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ORIGINAL RESEARCH

Insufficient Sleep Duration And Its Association With Breakfast Intake, Overweight/Obesity, Socio-Demographics And Selected Lifestyle Behaviors Among Saudi School Children

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Objective: Adequate sleep is an important factor for maintaining good health among children. However, there have been few studies reporting on the association of sleep duration with breakfast intake frequency. This study examined the prevalence of nocturnal sleep duration among Saudi children and its association with breakfast intake, screen time, physical activity levels and socio-demographic variables.
Methods: A multistage stratified cluster random sampling technique was used to select 1051 elementary school children in Riyadh. Weight and height were measured and body mass index was computed. The sleep duration, daily breakfast intake frequency, socio-demographic and lifestyle behaviors were assessed using a specifically designed self-reported questionnaire filled by the children's parents.
Results: Over 71% of the Saudi school children did not attain the recommended sufficient sleep duration at night. Results of logistic regression analysis, adjusted for confounders, exhibited significant associations between longer sleep duration and younger age (aOR=1.12, p=0.046), being female (aOR=1.39, p=0.037), higher father educational levels, daily breakfast intake (aOR=1.44, p=0.049) and lower screen time (aOR for >2 hrs/day=0.69, p=0.033). However, no significant (p> 0.05) association was found for mother education, family income, number of family member in the house, overweight/obesity, or physical activity levels.
Conclusion: The prevalence of insufficient nocturnal sleep among Saudi children was high. Insufficient sleep was associated with breakfast and several important socio-demographic and lifestyle behaviors. The findings of this study support the development of interventions to prevent insufficient sleep and help Saudi children improve their sleeping habits.
Keywords: children, skipping breakfast, lifestyles, Saudi Arabia, socio-demographics

Introduction

It is well recognized that adequate sleep duration is an important factor to consider for maintaining good health and well-being among children and adolescents.[1] On the other hand, inadequate sleep can have negative impacts on emotional and cognitive function, metabolic risk and increased sports injuries in adolescent athletes.[2–5] The American Academy of Sleep Medicine has recommended a sleep duration of at least 9 hrs for children 6–12 years of age and those who sleep fewer than the recommended amount of sleep were considered as having insufficient sleep duration.[6] In addition, recent reviews and meta-analyses have shown that short sleep duration in children

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was significantly associated with an increased risk of obesity.[2,7–9] By contrast, sufficient sleep appears potentially crucial for combating obesity among children. The epidemiologic as well as laboratory studies in adults and children indicate that sleep curtailment may increase the risk of obesity as a result of metabolic and endocrine changes, including lower insulin sensitivity, decreased glucose tolerance, increased evening cortisol concentrations, increased levels of ghrelin and decreased levels of leptin, thus resulting in increased hunger and appetite.[10]

Despite the importance of adequate sleep for physical and mental health of young people, insufficient sleep is quite prevalent among children and adolescents.[6,11–13] It is believed that the lifestyle habits and urban environment in modern society have greatly changed over the past decades, which may have impacted upon current sleep and dietary patterns and possibly health outcomes.[14] Numerous studies identified several risk factors that associate with sleep insufficiency, including gender, older age, higher body mass index and waist circumference and unhealthy lifestyle habits such as physical inactivity, high screen viewing and dietary choices.[1,15–20] However, not many studies have examined the association of sleep duration with skipping breakfast among children and adolescents.[19,21,22] One study showed that after controlling for age, sex and socioeconomic status, sleep timing and quality had influenced the dietary choices of a large number of Australian school children and adolescents, as those who missed breakfast reported significantly poorer sleep.[21] Among a large sample of Greek children and adolescents aged 8–17 year-olds, insufficient sleep duration was associated with unhealthy dietary habits including skipping breakfast.[19] Furthermore, findings from the 2011 to 2012 Australian National Nutrition and Physical Activity Survey indicated that inadequate sleep among children and adolescents was associated with skipping breakfast.[22]

