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The association between sleeping patterns, eating habits, obesity, and quality of life among Israeli adolescents

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Abstract: The aims of the study were to examine the association between self-reported sleep patterns, daytime sleep-related behaviors (DSRB), daytime sleepiness, depressed mood, eating habits, body mass index (BMI), and quality of life among Israeli adolescents. *Method:* Participants (844 adolescents; 457 females) completed several demographic and clinical (sleep–wake pattern, DSRB, eating habits, and quality of life) questionnaires. *Results and conclusion:* The average weekday and weekend sleep duration was 7.87 h; 17.8% of participants slept 7 h or less, and 12% slept an average of 9 h or more. Weekday and mean nighttime sleep duration was found to correlate with unhealthy eating habits, sleep behaviors, social and school performance, and quality of life measures (statistically significant). A linear association emerged between the percentage of students with BMI > 25 and weekday sleep duration only for females in 11–12th graders (after adjustment for gender and grade). BMI correlated with psychosocial and total quality of life (statistically significant). Future research should use objective tools to examine BMI categories and sleep duration.

Subjects: Behavioral Sciences; Health and Social Care; Physical Sciences

Keywords: sleep duration; eating behavior; quality of life; adolescent; gender

ABOUT THE AUTHOR

Orna Tzischinsky is an associate professor in Behavioral Science at the Emek Yezreel college. She is leading several research projects on the relationship between sleep disorders and eating disorders among patients with eating disorders, specifically patients suffering from night eating. In the last few years she has been studying sleeping patterns among children and adolescent, sleeping patterns with relation to media exposure, and the relation between sleeping and eating among healthy adolescents.

Orna Tzischinsky has published more than a hundred articles and book chapters in science journal and books. She has actively participated in many international and nation scientific conferences.

PUBLIC INTEREST STATEMENT

Short sleep duration in adolescents has been known to be associated with fatigue, lower academic performance, depressive mood, and behavior problems. The present study examined the association between self-reported sleep duration, daytime sleep related behaviors, daytime sleepiness, depressed mood, eating habits, body mass index (BMI), and quality of life among Israeli adolescents. 844 adolescents' participants completed several demographic and clinical questionnaires. The result describes normative age variations in sleep duration among adolescents in Israel. Average weekday and weekend sleep duration was 7.87 h; 17.8% of participants slept seven hours or less and 12% slept nine hours or more. Mean nighttime sleep duration during weekday was found to correlate with unhealthy eating habits, sleep behaviors, social and school performance, and quality of life measures. A linear association emerged between the percentage of students with BMI > 25 and weekday sleep duration for females in grades 11–12.

1. Introduction

In the past few decades, the prevalence of excess weight and obesity among children and adolescents has increased significantly in several countries, including Israel (Booth et al., 2003; Chinn & Rona, 2001; Knishkowy et al., 2006; Koplan, Liverman, Kraak, & Committee on Prevention of Obesity in Children & Youth, 2005; Krebs & Jacobson, 2003; Lytle, 2012; Ogden, Flegal, Carroll, & Johnson, 2002; Tremblay, Katzmarzyk, & Willms, 2002). The prevalence of adolescent obesity has more than tripled over the past four decades, from 5.2 to 18.4% (Flegal, Carroll, Kit, & Ogden, 2012; Troiano, Flegal, Kuczmarski, Campbell, & Johnson, 1995). Obesity often results in high comorbidity as well as medical, social, and emotional complications (İnanç, 2013), and leads to adverse medical conditions in adolescence and adulthood (Cheung, Machin, Karlberg, & Khoo, 2004; Gunturu & Ten, 2007; Israeli et al., 2006; Kiess, Galler, Reich, et al., 2001; Must, 2003). Being overweight often results in a lower quality of life, reduced self-esteem (Griffiths, Parsons, & Hill, 2010; Russell-Mayhew, McVey, Bardick, & Ireland, 2012), poor performance in school (Florin, Shults, & Stettler, 2011), and reduced sleep (Matricciani, Olds, & Petkov, 2012).

Self-rated health (SRH) is a subjective global summary measure of general health status that includes physical, mental, and social well-being (Okosun, Choi, Matamoros, & Dever, 2001). Micciolo et al. (2013) found an association between BMI and SRH across ages and genders. A study examining quality of life (QoL) among a group of obese adolescents, 10–14 years old, found a significant relationship between obesity and impaired overall QoL, including social, emotional, and psychosocial functioning. The greatest effect was revealed by psychosocial assessment (Turco et al., 2013).

In the past three decades, children and adolescents have been sleeping less, with only one-third of teens getting the recommended nine hours of nighttime sleep (Bonnet & Arand, 1995; Carskadon & Acebo, 2002; Carskadon, Harvey, & Dement, 1981; Carskadon et al., 1980; Hirshkowitz et al., 2015). Growing evidence from large cross-sectional studies conducted internationally indicates that shorter sleep duration is a risk factor for higher BMI in children and adolescents, as well as in adults, although the associations appear to be somewhat stronger in children (Olds, Maher, & Matricciani, 2011). Cappuccio et al. (2008) reported that short sleep duration was associated with an 89% increase in the odds of developing obesity among children and adolescents, and Chen, Beydoun, and Wang (2008) found that each hour of increased sleep duration was associated with a 9% decrease in the odds of developing excess weight or obesity.

