

## SHORT SLEEP DURATION AND OBESITY AMONG TUNISIAN ADOLESCENTS

## OBESITE ET DUREE DE SOMMEIL CHEZ LES ADOLESCENTS TUNISIEN

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**Abstract**

**Background:** Short sleep duration and other health behavior have been hypothesized to affect weight gain. Our aims were to describe sleep duration in a sample of Tunisian adolescents, to examine the association between short sleep duration and obesity and to elucidate whether sedentary behaviors underlay this association.

**Methods:** A sample of 1695 adolescents aged 15–18 years from Sfax city participated in this study.

**Results:** 43.7 % of participants were female. The prevalence of obesity was 4.4 %, and of overweight was 19.2%. 71.1% of adolescents did not achieve optimal sleep duration (defined as  $\geq 8.0$ h per day). The prevalence of obesity and the waist circumference value were significantly higher for short sleepers as compared with normal sleepers with ( $p=0.04$ ) and ( $p=0.05$ ) respectively.

**Conclusion:** Adequate sleep among adolescents is important in the prevention of obesity

**Keywords:** Sleep duration; Obesity; Sedentary time; Adolescents.

**Résumé**

**Introduction:** De très nombreuses études chez l'adulte, l'adolescent ou l'enfant, mettent en évidence une association indépendante entre temps de sommeil court et prise de poids. Le but de notre étude était d'évaluer la prévalence de l'obésité chez des adolescents et d'étudier son association avec la durée de sommeil et la sédentarité.

**Patients et méthodes:** La population étudiée était composée de 1695 adolescents inscrit à l'école secondaire Majida Boulila à Sfax et âgés entre 15 et 18 ans.

**Résultats:** Notre étude comportait 43,7% de filles. La prévalence de l'obésité était de 4,4% et du surpoids de 19,2%. La majorité (71,1%) des adolescents ont une durée de sommeil  $< 8$ h/j. Il existe une corrélation statistiquement significative entre une durée du sommeil courte et l'obésité en particulier androïde ( $p= 0.04$ ).

**Conclusion:** Encourager un sommeil adéquat chez les adolescents est important dans la prévention de l'obésité.

**Mots clés:** Durée de sommeil; Obésité; Sédentarité; Adolescents.

**ملخص**

**مقدمة:** إن انتشار السمنة و زيادة الوزن في ارتفاع. بمعدل ينذر بالخطر في العقود الأخيرة وخاصة عند الأطفال والمراهقين. بعض العوامل المؤثرة في استهلاك الطاقة، مثل مدة النوم، يفسر إلى حد كبير ظهور البدانة لدى المراهقين. الهدف من دراستنا هو دراسة ارتباط مدة النوم والسمنة لدى المراهقين. الطريقة: قمنا برصد 1695 مراهق مسجلين في مدرسة مجيدة بوليلة صفاقس اعمارهم بين 15 و 18 عاما. النتائج: شملت دراستنا 43.7% من الفتيات و 56.3% ذكور. متوسط العمر كان  $16.8 \pm 1.1$  سنة. (71.1%) من المراهقين لديهم مدة نوم  $> 8$  ساعات / يوم. هناك علاقة ذات دلالة إحصائية بين قصر فترة النوم والبدانة في كلا الجنسين. الخلاصة: تعزيز النوم الكافي لدى المراهقين أمر مهم لمنع البدانة.

**الكلمات المفاتيح:** مدة النوم ; البدانة ; نمط الحياة المستقرة ; المراهقين .

## BACKGROUND

Sleep is recognized as a major contributing factor to physical and mental maturation, and health in children and adolescents [1]. The prevalence of chronic partial sleep deprivation has increased dramatically in the past half century in parallel with the rising epidemics of obesity. Short sleep duration is related to decreased levels of leptin, glucose tolerance and insulin sensitivity, but increased levels of ghrelin, hunger and appetite [2, 3]. It is also associated with behaviors that are known to promote weight gain and obesity including lower physical activity and lower fruit and vegetable consumption [4]. Recently, there is increasing epidemiological evidence suggesting a link between sleep duration and obesity in children and adolescents [5,6].