In recent decades, the Kingdom of Saudi Arabia has experienced enormous economic development and modernization with rapid demographic transformation and extensive urbanization, which have resulted in some undesirable changes in the people's lifestyle behaviors.[23,24] Indeed, it is quite common now than ever before to have Saudi people frequently eating meals outside the home or family setting and having irregular eating patterns, including breakfast skipping and late-night snacking.[25,26] Such changes in urban environment and lifestyle behaviors over the past decades have vastly impacted sleep duration and quality, especially among children and adolescents.[11,15,27–29] In a recent research involving Saudi adolescents from three major cities in the country, it was demonstrated that short sleep duration was significantly associated with increased risk of overweight and obesity,[11] and that several lifestyle factors appeared to influence sleep duration.[15] Further, total sleep time among Saudi school children from Riyadh was reported to be affected by regularity of bedtime, day time nap, mother's level of education, and time spent in television (TV) viewing and computer games use.[27] Also, a cross-sectional survey conducted on a sample of Saudi adolescents attending high schools from Jeddah showed a high percentage of poor sleep quality.[28] In addition, among Saudi adolescents aged 10–19 years who were attending schools across the country, insufficient sleep (<7 hr/day) was reported by 46% on weekdays and 33% on weekends.[29]

Understanding the important determinants of insufficient sleep helps in identifying children at high risk of sleep-related disorders and may enhance our ability to design and implement effective interventions for preventing short sleeping habits in children. Therefore, the objectives of the present study were to provide an update on the prevalence of insufficient sleep duration among Saudi primary school children and to examine the association of insufficient sleep with breakfast intake, overweight/ obesity status, socio-demographic and selected lifestyle factors.

Methods

Participants And Sampling Technique

This is a cross-sectional study conducted in Riyadh city during the spring of year 2017. Riyadh is a cosmopolitan city with over 6 million inhabitants from almost all parts of the country. All Saudi children (boys and girls) enrolled in elementary schools (grades 1 to 6) during the study period were eligible for inclusion in the study, except if they have a medical condition that is not consistent with normal eating habits such as eating disorders. All normal children at school age are usually enrolled in Saudi primary schools. A representative random sample was selected from schools using a multistage stratified cluster random sampling technique. Stratification was based on boys' and girls' schools as well as on geographical areas. The sample was drawn from both public and private elementary schools, based on four geographical areas of Riyadh (east, west, north and south). Within each area, two private and four public schools were randomly selected. Then, within each school, a class was randomly chosen from each grade of the 6 grades. A total of 72 classes from grades 1 to 6 in boys and girls schools (36 classes from each group) were selected. All students in the selected classes were then invited to participate in the research. The sample size was calculated while assuming a population proportion that yields the maximum possible sample size required (P = 0.50), with a confidence level of 95% and a margin of error of 5%. Additional 20% of participants were added to account for the clustered design effect, non-responders and missing data. The minimum total sample size for each gender was calculated to be 460 students, or 920 boys and girls.

Ethical approval was obtained from the Institutional Review Board (IRB) at King Saud University (17/0064/IRB). The research procedures were conducted in according to the principles expressed in the Declaration of Helsinki. The participants (and their parents) were informed that they could quit at any time if they felt not comfortable taking part in the study or are not willing to answer the questions. Written informed consents secured from all parents. Also, approval for conducting this research in schools was attained from the directorate of schools at the Ministry of Education and the principals of the selected schools.