The relationship between sleep and obesity is of interest given that obesity rates are reaching record levels, and chronic sleep deprivation is affecting increasing numbers of adolescents and adults in the US (Hasler et al., 2004; Marshall, Glozier, & Grunstein, 2008; Patel & Hu, 2008) and elsewhere (Hart, Cairns, & Jelalian, 2011). The association between short sleep duration and obesity (high BMI) is particularly prevalent when sleep duration is less than six hours per night and the individual falls asleep after midnight (Shigeta, Shigeta, Nakazawa, Nakamura, & Yoshikawa, 2001; Vorona et al., 2005). Similar results have been obtained regarding the relations between sleep problems and long-term weight gain (Patel, Malhotra, White, Gottlieb, & Hu, 2006). A large-scale meta-analysis of sleep data obtained from children and adults exhibited a significant relationship between obesity and shorter sleep duration (Cappuccio et al., 2008).

The effect of short sleep duration on obesity can be explained by several possible pathways, including increased sympathetic activity, elevated cortisol and ghrelin levels, decreased leptin and/or impaired glucose tolerance (Spiegel, Leproult, & Van Cauter, 1999; Spiegel et al., 2004). According to prospective and cross-sectional studies, this relationship demonstrates that short sleep duration among children is associated with increased risk of obesity during adolescence (Calamaro et al., 2010; Lumeng et al., 2007; Lytle et al., 2012; Snell, Adam, & Duncan, 2007; Van Cauter, 2010). Lumeng et al. (2007) prospectively monitored children from preadolescence (3rd grade, age 9) to early adolescence (6th grade, age 12), demonstrating that shorter sleep in preadolescence increased

the risk of being overweight in the 6th grade, controlling for confounders such as race, maternal education, weight status, and normative maturational changes in sleep duration. These relationships were attenuated by age, so that sleep timing and duration had a greater effect on weight among younger than among older participants, suggesting that puberty may play a moderating role.

Yet, studies examining the relationship between sleep duration and overweight have had varied results. Cross-sectional studies among middle- and high- school students have provided support for an association between short sleep and overweight and/or obesity (Al-Hazzaa, Abahussain, Musaiger, Al-Sobayel, & Qahwaji, 2012; Garaulet et al., 2011; Knutson, 2005; Liou, Liou, & Chang, 2010; Moore et al., 2009; Noland, Price, Dake, & Telljohann, 2009; Park, 2011; Seicean et al., 2007; Weiss et al. 2010). For example, analysis of a web-based survey of nearly 74,000 students in South Korea found an inverse relationship between sleep duration and both BMI and being overweight or obese (Park, 2011). Each 1-h decrease in sleep duration increased the likelihood for overweight or obesity by 6.5%. Other studies have reported additional psychosocial and lifestyle factors affecting obesity, such as sedentary behaviors, inactivity, and poor diet (Garaulet et al., 2011; Liou et al., 2010; Seicean et al., 2007). Gender differences have been inconsistently implicated in the relationship between short sleep duration and obesity.

Although most studies of adolescents showed significant results in the expected direction (Chen et al., 2008; Eisenmann, Ekkekakis, & Holmes, 2006; Gupta, Mueller, Chan, & Meininger, 2002), some reported no such association among girls (Eisenmann et al., 2006; Knutson, 2005). No clear age pattern has been identified, but gender differences are apparent. In a US survey of over 4,000 adolescents, Knutson (2005) found a strong association for males only. Weiss et al. (2010) followed nutrient intake in 240 adolescents aged 16–19 using 24-h food recall questionnaires, and objectively monitored sleep using actigraphy. They used eight hours as the cut-off point for distinguishing short from long weekday sleep. Findings revealed that short sleep was associated with higher caloric intake derived from fat, and lower caloric intake from carbohydrates, even after controlling for gender, race, and parental education. These associations were stronger in girls than in boys. A European survey of over 3,000 adolescents reported the association to be more prominent among females (Garaulet et al., 2011). Further studies are needed to understand the association between short sleep duration and obesity, and to explain these inconsistent findings.

The highest rates of excess weight among adolescent boys and girls were found in North America and in southern and eastern European countries (Dupuy, Godeau, Vignes, & Ahluwalia, 2011; Rubin et al., 2013). In most countries, boys tend to be more overweight than girls, probably because girls eat more healthy foods and boys eat more fast foods (Sweeting, 2008), or because parents are less likely to encourage boys to control their weight (Ricciardelli & McCabe, 2001). Girls tend to gain body fat during puberty, which may serve as an incentive for initiating dieting practices (Bearman, Presnell, Martinez, & Stice, 2006). The prevalence of excess weight/obesity among adolescents in Israel is 8.5% for age 15 and 7.5% for age 11 (Currie et al., 2012).

To the best of our knowledge, the relationship between sleep and other health habits has not received much attention, and no study in Israel has examined the relationship between sleep patterns, including daytime sleep-related behaviors (DSRB), sleepiness, and mood on one hand, and eating behaviors, obesity (measured by BMI), and quality of life on the other among adolescents 12–18 years of age. The aim of the present study was to examine how self-reported sleep duration, DSRB, sleepiness, mood, eating habits, BMI, and quality of life are associated among Israeli adolescents in grades 7–12 (aged 12–18 years).

Specifically, our aims were:

(1) To assess the differences between females and males, by school grade, with respect to eating habits, BMI, sleep duration, DSRB (including sleep problem behaviors, sleepiness, and mood), and quality of life.
(2) To assess how eating behaviors are associated with sleep duration and DSRB (including sleep problem behaviors, sleepiness, and mood) among Israeli adolescents aged 12–18.
(3) To assess how BMI is associated with sleep duration, DSRB (including sleep problem behaviors, sleepiness, and mood), eating behavior, and quality of life among Israeli adolescents aged 12–18.

2. Methods and materials

2.1. Study population

Study participants included 844 adolescents (457 females) from middle and high schools (aged 12–18 years) in urban and rural middle-class communities in northern Israel. All were fluent Hebrew speakers and studied in normative grade 7–12 classes. Participants completed the questionnaires during class in the presence of the homeroom teacher and a research assistant.