In the context of elevated prevalence and negative consequences of obesity and sleep loss, it is important to examine the relation between short sleep duration and the risk of obesity in children and adolescents. Previous studies have suggested that the influential factors associated with sleep duration and obesity among adolescents included the lifestyle patterns and sociocultural conventions [6, 7]. The problem of shortened sleep durations in adolescence exists worldwide [5, 6, 7]. However, few studies have explored the associations between sleep duration, obesity and sedentary time in the developing countries. Similarly, to date, it is believed that (to the best of our knowledge) there is no information on sleep duration and obesity among Tunisian adolescent.

To fill these knowledge gaps, the present epidemiological study was designed to describe sleep duration among Tunisian adolescent from Sfax city and to assess the association of short sleep duration with excess adiposity and sedentary behaviors.

## METHODS

The present study was conducted with the agreement of the Ministry of Education and the Ethics Committee of Hedi Chaker Hospital, Sfax, Tunisia. All participating pupils and their parents provided written consent. Participants received no incentives were allowed to withdraw from the study if they wanted to.

The study was carried out in Sfax city, located at the South -East province of Tunisia. The population was recruited from Majida Boulila secondary school. The school where the study was implemented was selected on the basis that it is the

largest school in Sfax with 1980 pupils and it represents a broad spectrum of socioeconomic classes.

This study included 1695 pupils. Exclusion criteria were:

- Students aged less than 15 or older than 18 years on the day of the action taken.
- Students for who measures or questionnaires were missing.

All measures were conducted in the school clinic and performed by the school nurse. Anthropometrics standardization exercises were conducted to ensure uniform techniques. Each subjects completed a standardized questionnaire during a face to face interview with the school nurse.

## ANTHROPOMETRIC MEASUREMENTS BODY MASS INDEX (BMI)

Weight was measured without shoes and heavy clothes, using a Tanita electronic scale (Tanita BF 571, Tanita Corporation, Japan) and was recorded to the nearest 100 g. Standing height was measured with a suspended Microtoise tape to the nearest 0.1 cm. Weight and height were used to calculate the BMI :weight (kg) divided by squared height(m<sup>2</sup>). Overweight and obesity were defined according to the International Obesity Task Force (IOTF)

## WAIST CIRCUMFERENCE

Waist circumference (WC) was measured in cm with a non-elastic tape applied at a point midway between the lower border of the rib cage and the iliac crest at the end of normal expiration.

## QUESTIONNAIRE SEDENTARY TIME

The time spent in sedentary activities (SED) assessed by a set of questions. "On average, how many hours per day does the adolescent spend watching TV, and using computer"?

Adolescents reported for both a typical weekday and weekend day the time of usage of TV/computer the following statement "Excluding the school's requirements (e.g. get information for doing homework), I usually used computer for playing games or chatting with someone".

The average time spent in sedentary activities per day was calculated for each participant [(hours of sedentary week day x 5) + (hours of sedentary weekend x 2)]/7[5]. The time spent in sedentary activities was categorized as follows: ≤2hours/day, 2-4 hours/day and > 4 hours/day.

## SLEEP DURATION

Typical duration of sleep on a school night and on a weekend night was self reported, by the participants to the nearest 15 minutes. Past studies have shown that adolescents are able to recall their typical duration of sleep (b). The average time spent sleeping per day was calculated for each participant as: [(min Weekdays x 5) + (min weekend days x 2)]/7 [5].

Sleep duration was categorized as follows: less than 6 hours, between 6 and 7 hours, between 7 and 8 hours, between 8 and 9 hours and more than 9 hours of sleep.

The sleep length was also dichotomized in short (< 8 h) and optimal sleep duration ( $\geq 8$  h). Insufficient sleep was defined as sleeping < 8 h per night, according to the definition of the National Sleep Foundation for adolescent population [8]

## DATA ANALYSES

Statistical analysis was conducted using SPSS version 20 (SPSS Inc. Chicago, IL, USA). The quantitative variables are reported as mean and standard deviation (SD) and the qualitative variables as number and percentage. Chi-square test was used to measure association between qualitative variables. Quantitative variables were examined using student t-tests and ANOVA.

P-values below 0.05 were considered to be statistically significant.