Body weight was measured to the nearest 100 g using calibrated portable medical scales (Seca, Germany). All measurements conducted with minimal clothing and without shoes. Height was measured to the nearest centimeter using a calibrated measuring rod, while the subject was in a full standing position without shoes. Body mass index (BMI) was calculated as the ratio of weight in kilograms divided by the squared height in meters. The International Obesity Task Force (IOTF) age- and sex-specific BMI cutoff reference standards were used to classify normal weight and overweight or obesity relative to the child's age and sex.[30]

Assessment Of Sleep Duration

Sleep duration during each of weekdays (school days) and weekends were also assessed by the questionnaire. Parents were asked on how many hours their children sleep at night during school and weekend nights. We defined insufficient sleep (short sleepers) as sleeping less than 9 hrs per night, according to the definition of the National Sleep Foundation for school-age children 6–13 years.[6]

Assessment Of Breakfast Eating Habits

The breakfast eating habits and food choices were assessed using a specifically designed self-reported questionnaire that was filled by the children's parents. Breakfast is the food (like sandwich) the child eat to break his/her fast at home or in his/her way to school. Parent was asked to answer the questionnaire based on the child's usual breakfast habit. The questionnaire also included information on demographic and socioeconomic status.

Assessment Of Screen Time And Physical Activity

Questions on screen time viewing and physical activity were part of the research questionnaire. They intended to obtain important information from the parents about the typical daily time of the child spent on screen time, including time spent in viewing TV, playing video games, and computer and Internet recreational use. Parents provided the average number of daily hours during each of weekdays and weekends that were spent on screen time. For the sedentary time cut-off hours, we used the American Academy of Pediatrics guidelines of a maximum of 2 hrs per day.[31] Physical activity questions included items assessing the total daily time spent by the child on all types of physical activity including sports, in which his/her breathing was increased considerably. The sufficient physical activity level was based on 60 mins or more of daily physical activity.[32]

Data And Statistical Analysis

Data were entered into an SPSS data file, checked, cleaned and analyzed using IBM-SPSS program, version 22 (Chicago, IL, USA). Descriptive statistics were obtained for all variables and reported as means and standard deviations or percentage. Differences between boys and girls in anthropometric measurements and between sufficient and insufficient sleep duration were tested using *t*-tests for independent samples. Chi-Square tests of proportions were used to test differences in socio-demographic factors between children with and without sufficient sleep duration. Finally, we used logistic regression analysis with adjusted odds ratio (aOR), while controlling for confounders such as body weight, age and gender, to examine differences in selected variables between sufficient and insufficient sleepers. Alpha level was set at 0.05 and *p*-value less than alpha level was considered significant.

Results

The final sample size was 1051 children (523 boys and 528 girls). The response rate by parents was 95.4%. Questionnaires were completed by more mothers in girls' schools (59.5%) while more fathers (53.1%) answered the questionnaires in boys' schools. Two third of students in this sample came from public schools with no significant (p = 0.268) difference between the proportions of students from public or private schools relative to gender. The proportion of children in private schools closely resembles the proportion of students in private elementary schools in the city of Riyadh. As shown in Table 1, the mean age was 9.2 years, ranging from 5.9 to 13.4 years, with no significant differences between boys and girls. However, there were significant differences ($p < 0.001$) between boys and girls in body weight and BMI but not in height. Average sleep duration (SD) was 8.14 (1.2) hours per night with significant (p = 0.035) difference relative to sex. Compared with boys, girls showed significantly (p = 0.029) higher sleep duration during weekends but not on weekdays. Breakfast intake (SD) averaged 3.51 (2.3) days per week with no significant difference between boys and girls, while the mean (SD) of screen viewing time was 3.23 (1.7) hours per day, with boys showing significantly ($p < 0.001$) higher screen viewing time than girls.

Table 2 exhibits the participants' characteristics relative to insufficient or sufficient sleep duration. Over 71% of the Saudi school children did not attain the recommended sufficient sleep duration at night. There were significant (p values ranged from <0.001 to 0.026) differences between insufficient and sufficient sleepers relative to age, body weight, height, BMI, average sleep duration and average breakfast intake. However, no significant difference was observed in average screen time, number of family members living in the home, or number of family members below 18 years.

