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Association Between Sleep Quality and Overweight/Obesity Among Secondary School Adolescents in Yenagoa Local Government Area, Bayelsa State, Nigeria

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Abstract

Background: The prevalence of overweight/obesity has increased globally, and poor sleep in adolescents has been associated with it.

Objective: To evaluate the association between sleep quality and overweight/obesity among secondary school students.

Methods: A cross-sectional study was conducted among 890 adolescents aged 10-19 years in 20 public and private secondary schools selected by multistage sampling. Data collection was by questionnaires containing items from the Pittsburgh Sleep Quality Index. Weight/height were taken using standard protocols; BMI was obtained and compared with BMI z-scores.

Results: The significant associations found between sleep and overweight/obesity were: late bedtime/early waketime ($p = 0.005$ and 0.044 , respectively) and short sleep duration of ≤ 7 hours ($p = 0.028$). There was no relationship between overall sleep quality and overweight/obesity among all adolescents, by gender and in different age categories. Also, other sleep dimensions were not associated with overweight/obesity.

Conclusion: Poor sleep duration and sleep timing were associated with overweight/obesity in the study; hence, sleep education is recommended to aid in the reduction of obesity and ultimately improve adolescent health.

Keywords: *Adolescents, Bedtime, Overnutrition, Pittsburgh Sleep Quality Index, Sleep hygiene.*

Introduction

Rapid physical and cognitive growth is experienced within the period of adolescence, which spans from age 10-19 years. ¹ For adolescents, profound physical, social, and emotional development requires good quality sleep. ² Sleep problems in adolescents are not only prevalent, but the trend is increasing. ^{3,4} Adolescents are not just having insufficient sleep; they are also experiencing poor sleep quality. ^{5,6}

Consequences of insufficient sleep go beyond health problems such as obesity, depression and increased mortality, to poor school performance and economic losses. ^{3,7} According to the World Health Organisation, in 2022, over 390 million children and adolescents were overweight, with over one-third of this number being obese. ⁸

Sleep deprivation has been linked to hormonal changes that increase appetite and cravings for

high-energy foods, contributing to overweight/obesity.⁹ A reduction in leptin (which restrains appetite) and an increase in ghrelin levels (which stimulates appetite) translate to an increase in the leptin-to-ghrelin ratio, which has been found to increase hunger and appetite, mostly for energy-dense foods.¹⁰ Some studies suggest that insufficient sleep creates an energy deficit, leading to a reduction in energy for physical activity as well as the regulation of hormones which influence fat metabolism and satiety, resulting in obesity.^{11,12} However, sleep duration is only one measure of sleep and does not incorporate other unique dimensions of sleep that may provide a clearer understanding of the sleep-obesity nexus. Beyond sleep duration, sleep quality has been associated with weight status, as people with poor sleep quality are overweight or obese.^{5,13,14} Other dimensions of sleep such as sleep timing, sleep efficiency and sleep quality have been documented to be associated with overweight/obesity.^{5,13} Sleep timing, particularly late bedtime, has been identified as a contributor to dietary behaviours and outcomes.¹⁵ It could result in short sleep duration, intake of less healthy high-calorie dietary choices at night and alteration in the circadian rhythm with resulting changes in leptin and glucose levels.¹⁵ Liu *et al.*¹⁶ noted that adequate sleep efficiency measured with polysomnography is a significant dimension of sleep associated with reduced risk for overweight/obesity. Firouzi *et al.*,¹³ Morrissey *et al.*⁵ in Australia and Jarrin *et al.*¹⁴ in a longitudinal study in Montreal, Canada documented an association between poor sleep quality and overweight/obesity.

In the past few years, sleep health in adolescents has been receiving increased attention because adolescence is a crucial period where healthy habits (such as good sleep habits) which can persist into adulthood can be modelled.^{4,17} Also, some studies have identified an association

between sleep duration and overweight/obesity and noted the need to study sleep quality/ other dimensions of sleep health as a whole, not just sleep duration, which is one component of overall sleep quality.¹² It is, therefore, necessary to clearly understand if short sleep duration is associated with obesity and if other dimensions of sleep are independently related to obesity among adolescents in this study area. This study aimed to determine the association between sleep quality/ other dimensions of sleep health and overweight/obesity, as well as to determine how sleep hygiene affects the sleep quality of adolescents.