2.2. Demographic and clinical questionnaire

Participants self-reported their age, gender, grade in school, and their height and weight, which was used to calculate BMI (BMI expresses the weight/height relationship as a ratio of kilograms/meters^2) (Bray, 1992; McCarthy, Cole, Fry, Jebb, & Prentice, 2006). Adolescents' BMI calculated from self-report shows a high correlation with measured height and weight (Elgar, Roberts, Tudor-Smith, & Moore, 2005; Goodman, Hinden, & Khandelwal, 2000; Tokmakidis, Christodoulos, & Mantzouranis, 2007).

Normal weight was defined as BMI between 18.5 and 24.9 excess weight as BMI between 25 and 29.9, and obesity as BMI ≥ 30 (Cole, Bellizzi, Flegal, & Dietz, 2000; Flegal et al., 2012).

We also measured the prevalence of students with normal BMI (18.5 < BMI < 25) and excess weight or obesity (BMI ≥ 25) among Israeli adolescents.

2.3. School sleep habits survey (SSHS)

Wolfson and Carskadon (1998), Hebrew translation (Shochat, Flint-Bretler, & Tzischinsky, 2010): We used sleep patterns and DSBR (including sleep problem behaviors, daytime sleepiness, and depressed mood scales). Sleep patterns, including bedtime (h:min), sleep latency (the time it takes from light off until sleep onset), wake-up time (h:min), and total sleep duration (hours), both on weekdays (Sunday to Thursday) and weekends (Friday and Saturday), were self-reported by the participants to the nearest 15 min. Past studies have shown that adolescents are able to recall their typical duration of sleep (Wolfson et al., 2003).

Sleep problem behavior, sleepiness, and mood scales were each summed to obtain total scores. Reliability (Cronbach's α) in the current sample was 0.76 for the sleep problem behaviors scale, 0.7 for the sleepiness scale, and 0.77 for depressed mood.

2.4. Quality of life questionnaire

The Pediatric Quality of Life Inventory™ (PedsQL™) Short Form (Varni, 1999) is a self-report instrument that was translated into Hebrew (Tzischinsky & Shochat, 2011). The PedsQL scale includes 15 items describing situations such as finding it difficult to run, being afraid, and forgetting things, which participants rate for frequency on a five-point scale (total score ranging from 0 to 100, with higher scores indicating better health-related quality of life. The PedsQL includes five subscales: physical (reliability α = 0.81), emotional (reliability α = 0.86), social (reliability α = 0.72), school (reliability α = 0.80), psychosocial functioning (reliability α = 0.82), and overall QOL (reliability α = 0.87).

2.5. Eating habits questionnaire

The eating pattern self-report instrument assesses different areas of adolescent eating habits, using a four-point scale to indicate the frequency of occurrence (scores ranging from 0 = never to 3 = always). Four hundred participants (out of 844) were randomly selected to complete this questionnaire (no significant differences in demographic variables were found between the two samples). The original questionnaire (used in the pilot study, not included in the current sample) included 31 items; three of the items were removed from the questionnaire because of low reliability.

The last version of the eating habits questionnaire included 28 items such as "I eat breakfast every day" or "I usually eat in front of the TV".

The questionnaire was divided into two subscales: healthy habits (mean of 16 items, $\alpha = 0.764$; for example, "I eat three meals a day," "I have dinner with the entire family," and "I eat at least one fruit every day"), and unhealthy habits (mean of 9 items, $\alpha = 0.721$; for example, "In the morning I only have a drink," "I usually eat sweets between meals," and "I drink only sweet drinks").

2.6. Ethics

The study was approved by the Chief Scientist of the Israeli Ministry of Education and by the ethics committee of Emek Yezreel College. Parents were sent a letter explaining the aims of the study, and those who did not wish their child to participate in the study notified the homeroom teacher, resulting in a 95% participation rate. Questionnaires were completed during class, in the presence of the homeroom teacher and a research assistant.

2.7. Statistical analysis

Sleep duration was computed as the difference between bedtime and wake-up time minus sleep latency. For students who reported no weekday sleep latency or whose recorded weekday sleep latency was greater than 1 h ($n = 41$), a sleep latency of 0.33 (the median sleep latency) was used. For students who reported no wake-up time ($n = 75$), the wake-up time was assumed to be 7:00 (the median wake-up time for both males and females). For students who reported no weekend sleep latency or whose recorded weekend sleep latency was greater than 1 h ($n = 23$), a sleep latency of 0.25 (the median sleep latency) was used. Three variables of sleep duration were used for data analysis: weekday night sleep, weekend night sleep, and mean daily night sleep (average duration of weekday and weekend night sleep). We also measured the prevalence of students with insufficient (7 h or less) and long (9 h and more) sleep duration (Lowry et al., 2012).

Means and standard deviations are reported for the continuous variables (normally distributed), and frequencies and percentages are provided for the categorical variables.

We conducted between-gender and between-grades analyses for BMI and sleep patterns, sleep problem behaviors, sleepiness, and mood. We calculated Pearson correlations between sleep measures and eating habits, and between-sleep measures and BMI. We conducted linear and quadratic analyses between BMI ≥ 25 and weekday, and between weekend and mean nightly sleep duration, using SPSS 20 for statistical analysis.

3. Results

Study participants included 844 young adolescents (mean age 14.6 ± 1.1 years, between 12 and 18 years), including 457 females (mean age 14.62 ± 1.12 years, range 12–18; mean BMI 19.74, SD = 2.7; range 12.22–30.67) and 387 males (mean age 14.63 ± 1.1 years, range 12–18; mean BMI 20.62, SD = 3.29; range 12.74–39.38). Five percent of the questionnaires were partially completed and were therefore removed from the analysis.