Results of socio-demographics and lifestyle habits of Saudi children relative to insufficient or sufficient sleep duration are presented in Table 3. The proportion of girls having sufficient sleep duration was significantly (p = 0.002) higher than that of boys. There was a significant (p = 0.007) trend toward lower sleep duration with advancing age. The proportion of children in private schools having longer sleep duration was significantly (p = 0.036) higher than that in public schools. Moreover, the younger the mother age, the higher the educational levels of the mother or the father, the higher the proportion of children with sufficient sleep duration. Also, the lower the number of obese children in the family, the higher the proportion of sufficient sleep among children. In addition, daily breakfast intake and lower screen tome (<2 hrs per day), but not physical activity levels appear to significantly associate with higher proportion of sufficient sleep.

Results of logistic regression analysis, adjusted for body weight, age, and gender, for selected variables relative to insufficient or sufficient sleep duration among Saudi children are shown in Table 4. Several socio-demographic and lifestyle factors exhibited significant associations with longer sleep duration. These include younger age (aOR = 1.12, p = 0.046), being female (aOR = 1.39, p = 0.037), higher father educational levels, daily breakfast intake (aOR = 1.44, p = 0.049) and lower screen time (aOR for ≥2 hrs/day = 0.69, p = 0.033). On the other hand, no significant ($p > 0.05$) association was found for the following variables: family income, mother education,

Table 1 Characteristics Of The Participating Children

Variable	All (N = 1051)	Boys (N = 523)	Girls (N = 528)	*p*-Value[a]
Age (years)	9.2 ± 1.7	9.3 ± 1.7	9.2 ± 1.7	0.165
Body weight (kg)	35.8 ± 18.9	38.6 ± 23.2	33.2 ± 12.9	**<0.001**
Body height (cm)	133.4 ± 12.1	133.6 ± 11.7	133.1 ± 12.5	0.517
Body mass index (BMI)	19.4 ± 7.6	20.8 ± 9.6	18.2 ± 4.4	**<0.001**
Average sleep duration (hr/night)	8.14 ± 1.2	8.06 ± 1.2	8.22 ± 1.3	**0.035**
Sleep duration in weekdays	7.85 ± 1.4	7.77 ± 1.4	7.93 ± 1.5	0.074
Sleep duration in weekend days	8.86 ± 1.4	8.76 ± 1.4	8.95 ± 1.4	**0.029**
Average breakfast intake (day/week)	3.51 ± 2.3	3.44 ± 2.3	3.58 ± 2.3	0.350
Average screen time (hr/day)	3.23 ± 1.7	3.46 ± 1.8	3.00 ± 1.7	**<0.001**

Notes: Data are means and standard deviations. [a]*T*-test for independent samples (for the differences between boys and girls). Bold values indicate significance.

Table 2 Participants' Description Relative To Insufficient Or Sufficient Sleep Duration

Variable	Sleep Duration		*p*-Value[a]
	Insufficient N = 734 (71.1%)	**Sufficient N = 299 (28.9%)**	
Age (years)	9.4 ± 1.7	9.0 ± 1.7	**0.001**
Body weight (kg)	36.8 ± 19.3	33.4 ± 17.3	**0.009**
Body height (cm)	134.1 ± 12.0	131.6 ± 12.2	**0.003**
Body mass index (BMI)	19.7 ± 7.7	18.6 ± 7.1	**0.026**
Average sleep duration (hr/night)	7.56 ± 0.94	9.57 ± 0.54	**<0.001**
Average breakfast intake (day/week)	3.40 ± 2.3	3.76 ± 2.4	**0.025**
Average screen time (hr/day)	3.28 ± 1.7	3.07 ± 1.7	0.078
No. of family members living in the home	6.4 ± 1.9	6.5 ± 2.4	0.917
No. of family members below 18 years	3.3 ± 1.4	3.4 ± 1.5	0.270

Notes: Data are means and standard deviations. Sufficient sleep was based on 9 hrs or more per night. [a]*T*-test for independent samples. Bold values indicate significance.

number of family member in the house, number of obese children in the family, overweight or obesity or physical activity levels.