Methods

This cross-sectional study was carried out in Yenagoa Local Government Area, Bayelsa State. It has an area of 706km² and a 2022 population projection of 524,400 (from the 2006 census).¹⁸ The study was conducted from March to May 2024 among secondary school adolescents from 10 private and 10 public secondary schools selected by multi-stage random sampling.

The sample size was obtained using the Cochrane formula for cross-sectional studies.¹⁹

$$n = (Z^2 pq)/d^2$$

Where: n = minimum sample size, z = Standard normal deviation at 95% confidence level of 1.96, p = prevalence of overweight/obesity = 25% (according to Ujuanbi and Mezie-Okoye²⁰), while q = (1-p).

The calculated sample size was 800 students. After adjusting for non-response of 10 %, a sample size of 888 was obtained, and the sample size was rounded up to 890 students.

Adolescents who gave assent for inclusion in the study and whose parents gave informed consent were recruited for the study. Those receiving medications that could cause weight gain (such as steroids) or drugs that interfere with sleep, such as anticonvulsants, as well as those with genetic

causes of obesity (such as Down syndrome and hypothyroidism), were excluded from the study.

A semi-structured questionnaire was used for data collection. The questionnaire was divided into sections: (1) biodata; (2) socio-economic status of parents/caregivers; (3) risk factors for obesity such as sedentary lifestyle, physical inactivity, high-calorie diet, etc.; (4) sleep quality assessment using the Pittsburgh Sleep Quality Index (PSQI); and (5) anthropometry - weight, height, body mass index. The socioeconomic status of parents/caregivers was derived using the revised scoring scheme by Ibadin and Akpede.²¹ The PSQI is a self-rated standardised questionnaire used widely to assess sleep quality of an individual in the preceding one month.²² It has 19 questions grouped into seven component scores, each exploring different sleep features. Each sleep feature is scored 0-3 points, with 0 for no difficulty and 3 for severe difficulty. The global PSQI score is obtained by summing up all seven component scores and ranges from 0 to 21 points. A global score of >5 suggests poor sleep quality, while a global score of ≤ 5 suggests good sleep quality.

Weight measurement was done thrice (the average recorded as the student's weight) using the Omron® HN289 digital weighing scale (produced by Omron Healthcare, Japan), without heavy clothing, shoe/ bags and to the nearest 0.1kg. The weighing scale was calibrated every morning using an item of a known weight to minimise errors. The height was measured to the nearest 0.1cm using a portable wall stadiometer, Anthroflex® Stadiometer model #401 (made in China). Without shoes, caps or scarves, the subjects stood with both feet together on the floor, with their backs resting on the wall and their heels touching the wall. Their heads were positioned in the Frankfurt plane, which is an imaginary line passing through the lower margin of the bony orbit and the most forward point in the supratragal

notch (also referred to as the upper margin of the external auditory meatus). The headpiece was then lowered on the student's head, and the measurement was read off. The heights were recorded thrice and the average taken.

The questionnaires were pre-tested in two schools (1 private and 1 public), randomly selected from another LGA before the main study to ascertain feasibility of the study among 90 students. During the pretest sessions, the questionnaires were administered, and all necessary corrections were made to ensure that the questionnaires would meet the objectives of the study.

Data analysis

This was done using IBM Statistical Product and Service Solutions, formerly known as Statistical Package for the Social Sciences (SPSS) version 25. The Body Mass Index (BMI) for each subject was calculated using the formula, weight (kg)/height² (m) and compared to the WHO BMI chart for boys and girls, respectively.²³ The z-scores were generated using the WHO Anthroplus software, and these were used to categorise the students into obese, overweight, normal weight or underweight. Those above 1 z-score but not more than 2 z-scores were categorised as overweight, those above 2 z-scores as obese, those less than -2 z-scores as underweight and those between -2 and +1 z-score as normal BMI.

The Chi-Square test (χ^2) (or Fisher Exact test where applicable) was used to determine association between categorical variables such as sleep quality and overweight/obesity, etc. The Student's t-test was used to compare the means of continuous variables such as sleep duration, sleep efficiency and bedtimes/waketimes among those who were overweight/obese and those who were not.