BMI, eating habits, sleep duration (during weekdays, weekend, and mean between weekdays & weekend), DSRB, and quality of life with respect to gender differences and grade differences are presented in Tables 1 and 2.

3.1. BMI

Differences in BMI between males and females (20.62 ± 3.29 vs. 19.74 ± 2.7; $p < 0.001$) and between grades ($p < 0.001$) were statistically significant. There was no interaction between gender and grade for BMI ($p > 0.81$). Bonferroni-adjusted *post hoc* testing revealed no statistically significant difference in BMI between 8th and 9th graders ($p > 0.15$) and 10th and 11th + 12th graders ($p > 0.10$). The odds of a male adolescent having BMI > 25 were nearly twice that of a female (OR: 1.98; 95% CI: 1.05–3.74). Even after adjusting for gender, the difference between grades in the percentage of adolescents who had BMI > 25 was not statistically significant. A linear association emerged between the percentage adolescents who had BMI > 25 and grade, $p < 0.051$. This association was not significant for males ($p > 0.22$) and showed borderline statistical significance for females ($p < 0.08$). A linear association was also found between percentage adolescents who had BMI > 90th percentile of all adolescents and grade, $p < 0.001$. This association was significant within each gender (male: $p < 0.05$; female: $p < 0.001$; see Table 2).

In sum, the main results for BMI were a significant difference between males and females and between the grade groups, but no significant differences for adolescents with BMI > 25.

3.2. Eating habits

No significant differences were found between males and females in healthy and unhealthy eating habits (Table 1).

Sleep pattern (weekdays, weekends, and mean daily sleep duration), gender, and grade differences (Tables 1 and 2).

Students slept an average of 7.30 h on a weekday (median: 7.42). Male students slept significantly longer during the week than females (7.33 ± 1.01 vs. 7.07 ± 1.06; $t = 2.51$, $p < 0.01$). No statistically significant difference was found between male and female students in the number of hours slept during weekends (males: 9.34, median 9.5; females: 9.36, median 9.25, $p > 0.69$).

Table 1. Sleep pattern, daytime sleep-related behaviors (DSRB), eating habits, BMI, and quality of life (mean ± SD) comparison between female and male

	Female	Male	Significant
Age (years)	14.62 ± 1.12	14.63 ± 1.1	NS
Sleep Pattern			
Weekday sleep onset (h)	23.17 ± 0.99	23.15 ± 0.95	NS
Weekday sleep duration (h)	7.07 ± 1.06	7.33 ± 1.01	$t = 2.51$; $df = 358$; $p < 0.012$
Weekend sleep onset (h)	25.70 ± 1.69	25.67 ± 1.71	NS
Weekend sleep duration (h)	9.25 ± 1.49	9.20 ± 1.57	NS
Mean daily sleep duration (h)	8.11 ± 0.95	8.16 ± 0.99	NS
Daytime sleep-related behaviors (DSRB)			
Sleep problem behaviors	1.17 ± 0.65	1.13 ± 0.67	NS
Daytime sleepiness scale	0.47 ± 0.37	0.44 ± 0.36	NS
Mood scale	0.75 ± 0.48	0.64 ± 0.48	$T = -3.29$; $df = 358$; $p < 0.001$
Eating habits			
Healthy eating habits	1.76 ± 0.49	1.69 ± 0.49	NS
Non healthy eating habits	1.38 ± 0.51	1.38 ± 0.52	NS
BMI	19.74 ± 2.7	20.62 ± 3.29	$p < 0.001$
Quality of life (total)	76.65 ± 15.54	81.67 ± 14.98	$T = 4.75$; $df = 358$; $p < 0.0001$

The difference in the number of hours students slept by grade ($p < 0.001$) was statistically significant, with 7th graders sleeping statistically significantly more hours than 8th–10th graders (Bonferroni-corrected $p < 0.02$). During weekdays, 53.6% of students slept more than 7 h and less than 9 h, 40.0% slept 7 h or less (insufficient sleep, according to Lowry et al., 2012), and 5.7% slept 9 or more hours (long sleep). The percentage of students who had short or long sleep exhibited no statistically significant difference between males and females ($p > 0.10$, $p > 0.18$, respectively). But the difference in the percentage of students with insufficient sleep in the different grades was statistically significant ($p < 0.001$), with a lower percentage of 7th graders showing insufficient sleep than 8th–10th graders (Bonferroni-corrected $p < 0.001$). Students slept an average of 9.34 h on the weekend (median: 9.25). The difference in the number of hours students slept on the weekend by grade was statistically significant ($p < 0.03$), with 7th graders sleeping more hours than 11th–12th graders (Bonferroni-corrected $p < 0.02$) (Table 2).

3.3. Mean daily sleep duration

The average of weekday and weekend sleep duration was 7.87 h, with 17.8% of students getting an average of 7 h or less sleep, and 12.0% getting an average of 9 h or more. The difference between males and females in the percentage of students who had short or long sleep was not statistically significant ($p > 0.24$ $p > 0.94$, respectively). But the difference in the percentage of students with insufficient sleep in the different grades was statistically significant ($p < 0.001$), with a lower percentage of 7th graders getting insufficient sleep than 8th, 9th, and 11th–12th graders (Bonferroni-corrected $p < 0.001$, $p < 0.01$, $p < 0.001$) (Table 2).

3.4. Daytime sleep-related behaviors

Significant difference was found between males and females on the mood scale ($t = -3.29$; $p < 0.001$), with males reporting better mood than females (0.64 ± 0.8 vs. 0.75 ± 0.48), but no significant differences were found between males and females in sleep problem behaviors and on the daytime sleepiness scale (Table 1).