Discussion

The present study provides an update on the prevalence of insufficient sleep among Saudi children. The first study that examined sleep prevalence among Saud children was published 14 years ago.[27] The main findings of the current study showed that over 71% of the Saudi school children did not attain the recommended sleep duration (at least 9 hrs per night) at night.[6] Moreover, sufficient sleep duration was associated with being a female, higher father educational levels, daily breakfast intake and lower screen viewing time. Over the 14 years period between the findings of the first sleep study conducted on Saudi children,[27] and the current research findings, a reduction in nocturnal sleep duration of nearly 16 mins was apparent (from 8.4 to 8.14 hrs per night). Also, consistent with the previous local study,[27] sleep duration in the current research decreased with advancing age of the child, increased among girls compared with boys and that longer sleep duration associated with higher educational levels of the father. A recent national study conducted on a large group of Saudi adolescents indicated that factors associated with sleep deprivation included older age, female gender, lower perceived socioeconomic status and those reporting eating less than three main meals per day.[29] Also, another published local study found older age and being a male were risk factors for reduced sleep duration among Saudi adolescents.[15] Elsewhere, a cross-sectional study involving school children and adolescents from Ecuador showed that more younger aged- than older-aged students met sleep duration recommendations.[33] Age was also shown to be a determinant of sleep duration among German children and adolescents.[34] Our findings revealed that children attending private schools were showing a higher sleep duration than those in public schools. This may be largely due to the fact that students in private schools come from families with higher socioeconomic background.

Insufficient sleep duration appears quite common among school children but not as high as in the present study's findings. A previously published national study found that almost one-half of all adolescents in Saudi Arabia suffered from sleep deprivation during weekdays, and that sleep deprivation was higher on weekdays compared with weekends.[29] Elsewhere, the overall prevalence of short sleep duration among American middle school students (grades 6 and 7) in nine states was 57.8%.[35] In addition, insufficient sleep was reported among 42.1% of Greek children.[19] Our findings showed that sleep duration among the school children is lower during weekdays compared with weekend. It is worth mentioning that Saudi schools starts quite early in the morning (07:00 am) and this may partially explain the short sleep duration during the weekdays. Thus, early schooling time may negatively influence total sleep time among school children by making the child to wake-up early in the morning. A recent review indicated that delaying school start time increases weeknight sleep duration among adolescents, mainly by delaying rise times.[36]

Our findings showed that mean BMI value among sufficient sleepers was lower than that of insufficient sleepers, however, when confounders were adjusted in the logistic model, such association was no longer significant. Numerous recent studies including meta-analyses reviews, however, have observed adverse associations between insufficient sleep and obesity.[7–9,19,34] Also, among young adolescents from Italy, insufficient sleep duration and poor sleep were associated with an increase in BMI and fat mass.[37] In comparison, findings from the Australian National Children's

Table 3 Cross-Tabulation Of Socio-Demographics And Lifestyle Habits Among Saudi Children Relative To Insufficient Or Sufficient Sleep Duration (%)