Ethical considerations

Ethical approval was obtained from the State Ministry of Education and the Ethics Research

Committee of the Federal Medical Centre, Yenagoa. Permission was obtained from the school heads, while the principles of confidentiality and justice were upheld throughout the study.

Results

A total of 890 questionnaires were administered, of which 877 were returned filled, yielding a response rate of 98.5%. The subjects were categorised into early adolescents (10-12 years), middle adolescents (13-15 years) and late adolescents (16-19 years), with 442 (50.4%) of

the subjects being middle adolescents. About one-third of both parents (328 [37.4%] of fathers and 290 [33.1%] of mothers) were educated up to the university level. Four hundred and ninety-nine (56.9%) of the mothers and 345 (39.3%) of the fathers were clerical officers/retail traders. There were 134 adolescents whose BMI was above 1 z-score for age and sex and were categorised as overweight/obesity while 743 had normal weight/underweight with a z-score of +1 score or less and were categorised as not overweight.

Table Ia: Association of multiple dimensions of sleep with overweight/obesity Status

Characteristics	Overweight status			Chi-square test χ^2 (p-value)
	Total n = 877 (%)	Overweight/obese n = 134 (%)	Not Overweight/obese n = 743 (%)	
Self-reported sleep quality				
Very good	331 (37.7)	40 (29.9)	291 (39.2)	10.34 ^a (0.016)
Fairly good	416 (47.4)	80 (59.7)	336 (45.2)	
Fairly bad	98 (11.2)	12 (9.0)	86 (11.6)	
Very bad	32 (3.6)	2 (1.5)	30 (4.0)	
Sleep latency				
0 = <15 minutes	339 (38.7)	63 (47.0)	276 (37.1)	5.21 ^a (0.157)
1 – 2= 16-30 minutes	367 (41.8)	46 (34.3)	321 (43.2)	
3 – 4= 31-60 minutes	148 (16.9)	21 (15.7)	127 (17.1)	
5 – 6 = >60 minutes	23 (2.6)	4 (3.0)	19 (2.6)	
Sleep duration				
> 7 hours	486 (55.4)	61 (45.5)	425 (57.2)	9.02 (0.028)
6 – 7 hours	217 (24.7)	39 (29.1)	178 (24.0)	
5 – 6 hours	125 (14.3)	21 (15.7)	104 (14.0)	
< 5 hours	49 (5.6)	13 (9.7)	36 (4.8)	

^a Fisher's Exact Test

Association of multiple dimensions of sleep with overweight/obesity

Table I shows that 40 (29.9%) of the overweight/obese category had a significantly lower prevalence of very good sleep quality than 291 (39.2%) adolescents who were not

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overweight/obese. Also, fairly good sleep was recorded in 80 (59.7%) overweight/obese students compared to 336 (45.2%) of non-overweight subjects, and this difference was statistically significant ($p = 0.016$). Additionally, sleep duration of 7 hours or less was noted to be significantly higher in overweight/obese

adolescents than in those not overweight/obese, with statistical significance ($p = 0.028$). There was no statistically significant association between other dimensions of sleep (such as sleep latency, sleep efficiency, sleep disturbance, use of sleep medication, daytime dysfunction) and overweight/obesity.

Table Ib: Association of multiple dimensions of sleep with overweight/obesity status

Characteristics	Overweight status			Chi-square test χ^2 (p-value)
	Total	Overweight/obese	Not Overweight/obese	
	n = 877 (%)	n = 134 (%)	n = 743 (%)	
Sleep Efficiency				
> 85%	885 (97.5)	131 (97.8)	724 (97.4)	1.09 ^a (0.580)
75 – 84%	19 (2.2)	2 (1.5)	17 (2.3)	
65 – 74%	3 (0.3)	1 (0.7)	2 (0.3)	
Sleep Disturbance				
0 =0	41 (4.7)	2 (1.5)	39 (5.2)	3.98 ^a (0.264)
1 – 9= 1	587 (66.9)	93 (69.4)	494 (66.5)	
10 – 18 =2	247 (28.2)	39 (29.1)	208 (28.0)	
19 – 27= 3	2 (0.2)	0 (0.0)	2 (0.3)	
Use of sleep medication				
None during past month	788 (89.9)	124 (92.5)	664 (89.4)	3.32 ^a (0.346)
Less than once a week	52 (5.9)	8 (6.0)	44 (5.9)	
Once or twice a week	25 (2.9)	2 (1.5)	23 (3.1)	
Three or more times a week	12 (1.4)	0 (0.0)	12 (1.6)	
Daytime dysfunction				
None during past month	548 (62.5)	74 (55.2)	474 (63.8)	4.17 (0.243)
Less than once a week	167 (19.0)	28 (20.9)	139 (18.7)	
Once or twice a week	109 (12.4)	22 (16.4)	87 (11.7)	
Three or more times a week	53 (6.0)	10 (7.5)	43 (5.8)	