Table 2. Prevalence of insufficient (7 h or less) and long (9 h and more) sleep duration and BMI among Israeli adolescents

	N	Weekday sleep				Mean nightly sleep (*N* = 786)			Weight	
		Week duration	Insufficient (≤7 h)	Long (≥9 h)	Weekend duration (*N* = 790)	Duration	Insufficient (≤7 h)	Long (≥9 h)	BMI (*N* = 773)	BMI > 25
			N (%)	*N* (%)			*N* (%)	*N* (%)		*N* (%)
Total	843	7.30 ± 1.10 (2.67–10.16)	337 (40.0%)	48 (5.7%)	9.34 ± 1.64 (4.34–15.84)	7.88 ± 0.97 (3.55–10.51)	140 (17.8%)	94 (12.0%)	20.16 ± 3.01 (12.22–39.38)	43 (5.1%)
Gender										
Male	383	7.35 ± 1.06 (2.67–10.00)	143 (39.5%)	18 (7.6%)	9.34 ± 1.77 (4.34–15.84)	7.92 ± 0.97 (3.55–10.51)	56 (15.9%)	43 (12.2%)	20.62 ± 3.29 (12.74–39.38)	27 (7.5%)
Female	455	7.26 ± 1.12 (3.00–10.16)	192 (45.4%)	29 (11.2%)	9.36 ± 1.52 (5.50–14.00)	7.84 ± 0.96 (4.43–10.50)	82 (19.1%)	51 (11.9%)	19.74 ± 2.70 (12.22–30.67)	16 (3.9%)
Grade										
7	242	7.55 ± 1.03 (2.67–10.00)	64 (28.3%)	15 (8.5%)	9.52 ± 1.58 (5.50–14.92)	8.12 ± 0.92 (3.55–10.51)	19 (8.5%)	34 (15.2%)	19.02 ± 3.06 (12.22–39.35)	9 (4.3%)
8	142	7.05 ± 1.16 (3.00–9.75)	70 (52.2%)	5 (7.2%)	9.41 ± 1.88 (5.25–15.84)	7.70 ± 1.06 (4.43–10.39)	31 (25.0%)	15 (12.1%)	19.88 ± 3.18 (13.22–39.38)	6 (4.3%)
9	317	7.30 ± 1.08 (3.09–10.16)	133 (44.9%)	19 (10.4%)	9.30 ± 1.60 (4.34–13.95)	7.86 ± 0.93 (4.73–10.18)	56 (18.8%)	32 (10.7%)	20.18 ± 2.58 (13.34–29.39)	16 (5.7%)
10	86	7.03 ± 1.01 (4.75–10.00)	46 (56.8%)	5 (12.5%)	9.28 ± 1.49 (4.75–13.50)	7.67 ± 0.90 (5.64–9.93)	18 (20.9%)	7 (8.1%)	21.44 ± 2.78 (16.41–32.87)	6 (7.2%)
11–12	53	7.22 ± 1.17 (4.00–9.75)	23 (46.9%)	4 (13.8%)	8.76 ± 1.68 (4.75–13.50)	7.66 ± 1.09 (4.79–10.32)	16 (30.2%)	6 (11.3%)	22.51 ± 3.06 (16.95–33.75)	6 (11.3%)

Table 3. Correlation between BMI, weekday sleep duration and mean nightly sleep duration with eating habits, Sleepiness, sleep behaviors, mood, and quality of life data after controlling for gender and class

	BMI		Weekday sleep duration		Mean nightly sleep duration	
	r	*p*	*r*	*p*	*r*	*p*
BMI			0.026	0.606	0.018	0.626
Eating habits						
Healthy	−0.056	0.27	0.136	0.007	0.124	0.01
Not healthy	−0.025	0.63	−0.208	<0.001	−0.230	<0.001
Sleepiness	0.042	0.24	−0.116	0.02	−0.068	0.18
Sleep behaviors	0.023	0.52	−0.302	<0.001	−0.243	<0.001
Mood	0.037	0.30	−0.040	0.43	−0.032	0.52
Quality of life						
Physical	−0.097	0.007	−0.01	0.84	0.009	0.86
Emotional	−0.087	0.02	−0.56	0.27	−0.018	0.72
Social	−0.099	0.006	−0.162	0.001	−0.132	0.008
School performance	−0.070	0.05	0.157	0.002	0.214	<0.001
Psychosocial functioning	−0.107	0.003	0.003	0.95	0.058	0.25
Total quality of life	−0.117	0.001	−0.002	0.97	0.045	0.22

3.5. Quality of life (total)

Significant difference was found between males and females in quality of life (total), (t = 4.75; df = 358, p < 0.001), with males reporting higher quality of life than females (81.67 ± 14.98 vs. 76.65 ± 15.54).

The association of eating behaviors and BMI with sleep duration, DSRB and eating behavior (Table 3).

Table 4. Linear and quadratic associations between BMI > 25 and weekday sleep duration and Mean nightly sleep