Variable	Sleep Duration		*p*-Value[a]
	Insufficient (N = 734)	**Sufficient (N = 299)**	
Gender			**0.002**
Male	75.5	24.5	
Female	66.7	33.3	
Child's age (years)			**0.007**
6–7	62.5	37.5	
8–9	69.2	30.8	
10–11	76.1	23.9	
12–13	74.8	25.2	
School type			**0.036**
Public	73.1	26.9	
Private	66.8	33.2	
Father's age (years)			0.119
<30	66.7	33.3	
30–39	66.1	33.9	
40–49	71.7	28.3	
50–59	72.6	27.4	
60+	85.7	14.3	
Mother's age (years)			**0.023**
<30	64.8	35.2	
30–39	68.3	31.7	
40–49	74.7	25.3	
50–59	84.8	15.2	
60+	100.0	00.0	
Father's education			**<0.001**
<High school	84.2	15.8	
High school	73.2	26.8	
University degree	69.4	30.6	
Post-graduate degree	59.1	40.9	
Mother's education			**0.008**
<High school	79.8	20.2	
High school	72.3	27.7	
University degree	67.8	32.2	
Post-graduate degree	58.8	41.2	
Family income (SR)[b]			0.377
Low (<10,000)	73.2	26.8	
Medium (10,000–20,000)	70.7	29.3	
High (>20,000)	67.5	32.5	
No. of obese children in the family			**0.034**
None	68.7	31.3	
1–2	74.6	25.4	
3+	82.1	17.9	
Overweight/obesity			0.238
Non-overweight/ non-obese	69.4	30.6	
Overweight/obesity	72.9	27.1	
Breakfast intake			**0.001**
Non-daily	73.2	26.8	
Daily	60.4	39.6	
Screen time			**0.005**
<2 hrs/day	64.5	35.5	
≥2 hrs/day	73.4	26.6	
Physical activity level			0.941
Low (<30 min/day)	71.2	28.8	
Medium (30–59 min/day)	71.7	28.3	
High (>60 min/day)	69.7	30.3	

(*Continued*)

Table 3 (Continued).

Notes: [a]Chi-Square tests of proportions. [b]SR = Saudi Riyal = 3.75 US$. Bold values indicate significance.

Nutrition and Physical Activity Survey showed that late bedtimes and late wake up times among children and adolescents aged 9–16 years were associated with higher BMI z-score and poorer diet quality, independent of sleep duration.[38] The wide range of associations between short sleep duration and obesity reported by previous studies may reflect differences in cutoff scores of insufficient sleep duration, definition and classification of overweight and obesity, regional prevalence of obesity, geographical location or confounders. Indeed, findings from the Identification and prevention of Dietary- and lifestyle-induced health EFfects In Children and infantS (IDEFICS) study, revealed that sleep duration and overweight were associated, however, this association was no longer detected after adjustment for other behavioral factors and for parental education.[12]

Macronutrient composition can play a role in the association of sleep duration with obesity. In fact, one study assessed macronutrient intake and objectively measured sleep duration in adolescents and showed that shorter sleep duration was significantly associated with an average daily increase of calories consumed from fat, thus insufficient sleep duration may increase obesity risk by bringing small changes in eating patterns that cumulatively modify energy balance.[39] However, findings from a local study conducted on adolescent girls found that short sleep duration (<5 hrs/day) was associated with increased carbohydrates intakes when compared with those girls sleeping

Table 4 Results Of Logistic Regression Analysis, Adjusted For Age, Weight And Gender, For Selected Variables Relative To Sleep Duration Categories Among Saudi Children

Variable	Sleep Categories (<9 hrs Versus ≥ 9 hrs)[a]			
	aOR	(95% CI)	SE	*p*-Value
Body weight	1.00	0.990–1.02	0.007	0.651
Age (older age = ref)	1.00			
Younger age	1.12	1.00–1.24	0.055	**0.046**
Gender (boy = ref)	1.00			
Girl	1.39	1.02–1.88	0.156	**0.037**
Father education (<high school = ref)	1.00			
High school	1.80	1.14–2.83	0.231	**0.011**
College degree	2.01	1.22–3.32	0.257	**0.007**
Post-graduate degree	3.00	1.46–6.14	0.366	**0.003**
Mother education (<high school = ref)	1.00			
High school	1.42	0.62–3.21	0.418	0.405
College degree	1.44	0.65–3.18	0.404	0.365
Post-graduate degree	2.05	0.84–4.97	0.453	0.114
Family income (≥20,001= ref)	1.00			
10,000–20,000	1.01	0.66–1.54	0.217	0.975
≤ 10,000	0.87	0.55–1.39	0.239	0.571
No. of Family member in the house (≥10 = ref)	1.00			
6–9	1.64	0.88–3.05	0.317	0.120
2–5	1.67	0.93–3.01	0.301	0.089
No. of obese children in the family (none = ref)	1.00			
1–2	0.79	0.36–1.74	0.402	0.560
3+	0.49	0.23–1.05	0.386	0.066
Overweight/obesity (Overweight/obesity = ref)	1.00			
Non-overweight/non-obese	1.08	0.71–1.64	0.214	0.717
Breakfast intake (non-daily = ref)	1.00			
Daily	1.44	1.01–2.08	0.186	**0.049**
Screen time (<2 hrs/day = ref)	1.00			
≥2 hrs/day	0.69	0.50–0.97	0.168	**0.033**
Physical activity (high level = ref)	1.00			
Medium	0.92	0.48–1.76	0.333	0.789
Low	0.82	0.51–1.34	0.250	0.438