## RESULTS

### ANTHROPOMETRIC MEASUREMENT

A total of 1695 subjects (954 girls and 741 boys), ranging in age from 15–18 years of age (mean 16.8  $\pm$  1.1 years) were studied. The characteristics data of this sample are shown in Table 1. Table 2 shows that the prevalence of overweight and obesity stratified by age, gender and SED. In this cohort of school adolescent, according to IOTF cut off points overall prevalence of overweight and obesity was respectively 16.4 % and 5.8 % in boys and 21.2% and 3.4% in girls ( $p=0.005$ ).

ANOVA demonstrated that overweight was associated to the time spent in SED. In effect, there was a significant difference between more than two hours/day and less than two hours/day ( $P = 0.02$ ). Also, the high level of SED (more than 2 h/day) is associated with increases of BMI and WC ( $P<0.001$ ). However, there were no significant differences in the mean values of BMI and WC

between 2 to 4 h/day and more than 4 h/day ( $p= 0.2$  and  $p=0.13$ ; respectively) table 3.

Figure 1 represents the distribution of self-reported daily sleep duration in the population studied. The most frequent sleep duration (51% of the population) ranges from 7 to 8 hours, 23.7% fluctuates between 8 and 9 hours, 17.1% between 6 and 7 hours and only 2.3% is less than 6 hours.

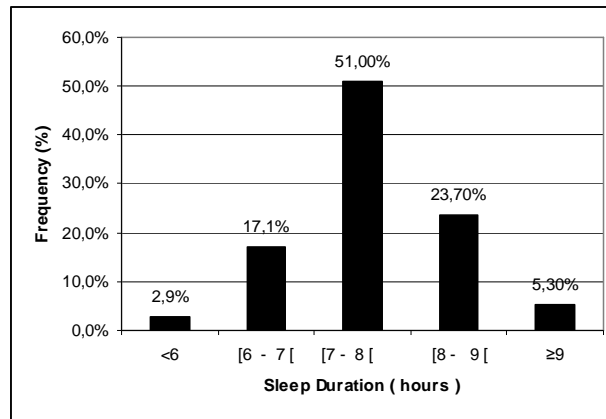
In all, 71.0% of adolescents did not achieve optimal sleep duration (defined as  $\geq 8.0$  h per day). Table 3 shows that, the gender difference was not found (girls 70.9% % vs. boys 71.1%,  $P =0.4$ ). With increasing age, the prevalence of sleep duration <8.0 h augmented ( $P=0.05$ ).

In addition, the prevalence of obesity was significantly different among sleep duration groups. The frequency of obesity and overweight was higher among short sleepers ( $p=0.04$ ). Also, it was noted that adolescents were more likely to report spending more time of sedentary activities were more likely to sleep less than 8 hours a night ( $p=0.01$ ).

When data were dichotomized in short (<8 h) or adequate sleepers ( $\geq 8$  h), shorter sleepers showed no significantly higher values of BMI ( $p=0.4$ ) (Table 4). However, the WC value was significantly higher for short sleepers as compared with normal sleepers, in total group, in boys and in girls, with ( $p=0.05$ ), ( $p=0.04$ ) and ( $p=0.05$ ) respectively.

**Table 1** Baseline characteristics of study

Variables	Total
<b>Sex No. (%)</b>	
Boys	954(56.3)
Girls	741(43.7)
Age( years)	16.8 $\pm$ 1.1
Height(cm)	166.78 $\pm$ 8.4
Weight (kg)	61.52 $\pm$ 11.79
Body mass index (kg/m <sup>2</sup> )	22.08 $\pm$ 3.64
Waist circumference (cm)	71.2 $\pm$ 8.54
<b>Weight status, No. (%)</b>	
Normal and Underweight	1295 (76.4)
Overweight	325(19.2)
Obese	75(4.4)
<b>Sleep length, No. (%)</b>	
$\geq 8$ hours/day	491(29.)
<8 hours/day	1204(71.)
<b>Sedentary activities, No. (%)</b>	
$\leq 2$ hours/day	232 (13.7)
2-4 hours/day	1121(66.1)
>4 hours/day	342(20.2)