	Week day night sleep duration (hours)							Mean nightly sleep						
	≤6 (*N* = 116)	6.01–7.00 (*N* = 221)	7.01–7.99 (*N* = 263)	8.00–8.99 (*N* = 189)	≥9 (*N* = 48)	Linear trend	Quadratic trend	≤6 (*N* = 21)	6.01–7.00 (*N* = 110)	7.01–7.99 (*N* = 247)	8.00–8.99 (*N* = 255)	≥9 (*N* = 85)	Linear trend	Quadratic trend
All students	3 (2.8%)	7 (3.5%)	15 (6.3%)	14 (8.0%)	4 (9.3%)	0.03	0.52	1 (4.8%)	5 (4.5%)	10 (4.0%)	17 (6.7%)	7 (8.2%)	0.14	0.21
Males	3 (6.4%)	6 (6.9%)	10 (9.1%)	8 (8.5%)	0 (0.0%)	0.89	0.27	1 (11.1%)	5 (11.4%)	6 (5.8%)	11 (8.1%)	2 (5.0%)	0.44	0.95
Females	0 (0.0%)	1 (0.9%)	5 (3.9%)	6 (7.5%)	4 (16.0%)	<0.001	0.72	0 (0.0%)	0 (0.0%)	4 (2.8%)	6 (5.0%)	5 (11.1%)	0.003	0.05
Grade														
7	0 (0.0%)	0 (0.0%)	5 (6.6%)	3 (4.7%)	1 (6.7%)	0.18	0.44	0 (0.0%)	0 (0.0%)	3 (5.1%)	2 (2.2%)	2 (6.5%)	0.58	0.68
8	1 (3.2%)	1 (2.8%)	1 (2.9%)	2 (6.7%)	1 (20.0%)	0.20	0.62	1 (16.7%)	0 (0.0%)	1 (2.3%)	2 (6.1%)	1 (6.7%)	0.70	0.17
9	2 (5.7%)	4 (4.9%)	5 (5.8%)	5 (8.2%)	0 (0.0%)	0.91	0.60	0 (0.0%)	4 (8.9%)	3 (3.2%)	7 (7.6%)	2 (7.4%)	0.66	0.58
10	0 (0.0%)	2 (6.9%)	2 (7.1%)	1 (16.7%)	1 (25.0%)	0.08	0.76	0 (0.0%)	1 (6.3%)	1 (2.8%)	3 (13.0%)	1 (16.7%)	0.17	0.28
11–12	0 (0.0%)	0 (0.0%)	2 (14.3%)	3 (25.0%)	1 (25.0%)	0.02	0.72	0 (0.0%)	0 (0.0%)	2 (14.3%)	3 (17.6%)	1 (16.7%)	0.13	0.98

Table 5. Associations between insufficient and long weekday sleep duration and BMI with eating habits, sleepiness, sleep behaviors, mood, and quality of life data. Odds ratio adjusted for gender and class

	Insufficient weekday sleep			Long weekday sleep			Insufficient nightly sleep			BMI > 25		
	AOR	95% CI	*p*	AOR	95% CI	*p*	AOR	95% CI	*p*	AOR	95% CI	*p*
Eating habits												
Healthy (change of 1 unit)	0.47	0.30–0.74	<0.001	0.42	0.16–1.12	0.08	0.79	0.48–1.30	0.35	0.67	0.28–1.62	0.37
Not healthy (change of 1 unit)	1.60	1.06–2.41	0.02	0.64	0.28–1.50	0.31	1.60	1.00–2.55	0.05	0.37	0.16–0.88	0.02
Sleepiness	1.27	0.85–1.88	0.24	0.92	0.40–2.10	0.84	1.41	0.86–2.31	0.17	1.06	0.46–2.43	0.89
Sleep behaviors	1.60	1.27–2.00	<0.001	1.13	0.70–1.82	0.62	1.68	1.27–2.23	<0.001	0.75	0.45–1.24	0.27
Mood	1.25	0.92–1.70	0.15	1.39	0.73–2.66	0.31	1.26	0.85–1.85	0.25	0.86	0.45–1.65	0.64
Quality of life												
Physical	1.00	0.99–1.01	0.98	1.00	0.98–1.01	0.71	1.00	0.99–1.01	0.72	0.99	0.97–1.002	0.10
Emotional	1.00	0.99–1.01	0.92	1.00	0.99–1.02	0.69	1.01	1.00–1.02	0.17	1.00	0.98–1.01	0.54
Social	1.01	1.00–1.02	0.02	1.02	1.00–1.05	0.10	1.02	1.00–1.03	0.04	0.98	0.97–1.00	0.05
School performance	0.99	0.98–1.00	0.002	0.99	0.98–1.01	0.31	1.00	0.99–1.00	0.18	1.00	0.99–1.01	0.79
Psychosocial functioning	1.00	0.99–1.01	0.41	1.00	0.98–1.02	0.82	1.00	0.99–1.02	0.48	0.99	0.97–1.01	0.32
Total quality of life	1.00	0.99–1.01	0.53	1.00	0.98–1.02	0.99	1.00	0.99–1.02	0.51	0.99	0.97–1.01	0.17

After adjusting for gender and grade, and after Bonferroni correction, a statistically significant correlation emerged between unhealthy eating habits, sleep behaviors, social and school performance, and quality of life measures on one hand, and weekday ($p < 0.001$, $p < 0.001$, $p < 0.001$, $p < 0.002$ respectively) and mean nighttime ($p < 0.001$, $p < 0.001$, $p < 0.008$, $p < 0.001$) sleep duration on the other (Table 3). BMI was statistically significantly correlated with psychosocial ($p < 0.003$) and total ($p < 0.001$) quality of life (Table 3). There was not significant association between BMI and eating habit (healthy or unhealthy, based on Spearman correlation ($r = -0.09$, $p < 0.077$; $r = -0.029$, n.s. respectively), but a significant negative correlation was found between healthy and unhealthy eating habits ($r = -0.24$, $p < 0.000$).

Association between BMI > 25 and sleep duration (Table 4)

After adjusting for gender and age, a linear trend emerged between the percentage of students with BMI > 25 and weekday sleep duration ($p < 0.03$). But this linear association was found only among females ($p < 0.001$) and among 11th–12th graders ($p < 0.02$). With respect to mean daily sleep, a linear trend emerged only among female students ($p < 0.003$).

