BMI average decreases. Likewise, the difference in between is statistically significant.

Sleep quality has a long-term impact on health among adolescent students.[31] Both biological and social factors contribute to sleep quality. Adolescents' sleep pattern requires specific attention because it may affect their academic environment.[32,33] In the study conducted on Turkish adolescents which evaluates the sleep quality of adolescents with the mean age of 15.8±0.9 years, 89.9% of the students were found to sleep 7 or more hours while this number for 1.5% of them was 5 or less. In addition, the PSQI score of 4.1% of the students was 5 or more, which was evaluated as poor.[34] According to the study results, the students' sexes, parents' educational backgrounds and jobs or school success do not affect their sleep quality. On the other hand, factors such as broken families, present or past smoking habits, falling asleep after more than 30 minutes and night sleep duration of 5 or less hours were detected to have adverse effects on the students' sleep quality.[34] Similarly in our research, among the smoking students the ratio of the ones with 5 or more PSQI scores is reported to be higher than the ones with less than 5 PSQI scores. However, the difference is not detected to be statistically significant. Furthermore, the sleep quality of 80% of the students who evaluate their own appetite as "very poor" is found to be bad. As a result, we did not find a significant relationship between the sleep quality and, smoking habits, family types, self-evaluated school success and appetite based on the PSQI score. Significant difference between sleep quality and age groups was noted among adolescents.

CONCLUSION

Sleep quality can be affected positively or negatively by eating habits, medicine usage, psychological or cognitive condition and age along with sex. Short sleep duration, especially ≤8 h, may be a risk factor of overweight or obesity. Providing ≥10 h of sleep may be recommended as a part of interventions to prevent obesity, especially for children and adolescents. However, it is necessary to assess these factors and the relation among them together to obtain more accurate results.

The limitation of this study may be self-reports of adolescents, which may interact the accuracy of reported sleep duration, and sleep quality.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was approved by Ethics Committee of the Faculty of Medicine, Erciyes University (Date: 19.11.2009, Decision no:151)

Informed Consent: All parents signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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