**Figure 1:** Distribution of sleep duration per day in the adolescents

**Table 2.** The prevalence of overweight and obesity depending on the age categories, sex and sedentary time

Variables (n)	Normal and	Overweight	Obese	P-values
	Underweight			
	Number (%)	Number (%)	Number (%)	
<b>Total</b>	1295 (76.4)	325(19.2)	75(4.4)	
<b>Age(year)( No)</b>				0.8
15-16(535)	410(76.6)	103(19.3)	22(4.1)	
16-17(512)	395(77.1)	97(18.9)	20(3.9)	
17-18(648)	490(75.6)	125(19.3)	33(5.1)	
<b>Gender(n)</b>				0.005
Girls(954)	720 (75.5)	202 (21.2)	32 (3.4%)	
Boys(741)	575(77.6)	123 (16.6)	43 (5.8%)	
<b>Sedentary activities(n)</b>				0.02
<2hours/day (232)	188 (81)	39 (16.8)	5 (2.2)	
2-4 hours/day (1121)	863 (77)	208 (18.5)	50 (4.5)	
>4 hours/day (342)	244(71.3)	78 (22.8)	20(5.9)	

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**Table 3.** Prevalence of short sleepers (< 8 h) and normal sleepers (≥8 h) according to the age categories, sex, weight status and sedentary time

Variables (n)	<8 hours/day Number (%)	≥8 hours/day Number (%)	P-values
Age(years)			
15-16 (536)	364(67.9)	172 (32.1)	0.05
16-18 (1159)	840(72.5)	319(27.5)	
Gender			
Girls (954)	677 (70.9)	277 (29.1)	0.4
Boys(741)	527 (71.1)	214 (28.9)	
Weight status			
Normal and Underweight (1295)	909(71.2)	386(29.8)	0.04
Overweight/obese( 400)	295 (73.8)	105 (26.2)	
Sedentary activities			
≤2hours/day (232)	142 (61.2)	90 (38.8)	0.01
2-4 hours/day (1121)	804 (71.7)	317(28.3)	
>4 hours/day ( 342)	258(75.4)	84 (24.6)	

**Table 4.** Body mass index (BMI) and waist circumference (WC) according to gender, sedentary time and sleep length

Variables	<b>BMI</b> means ±s. d	P-values	<b>WC</b> means ±s. d	P-values
<b>Gender</b>				
Boys	21.87± 3.9	0.38	72.74 ± 9.41	<0.001
Girls	22.24±3.4		70,01 ±9.59	
<b>Sedentary activities</b>				
≤2hours/day	21.29± 3.45	<0.001	68.58±7.7	<0.001
2-4 hours/day	22.12± 3.47		71.37±8.0	
>4 hours/day	22.48± 4.18		72.43±10.2	
<b>Sleep length</b>				
<i>Total</i>				
≥8 hours/day	22.0± 3.6	0.46	70.95±8.23	0.05
<8 hours/day	22.2 ± 3.9		71.79± 9.2	
<i>Boys</i>				
≥8 hours/day	21.8± 4.4	0.3	72.4 ± 8.5	0.04
<8 hours/day	22.1± 3.6		73,7±11.1	
<i>Girls</i>				
≥8 hours/day	22.2± 3.3	0.1	69.9± 7.6	0.05
<8 hours/day	22.3±3.4		70.3± 7.1	

## DISCUSSION

This study demonstrated that insufficient sleep duration, defined as sleep duration <8.0 h per day, was widespread in Tunisian adolescents. Also, it was found that short sleep duration was associated with increased risk of obesity. Although a trend was seen for an effect in age, no significant difference was noticed between the genders. The high level of SED added an additional risk of obesity to short sleep duration.

This survey confirms that adolescent overweight has become a major public health challenge in Tunisia. Almost more than 1 in every 5 adolescents in Sfax public secondary school have been reported to be overweight or obese. Discussion of results of the prevalence of overweight and obesity have been reported elsewhere [9].