Association of sleep duration with eating habits and quality of life (Table 5):

After adjusting for gender and grade, an association was found between unhealthy and healthy eating habits, sleep behaviors, social and school performance, and quality of life measures on one hand with insufficient weekday sleep on the other. After adjusting for gender and grade, none of the eating habits, sleep, or quality of life measures was associated with long weekday sleep duration. When the above analysis was repeated using mean nightly sleep instead of weekday sleep, and after adjusting for gender and grade, unhealthy eating habits, sleep behaviors, and social quality of life measures were found to be associated with insufficient sleep. After adjusting for gender and grade, no behavioral or quality of life measure was associated with long mean nighttime sleep, with the exception of unhealthy eating ($p < 0.002$; OR: 0.37; 95% CI: 0.19–0.70).

Table 6. Prevalence of obesity (BMI > 25) by sleep duration, for total sample, male, female and Lowry et al., 2012, linear and quadratic regression

Sleep duration	≤5	6	7	8	≥9	Linear	Quadratic
Total	4.2%	1.3%	2.0%	4.1%	7.1%	0.04	NS
Male	11.1%	3.1%	4.3%	7.6%	0.0%	NS	NS
Female	0.0%	0.0%	0.0%	0.0%	12.0%	0.001	NS
Lowry et al., 2012, Article Total sample	14.8%	11.5%	12.2%	12.1%	13.0%	NS	0.03

Unhealthy eating habits and social quality of life measures were associated with BMI > 25.

Multivariate analysis (BMI > 25 as outcome) (Table 6):

After adjusting for gender, grade, sleep behaviors, social and school performance, and quality of life measures, weekday sleep duration tended to be associated with BMI > 25 ($p < 0.051$; OR: 1.37; 95% CI: 0.99–1.89). After adjusting for gender, grade, sleep behaviors, and quality of life (total), weekday sleep duration was found to be associated with BMI > 25 ($p < 0.04$; OR: 1.40; 95% CI: 1.02–1.91). It was not possible to adjust for eating behaviors because the model became numerically unstable. Modeling weekday sleep duration as insufficient, adequate, and long revealed that students with insufficient sleep had statistically significantly lower odds of BMI > 25 than students with adequate sleep ($p < 0.029$; OR:0.43; 95% CI: 0.20–0.92) after adjusting for gender, grade, and sleep behaviors. Students with long sleep duration had rates of BMI > 25 similar to students with adequate sleep duration ($p > 0.54$; OR: 1.42; 95% CI: 0.46–4.35) (Table 6).

After adjusting for gender and age, a linear trend emerged between the percentage of students with BMI > 25 and weekday sleep duration (OR: 1.41, 95% CI: 1.04–1.93 $p < 0.03$), but the association was found only among female students (OR: 2.74, 95% CI: 1.59–4.72, $p < 0.001$) and among 11th–12th graders (OR: 3.17, 95% CI: 1.19–8.46 $p < 0.02$). With respect to mean daily sleep, a linear trend emerged only among female students (OR: 2.23, 95% CI: 1.29–3.87, $p < 0.003$).

4. Discussion

The present study was designed primarily to investigate how sleeping patterns (specifically sleep duration), DSRB, and quality of life are related to healthy or unhealthy eating behaviors and BMI among Israeli adolescents. Short sleep duration in adolescents is known to be associated with fatigue, lower academic performance, depressive mood, and behavior problems (Pasch, Laska, Lytle, & Moe, 2010; Smaldone, Honig, & Byrne, 2007). But few studies have investigated how sleep duration is associated with eating behaviors, BMI, and quality of life (Bel et al., 2013; Hitze et al., 2009).

Adolescent students in Israel slept 7.88 h per night on average (weekdays and weekends). There were 17.8% short sleepers (7 h or less of sleep per night), and 12.0% long sleepers (9 h or more of sleep per night). Of the participants, 40% were short sleepers and 5.7% long sleepers, with 54.3% reporting moderate sleep duration (between 7–9 h). There were no statistically significant gender differences in the percentages of adolescents who reported short or long nightly sleep duration.

Wheaton, Perry, Chapman, and Croft (2013) reported similar results among US high-school students, with 31.4% of male students and 27.4% of female students reporting sleeping 8 or 9 h (moderate sleep) on an average school night. Short sleep duration of 6 or 7 h was reported by 51.8% of male and 54.3% of female students, and very short sleep duration of 5 h or less was reported by 14.8% of male and 16.9% of female students in grades 9–12.

Similar to earlier studies, students in grade 7 slept significantly longer than those in grades 8–12 (Knutson & Lauderdale, 2007; Mercer & Merritt, 1998; National Sleep Foundation, 2006; Wheaton et al., 2013). At the same time, only a borderline statistically significant *difference was found between male and female students in the number of hours slept*. A similar difference was found earlier among Israel adolescents aged 14 (Shochat et al., 2010). Recently, Maslowsky and Ozer (2014) reported that male adolescents sleeping significantly longer than female adolescents (7.8 vs. 7.6 h, respectively).

Furthermore, the percentage of adolescents reporting short sleep duration (<6 h per night) increased from 1.1 to 8.5%, and the percentage of adolescents reporting long sleep duration (>10 h per night) decreased from 4.5% at age 13 to 1.6% at age 18. In the present study, 46.9% of the Israeli adolescents slept 7 h or less, and 13.8% slept 9 h or less during grades 11–12. In regard to DSRB, no significant differences were found between male and female adolescents in sleep problem behaviors and daytime sleepiness, but a significant difference was found between male and female adolescents on the mood scale, with male adolescents exhibiting better mood than their female counterparts. No significant differences were found between male and female adolescents with respect to healthy and unhealthy eating habits, however, a study by Musaiger and Kalam (2014) indicated a significant variation in dietary habits and lifestyles between male and female adolescents in Syria. Although both genders reported many unhealthy food and lifestyle behaviors, female adolescents reported more unsatisfactory lifestyle behaviors than did their male counterparts.