Note: [a]Insufficient sleep was used as a reference category.
Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; hrs, hours per night; ref, reference category; SE, standard error. Bold values indicate significance.

>7 hrs per day.[40] Moreover, recent research indicated that macronutrient intake, sleep duration and obesity can be influenced by circadian rhythms, as reduced carbohydrate intake, especially during morning and midday meals following the recommended night sleep duration, may protect children from being overweight in the future.[18]

The current study found a significant association between sleep duration and daily breakfast consumption. It appears that there are limited published data on the relationship of sleep duration and breakfast intake among children.[19,21,22] After controlling for age, sex and socio-economic status, sleep timing and quality were shown to influence the dietary choices of a large number of Australian school children and adolescents, as those who missed breakfast reported significantly poorer sleep.[21] In addition, among a large sample of Greek children and adolescents aged 8–17 year-olds, insufficient sleep duration was associated with unhealthy dietary habits including skipping breakfast.[19] Findings from the 2011 to 2012 Australian National Nutrition and Physical Activity Survey indicated that inadequate sleep among children and adolescents was associated with skipping breakfast.[22] In line with the current research, adequate sleep among Taiwani adolescents aged 13–18 years old was associated with eating a healthy diet, including having daily breakfast.[1] Additionally, among Japanese high school students, the proportion of adolescents who regularly consume breakfast was significantly higher among long sleepers.[41] More frequent intakes of breakfast were also reported to be significantly related to adequate sleep duration among Saudi adolescents.[15] The combination of insufficient sleep and skipping breakfast may have adverse effect on health. Recent findings showed that boys who skipped breakfast and had short night-time sleep and girls who skipped breakfast and had higher than 4 hrs per day of computer use and short night-time sleep duration were more likely to have poor health status.[42] Furthermore, skipping breakfast has been reported to associate with obesity among children and adolescents,[43] and with increased risk of type 2 diabetes mellitus.[44]

It appears that the plausible explanation behind the associations between insufficient sleep duration and breakfast skipping is that school children with short sleep duration were less expected to have time to eat breakfast at home before going to school, especially when Saudi schools start very early in the morning. It is also likely that having regular adequate sleep and daily breakfast may reflect more stable family structures, organized households and/or high parental supervision. It is also possible that higher time spent on screen viewing increase the chances of children going late to bed, thus reducing the total night sleep and impacting negatively upon breakfast intake. Sleep duration in the present study significantly associated with screen time. Furthermore, short sleep duration could also lead to overweight by increasing the time available to eat and drink during the night-time.[45,46]

Our present findings revealed that insufficient sleep duration was associated with increased screen time. Results of a local study on children from 6 to 13 years of age indicated that sleep time was affected by watching TV and playing computer games after 20:00 hrs.[27] Electronic devices with screen viewing are becoming handy and popular among today's children. Our findings appear consistent with many previous studies conducted elsewhere showing significant associations between higher screen time and short sleep duration. For instance, a research conducted on German children showed that having short sleep duration was associated with increased screen time compared with those children having long sleep duration.[34] Moreover, findings from a study involving Dutch children aged 4 to 13 years indicated that TV viewing time and computer use were both related to shorter sleep duration.[16] In addition, a systematic review examining 67 articles found that in 90% of the reviewed studies screen time is adversely associated with sleep outcomes, including insufficient sleep duration and delayed timing of sleep.[17]