Adequate sleep is a critical factor for adolescents' health and health-related behaviors [10]. In the present study the most frequent sleep duration ranges from 7 to 8 h, which were similar to data obtained in others countries; China [11], India [12] and South Africa [13]. However our results were lower than the ones concerning European adolescents obtained from studies carried out in nine countries (the most frequent sleep duration; 40% of the population was 8 h) [5]. Sleep experts propose that school-aged children obtain from 10 to 11 h of sleep while adolescents have recommendations of 8.5 to 9.5 h and younger adults 7 to 9 h [6,14,15]. These recommendations are largely unmet, with most obtaining roughly 7.5 h of sleep per night [15]. Our findings showed that, the frequency of adolescents who had a short sleep time increased with age. In their study, Garaulet and al [5] reported that average hours of sleep a day varied depending on the Tanner stages. Effectively, data ranged from  $9.1 \pm 1.1$  h in Tanner 1 to  $7.9 \pm 1.1$  h in Tanner 5 ( $P > 0.0001$ ) [5]. Therefore, based on findings from most of the studies, interventions targeting adequate sleep should focus on younger age groups.

It has been observed that short sleepers reported more time watching TV and playing games or chatting with someone. These findings were consistent with previous studies on sleep and sedentary times among children and adolescents [5,7]. In fact, cross-sectional studies in children and adolescents have demonstrated that the relationship between sleep and sedentary habits was clear. A comprehensive review by Cain and al [16] showed that television watching; computer usage and electronic gaming had significant

consequences for the sleep of children. Mobile phone usage prior to sleep is shown to potentially modify sleep architecture [17,18]. Similarly, the prevalent use of the Internet and online social media during the night may cause delays to bedtimes and shorten sleep durations [19,20].

The decline in sleep duration has paralleled a dramatic increase in the prevalence of obesity [21]. The findings of the study show an inverse association between sleep duration and overweight/obesity prevalence in Tunisian adolescents. Several studies developed in different regions including Asian, European and American countries [22, 23] have also demonstrated the interrelationship between sleep habits and weight gain in children and adolescents. For example, in meta-analysis children < 10 years of age with short sleep duration had 58% higher odds of overweight or obesity compared with children with longer sleep duration [6]. Silva et al [24] recruited children (aged 6–12) who were followed-up 5 years later (aged 10 to 18), and observed that sleeping for, 7.5 hours per day at baseline, compared with 9.0 hours per day at baseline, was associated with a threefold increased likelihood of being obese at follow-up. Interestingly, previous works have found that short sleep is related to increased fat intake [25] and increased intake of energy from snacks [26]. In effect, when one sleeps less, he/she simply has more time and/or more opportunities to eat [27]. Sleep deprivation may influence the development of obesity through several possible biological pathways including decreased glucose tolerance, decreased insulin sensitivity, elevated sympathovagal balance, increased evening concentrations of cortisol, increased levels of ghrelin, decreased levels of leptin, and increased hunger and appetite [27,28,29].

In this study, shorter sleepers showed higher values of BMI and WC, but it was significant only with WC. Several studies which examined the association between short sleep duration and obesity among adolescent reported also inconsistent findings [30,31].

The results of previous studies investigating the relationship between sleep duration and BMI found evidence that less sleep led to an increased likelihood of being classified as obese at follow-up [32,24]. Whereas, Calamaro and al [33] reported a null association between short sleep duration and obesity in a survey of 90,000 youths, aged 12-18 years participating in the Add Health study.

Taking into account for the differential associations by sex, our findings are in agreement with previous

studies which reported no gender difference on the association between short sleep duration and obesity [34, 15]. However; other studies have noted sex differences [5, 7, 15, 35]. The reason for these differences was unclear. Further research is needed to clarify these findings. Besides, it is important to note that an additive interaction was found between sedentary time and short sleep duration. In effect, adolescents spending more time in sedentary activities were more likely to sleep less than 8 hours a night and were more likely to have higher BMI and WC values. Similarly, an European study indicated that adolescents, who slept >8 h per day, spent more time watching TV during weekdays, and these differences were maintained even after adjusting for BMI [5,7]. In this latest study, sedentary habits may be more important than energy intake, in the relationships between short sleep duration and obesity. According to Shi study, children with low levels of physical activity and short sleep had 3.4 times higher the OR of obesity [6]. More precisely, it seems that sleep increases adolescents' obesity by decreasing physical activity and by increasing sedentary activity as a consequence of fatigue and changes in hormones that regulate energy expenditure, and increasing energy intake [22, 36]. An important question raised by these results is whether short sleep duration contributes directly to the mechanisms of obesity or reflects the presence of other relevant risk factors and pathways of reverse causation [37]. This study has a number of strengths. Importantly, a relatively large sample of Tunisian adolescents with a reduced age range was observed. Additionally, obesity was assessed using two methods of measures: BMI and WC. There are also limitations to the study. Our assessment of sleep duration was based on self report. No information on the quality of sleep or on other indicators of sleep problems among the respondents was provided. Moreover, no difference in sleep duration between week days and weekend days was examined and the dietary pattern and physical activity were not measured as well.