A positive association was found between BMI and sleep duration among female adolescents and among the total sample, as reflected in the linear regression (Table 6). These results were contrary to the research hypothesis. Note that only a few of the female adolescents were overweight, a finding that is consistent with those of Lowry et al. (2012). Earlier, Hargreaves and Tiggemann (2006) reported that girls' weight-reduction behavior was manifest by age 13, with consistently increasing rates thereafter, regardless of country or region. The frequency of weight-reduction behaviors does not increase with age among boys, however. Gender differences can be partly explained by pubertal changes, with girls perceiving increases in weight and body fat as an obstacle to attaining their ideal body shape

Eating behaviors (specifically, unhealthy ones) were found to be negatively associated with sleep patterns and DSRB (including sleep problem behaviors, sleepiness, and mood) and with insufficient weekday sleep. After adjusting for gender and grade, unhealthy eating habits were associated with insufficient sleep.

Hitze et al. (2009) reported that sleep duration in children and adolescents (6–20 years) was determined by a higher nutritional quality level, but only in girls. Westerlund, Ray, and Roos (2009) showed that among 10–11-year-old children, shorter sleep duration is associated with the consumption of more energy-rich foods and fewer nutrient-dense ones, with boys exhibiting a stronger association than girls.

Nguyen-Rodriguez, McClain, and Spruijt-Metz (2010) found that sleep onset latency among 356 5th-grade students was significantly related to emotional eating, depressive symptoms, and anxiety traits. Sleep disorders were shown to contribute to weight gain and obesity, with consequent impairment in quality of life. More recently, Wheaton et al. (2013) also found that very short sleep duration is associated with increased prevalence of weight-control behaviors, especially unhealthy ones, in both male and female high school students. Among male students, excess weight/obesity did not differ significantly in relation to sleep duration, but female students who were short sleepers (6 or 7 h) were less likely to be overweight/obese than controls (OR = 0.8; 95% CI = 0.7–1.0). Although Wheaton et al. (2013) reported an association between sleep duration and dieting, which may be considered a relatively healthy weight-control behavior, the association with unhealthy weight-control behaviors was even stronger. Another study among young men found that sleep deprivation is associated with increased self-reported hunger and larger portion size, especially with regard to

snack foods (Hogenkamp et al., 2013). Bel et al. (2013) found a positive association between sleep duration and the diet quality index (DQI-AM) among adolescents. Those with optimal sleep duration achieved a better DQI-AM score than those with insufficient or borderline sleep duration. Other study (Turco et al., 2013) found that obesity in adolescence is associated with impaired quality of life (QoL) and higher frequency of sleep problems. The most affected QoL domains in this group were physical, emotional, and social functioning. A recent study of Danish school children found that sleep duration is negatively associated with dietary risk factors for obesity, such as energy density, added sugars, and consumption of sugar-sweetened beverages (Kjeldsen et al., 2014). These results are similar to ours regarding the negative correlation between sleep duration and unhealthy eating patterns.

Kilani, Al-Hazzaa, Waly, and Musaiger (2014), found that 42.5–57.6% of Omani adolescents do not get enough sleep. The average nightly sleep duration of 6.721 h appears lower than that reported for Saudi Arabian adolescents (Olds, Maher, Blunden, & Matricciani, 2010) and adolescents in the US (McKnight-Eily et al., 2011), which ranged from 6.4 to7.2 and 8.40 to 9.10 h for 14–19 and 15.5–17.5-year-olds, respectively. The findings of Kilani et al. (2014) showed that about half the Omani adolescents sleep less than 7 h per night. Although these participants led a sedentary lifestyle (lack of physical activity, low number of sleeping hours, and unhealthy eating habits), they maintained a normal BMI of <25 kg/m^2.

Consistent with the current results, Alison, Lumenga, and LeBourgeoisda (2015) summarized that the relationship between short sleep duration and obesity during early childhood has occurred in numerous epidemiological studies over the last decade; however, this association between sleep duration and obesity at other developmental stage are less well studied and less understandable. Identifying how sleep patterns may contribute to obesity risk, specifically, during adolescence can help us understand these associations and design effective interventions.

5. Research limitations and implications

Limitations of the present study include reliance on adolescent subjective reports rather than objective measures, and reliance on retrospective subjective reports rather than prospective diaries. Although some studies have reported disagreement between objective and subjective reports (Arora, Broglia, Pushpakumar, Lodhi, & Taheri, 2013), self-reported duration of sleep has been validated against actigraphy (Lockley, Skene, & Arendt, 1998).With respect to BMI, these findings must be interpreted with caution owing to the self-report nature of height and weight data (Kurth & Ellert, 2010). Although, self-reported height and weight was highly correlated with measured values, self-report is less accurate. Reporting bias may be greater in girls, because they may be more conscious of their appearance, particularly at older ages (Dupuy et al., 2011).

Eating behavior traits and weight loss according to sleep quality and duration among adolescents can lead to scientific proven recommendation in order to prevent development of chronic internal diseases in the future.

Future research should examine BMI and sleep patterns using objective tools and actual observations of health habits, DSRB, and quality of life. Short sleep duration was found to be related to unhealthy eating behaviors. These results provide further evidence that inadequate sleep may contribute to an increase in risky behaviors among adolescents. Because this is the latest study to document an association between weight-control behaviors and short sleep duration in the general adolescent population in Israel, more studies are warranted to confirm these results. If our findings are confirmed, intervention studies should be conducted to examine the effect of educational interventions that target sleep hygiene and eating habits.

The present study has emphasized the association with different patterns of the QoL but not with physical activity or with the involvement of adolescents in different sports and exercises. These activities should be examined in future research.

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