^a Fisher's Exact Test

Association between other dimensions of sleep and overweight/obesity

The mean sleep duration, as shown in Table II, was significantly lower (7.0 ± 1.4) in the overweight/obese adolescents when compared

with the non-overweight/obese category (7.5 ± 1.5) ($p = 0.001$). Similarly, a later bedtime was observed in the overweight category than in the non-overweight/obese adolescents (22.25 ± 1.35 o'clock and 21.55 ± 1.25 o'clock, respectively), and this was statistically significant ($p = 0.005$).

Additionally, the overweight/obese adolescents woke up earlier (5.45 ± 0.50 o'clock) than their non-overweight/obese counterparts (6.00 ± 0.44 o'clock), and this was also statistically significant ($p = 0.044$), as depicted in Table II.

Table II: Association between Other Sleep Dimensions and Nutritional Status of Adolescents

Characteristics	Nutritional Status			Student's t-test (p-value)
	Total	Overweight/O besity	Not Overweight/obese	
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	
Number of sleep hours	7.40 ± 1.49	7.0 ± 1.4	7.5 ± 1.5	3.53 (0.001)
Bedtime in hours(o'clock)	22.00 ± 1.25	22.25 ± 1.35	21.55 ± 1.25	2.79 (0.005)
Sleep latency in minutes	14.9 ± 16.8	14.7 ± 16.7	14.9 ± 16.9	0.11 (0.916)
Wake up Time in hours	6.00 ± 0.45	5.45 ± 0.50	6.00 ± 0.44	2.01 (0.044)
Sleep efficiency (%)	97.0 ± 12.8	96.5 ± 4.9	97.1 ± 13.7	0.53 (0.599)

Association between overall sleep quality and overweight/obesity in general and according to sex

Table III shows that the prevalence of poor sleep quality among the overweight/obese adolescents was 45.5%. There was no statistically significant association between overall sleep quality (using the global PSQI scores) and overweight/obesity among the adolescents studied in general, among both genders, and among the different age categories ($p = 0.380, 0.447, 0.172, 0.511, 0.159$ and 0.072 , respectively).

Discussion

This study observed a significant association between a shorter sleep duration and overweight/obesity consistent with the findings of Cao *et al.*²⁴ in China, Anam *et al.*²⁵ in Bangladesh, and Ramirez-Contraeras *et al.*²⁶ in Barcelona, Spain. Conversely, a study by Firouzi *et al.*¹³ in Malaysia found no significant association between sleep duration and

overweight/obesity. This contrasting finding may have been due to the lower age group of 6-12-year-olds involved in the study of Firouzi *et al.*¹³, as younger children have a greater tendency to sleep more, as well as no consideration for sleep latency in the report of sleep duration, unlike what was obtainable in this study. Also, of note, the Malaysian study assessed the children's sleep from parental report in contrast to the use of self-report of sleep by the adolescents in the present study.

With respect to sleep timing, late bedtime and early wake time were significantly more common among the overweight/obese in this study. Firouzi *et al.*¹³ and Skjåkødegård *et al.*²⁷ reported that BMI positively correlated with bedtime. Also, Morrissey *et al.*¹³ reported that those who sleep late were more likely to be obese than those who go to bed early. Since late bedtime could be a driver of short sleep duration, the significant association between both sleep timing and sleep duration and obesity in this study and previous

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studies ^{5,10,28} appear to support that both relationships are in tandem with each other. Therefore, attention should also be paid to early

bedtime in order to contribute to a longer sleep duration.