The present findings did not show any significant association between insufficient sleep and physical activity levels. This could have been due to the fact that physical activity questions inserted in the study's questionnaire lacked construct validity. Previous local study, using a validated questionnaire, observed a positive association between low to medium physical activity levels and sleep duration among Saudi adolescent.[15] In addition, a cross-sectional study involving school children and adolescents from Ecuador revealed that sleep duration among young adolescents was positively associated with daily active commuting to school.[33] However, in agreement with our findings, a study conducted on Italian adolescents aged 11 to 14 years showed that sleep duration on weekdays and on weekend days did not associate with physical activity levels.[37] Also, there was no association between insufficient sleep and physical activity level among Greek children.[19]

In order to establish an association between physical activity and other behaviors like sleep, measurement of physical activity needs to be precise and objective. However, a multi-center, observational study involving children aged 10.5–12 years from Croatia, Slovenia and the US, had monitored sleep and physical activity using multi-sensor body monitor and the results showed no evidence for a link between short sleep and low levels of physical activity.[47] Furthermore, a recent study conducted on Australian children aged 8–11 years found no significant temporal or bidirectional relationship between objectively measured physical activity and sleep duration.[48] To complicate this issue, an earlier study using also an objective measurement (actigraphs) of both sleep and physical activity for 1 week among eight-year-old children, revealed bidirectional relationship between higher levels of physical activity and poorer sleep.[49] The above findings, however, challenge epidemiological findings revealing that more active young people were showing better sleep.[15,34,41,50–53]

The findings of this study have some strengths and limitations and should be interpreted accordingly. The strength of the present study includes the use of a large and representative sample of Saudi children from both the public and the private schools. On the other hand, among the limitations of the present study is the cross-sectional nature of the study. Therefore, the temporality of associations cannot be established from this type of research design. Also, the possible recall bias in the sleep duration questionnaire cannot be completely ruled out. However, self-reported information on sleep duration is a method that was frequently used in almost all major epidemiological research.[13,18,21,42,54] Further, we recognize that sleep duration per se may not always reflect sleep quality for individuals. In addition, the early start times for Saudi school children may place a constraint on sleep duration for some students and could have resulted in confounding the relationship between sleep duration and the selected behavioral variables. Finally, although Riyadh, where data were collected, is a cosmopolitan city having people from all parts of the country, the present findings may not be entirely generalized to other cities, especially to those towns in rural areas of the country.

Conclusions

The present study observed a high prevalence of insufficient nocturnal sleep among Saudi children 6 to 13 year olds. Moreover, insufficient sleep duration was significantly associated with advancing age of the child, being a male, lower father educational levels, non-daily breakfast intake and higher screen viewing time. After controlling for confounders, mother education, the number of children living at home, overweight or obesity status, and physical activity levels did not show any significant association with sleep duration. Further, the findings of the present study support the development of interventions to prevent insufficient sleep duration and help Saudi children improve their sleeping habits.

Data Sharing Statement

All data generated or analyzed during this study are included in this published article. Any additional data will be available from the corresponding author upon reasonable request.

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Author Contributions

Study concept and design: HMA and OAO; data collection: HMA, MHA and AMA; statistical analysis: HMA; findings interpretation: HMA, OAO, AMA and MHA; drafting the paper: HMA; critically revising the draft for important intellectual content: OAO, AMA and MHA. All authors critically read and gave final approval for the version to be published and agree to be accountable for all aspects of this work.

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Disclosure

The authors report no conflicts of interest in this work.

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