## CONCLUSION

In summary, the current study confirms that short sleep duration is associated with overweight and obesity among adolescent in Tunisia, sedentary behaviors added an additional risk to short sleep duration. Regardless of the cause and effect relationship, given the existing evidence, encouraging adequate sleep among adolescent is important in the prevention of obesity.

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## REFERENCES

- [1] Mindell JA, Owens JA, Carskadon MA. Developmental features of sleep. *Child Adolesc Psychiatr Clin N Am.* 1999;8: 695-725.
- [2] Van Cauter E, Knutson KL. Sleep and the epidemic of obesity in children and adults. *Eur J Endocrinol.* 2008;159: 59- 66.
- [3] Buxton OM, Pavlova M, Reid EW, Wang W, Simonson DC. Sleep restriction for 1 week reduces insulin sensitivity in healthy men Sleep Restriction for One Week Reduces Insulin Sensitivity in Healthy Men. *Diabetes.* 2010;59: 2126-2133.
- [4] Stamatakis KA, Brownson RC. Sleep duration and obesity-related risk factors in the rural Midwest. *Preventive Medicine.* 2008;46: 439-444
- [5] Garaulet M, Ortega FB, Ruiz JR, Rey-Lopez JP, Beghin L et al. Short sleep duration is associated with increased obesity markers in European adolescents: effect of physical activity and dietary habits. The HELENA study. *International journal of obesity.* 2011;35:1308-1317.
- [6] Chen X, Beydoun MA, Wang Y. "Is sleep duration associated with childhood obesity? A systematic review and meta-analysis." *Obesity.* 2008;16: 265-274.
- [7] Suppiah HT, Chia M. The Somnolent Youth-Sleep and the Influence of Exercise: A Narrative Review. *Sports 3.* 2015;116-135
- [8] Lund HG, Reider BD, Whiting AB, Prichard JR. Sleep patterns and predictors of disturbed sleep in a large population of college students. *Journal of adolescent health.* 2010;46: 124-132.
- [9] Regaieg S, Charfi N, Elleuch M, Mnif F, Marrakchi R, M,Abid. Obesity, physical activity and sedentary time among school adolescents aged 15 to 18 years in the city of Sfax (Tunisia). *Pan Afr Med J.* 2015;22: 370.
- [10] De Henauf S, Gottrand F, De Bourdeaudhuij I, Gonzalez-Gross M, Leclercq C. Nutritional status and lifestyles of adolescents from a public health perspective. The HELENA Project-Healthy Lifestyle in Europe by Nutrition in Adolescence. *J Public Health.* 2007;15: 187-197.
- [11] Nagy E, Vicente-Rodriguez G, Manios Y, Beghin L, Iliescu C. Harmonization process and reliability assessment of anthropometric measurements in a multicenter study in adolescents. *Int J Obes.* 2008;32: 58-65.
- [12] Sun SS, Chumlea WC, Heymsfield SB, Lukaski HC, Schoeller D. Development of bioelectrical impedance analysis prediction equations for body composition with the use of a multicomponent model for use in epidemiologic surveys. *Am J Clin Nutr.* 2003;77: 331-340.
- [13] Reid A, Maldonado CC, Baker FC. Sleep behavior of South African adolescents. *Sleep.* 2002;25: 423-427.
- [14] Suppiah, Haresh T and Michael Chia. The Somnolent Youth-Sleep and the Influence of Exercise: A Narrative Review. *Sports 3.* 2015; 116-135.
- [15] Olds T, Blunden S, Petkov J, Forchino F. The relationships between sex, age, geography and time in bed in adolescents: A meta-analysis of data from 23 countries. *Sleep Med. Rev.* 2010;14: 371-378.