Table III: Association between overall sleep quality (using the global PSQI scores) and presence of overweight/obesity according to sex

Sleep Quality	Overweight status			Chi-Square
				Test χ^2
	Total	Overweight/obese	Not Overweight/not-obese	(p-value)
	n = 877 (%)	n = 134 (%)	n = 743 (%)	
Total				
Good Quality	508 (57.9)	73 (54.5)	435 (58.5)	0.77 (0.380)
Poor Quality	369 (42.1)	61 (45.5)	308 (41.5)	
Male				
Good Quality	218 (61.1)	26 (66.7)	192 (60.4)	0.58 (0.447)
Poor Quality	139 (38.9)	13 (33.3)	126 (39.6)	
Female				
Good Quality	290 (55.8)	47 (49.5)	243 (57.2)	1.87 (0.172)
Poor Quality	230 (44.2)	48 (50.5)	182 (42.8)	
Early Adolescents				
Good Quality	149 (64.8)	37 (68.5)	112 (63.6)	0.43 (0.511)
Poor Quality	81 (35.2)	17 (31.5)	64 (36.4)	
Middle Adolescents				
Good Quality	254 (57.5)	30 (49.2)	224 (58.8)	1.99 (0.159)
Poor Quality	188 (42.5)	31 (50.8)	157 (41.2)	
Late Adolescents				
Good Quality	105 (51.2)	6 (31.6)	99 (53.2)	3.23 (0.072)
Poor Quality	100 (48.8)	13 (68.4)	87 (46.8)	

With findings similar to previous studies by Chen *et al.* ²⁹ in China and Anam *et al.* ²⁵ in Bangladesh, this study found no significant association between sleep quality and overweight/obesity. However, Morrissey *et al.* ⁵ and Firouzi *et al.* ¹³ in Australia and Malaysia, respectively, reported that poor sleep was associated with overweight/obesity. These findings may be attributed to the differences in sleep assessment tools used. While this study assessed sleep over the preceding four weeks using the well-validated

PSQI, Morrissey *et al.* ⁵ assessed sleep using a self-developed tool that evaluated sleep in the preceding two weeks, and Firouzi *et al.* ¹³ used a parental report that assessed sleep in the preceding one week, both of which may not have been long enough in duration to assess sleep quality, considering that acute events that could disturb sleep may occur over a short period of time. It has been postulated that sleep quality estimates may be an indirect marker of restorative slow wave sleep (N3) dominated by increased

parasympathetic activity and reduced sympathetic activity/ glucose use, which, when not sufficiently obtained during sleep, may predispose to obesity.¹⁴ This calls for more studies on this subject that will employ objective measurement of sleep.

Also, this study found no significant gender variation in the association between sleep quality and overweight/obesity, contrary to the significant association between sleep quality and overweight/obesity in girls documented by Chen *et al.*²⁹ They attributed the tendency for boys to be less affected to protective factors against obesity such as increased muscle mass, reduced fat mass and increased basal metabolic rate in boys. Sluggett *et al.*³⁰ and Cao *et al.*²⁴ have also reported conflicting gender variation in the association between sleep duration and overweight/obesity. More studies may be needed to explore the causal relationship between sleep quality and overweight/obesity with respect to gender.

This study found no significant association between other dimensions of sleep and overweight/obesity, in contrast to Ramirez-Contreras *et al.*²⁶ and Morrissey *et al.*⁵, who reported an association between sleep efficiency and overweight/obesity. Their studies, however, found a higher prevalence of poor sleep efficiency, which might have been due to the use of different tools other than the PSQI for assessing sleep efficiency, as well as the higher prevalence of obesity in both studies when compared to the present study.

Limitations

The limitation of this study is its cross-sectional design as well as the subjective assessment of sleep. Also, the effects of other sleep confounders such as stress (physical, psychological), exercise) were not considered in this study. A longitudinal study on the association between sleep quality

and overweight/obesity, as well as the association between sleep quality and overweight/obesity using objective assessment of sleep such as actigraphy among adolescents is recommended.

Conclusion

This study reports that shortened sleep duration, late bedtime and early wake time were significantly associated with overweight/obesity among secondary school adolescents. There was no significant association between overall sleep quality and overweight/obesity among the adolescents in the present study. It is imperative that stakeholders advocate for and make policies on the need to improve sleep quality in all its dimensions. This understanding of poor sleep as a likely-to-be overlooked modulator of obesity will provide an opportunity to intervene early and mitigate or slow down progression of weight gain among adolescents by improving sleep health.

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