Eating Behaviors Are Associated with Excessive Daytime Sleepiness

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Research

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Abstract

Background

Excessive daytime sleepiness (EDS) is a common sleep abnormality among adolescents, and it’s associated with increased risk of morbidity and mortality. We aimed to explore the relationships between eating behaviors and EDS among female adolscents.

Methods

In this cross-sectional study 988 Iranian adolescent girls aged between 12-18 years old were recruited. Presence of EDS was determined by the Epworth Sleepiness Scale, and eating behaviors was assessed by a pre-validated questionnaire. To investigate the association between dietary behaviors and the prevalence of EDS, we applied logistic regression analysis in crude and adjusted models (adjustments for age, physical activity, menstruation and second hand smoke and general obesity).

Results

The prevalence of esccesive daytime sleepiness was obtained 24.3. The participants who consumed a major meal three times daily had a 0.56 lower odds for EDS compared to those who consumed a single major meal (OR: 0.46, 95% CI: 0.21- 0.91). Individuals with a ‘high-rate of food chewing’ were less likely to have EDS (OR: 0.55, 95% CI: 0.29 -1.04) compared with low and moderate rate of food chewing. Compared with those who consumed fried or spicy foods daily, individuals who never consumed fried (OR: 1.8, 95% CI: 0.55- 5.86) or spicy foods (OR: 1.71, 95% CI: 0.55- 5.29) had a greater risk for EDS. In addition, there were direct associations between lower meal regularity (OR: 0.53, 95% CI: 0.29- 0.95) and intra-meal fluid intake (OR: 3.00, 95% CI: 1.2- 7.3) with EDS in adjusted models. Neither in the crude nor in the adjusted models, were there significant associations between breakfast intake and frequency of snack consumption with EDS.

Conclusion

The lowest frequency of main meal frequency, irregular meal consumption, breakfast skipping, low rate of food chewing, intra-meal fluid intake, and consumption of spicy and fried foods were associated with increased odds of EDS. Further prospective studies are required to confirm this finding.

Background

Sleep is an important part of the body's physiological cycle and is essential for normal health. A disturbance in sleep patterns may be related to the pathogenesis of physical and mental disorders (Lund, Reider, Whiting, & Prichard, 2010). Excessive daytime sleepiness (EDS) is one of the main consequences of sleep-related disorders, and is characterized by persistent sleepiness, increased napping together with the inability to stay awake and alert during the day. Evidence has shown that the prevalence of daytime sleepiness in children over 9–12 years is equal or greater than in adults and the elderly (Gustafsson et al., 2016; Khan et al., 2015). Poor sleep quality is related to lack of attention in class, impairment of learning, poor school performance and lower overall productivity among school-children (Mume, Olawale, & Osundina, 2011) especially in adolescent girls who also experience puberty-related biopsychosocial changes and menstrual periods (Liu et al.,2019).

Diet as a main component of life-style plays an important role in the etiology of sleep-related disorders (Gaina et al., 2007). Diet patterns which are highly loaded with fat, refined carbohydrates and sugary drinks, low consumption of fruit and vegetables have been associated with lower sleep quality (Cao et al., 2016; Nakade, Takeuchi, Kurotani, & Harada, 2009; Pereira et al., 2015). Eating bahaviors are infuenced by demographic variables, culture and religion (Maddah et al.,2009) and little is known on the relationship between eating behaviors and sleep-related disorders. With respect to dieary intake, consuming a regular breakfast was found to be related to good sleep in Japanese female students (Nakade et al., 2009), whereas a high-fat dinner was associated with poor sleep quality in chinese adults (Cao et al., 2016). Some previous studies reported that insufficient sleep or late bedtimes in adolescents is related to high intake of high-calorie food, sweets, and snacks (Wu, Gong, Zou, Li, & Zhang, 2016; McDonald, Wardle, Llewellyn, & Fisher, 2015). In addition, adolescents with insufficient sleep or late bedtime consumed less milk, fruit, and vegetables (Golley, Maher, Matricciani, & Olds, 2013; Fleig & Randler, 2009). The role of eating behaviors that may contribute to daytime sleepiness has received little attention in epidemiological studies, and there is no information on the association between eating behaviors and daytime sleepiness. Given the detrimental effects of sleep disturbances and potential importance of eating behaviors, we aimed to evaluate the association between eating behaviors and excessive daytime sleepiness in a population of Iranian junior high school girls.

Methods

Study design and participants

This cross-sectional study was conducted in Khorasan Razavi, northeastern Iran in January 2015. All the participants (n = 988) were female students aged 12–18 years. The study population was recruited using a random cluster sampling method from several schools in different areas of the city. Those with autoimmune disease, cancer, metabolic bone disease, hepatic or renal failure, cardiovascular disorders, malabsorption or thyroid, parathyroid, adrenal diseases and anorexia nervosa or bulimia were excluded. In addition, subjects taking anti-inflammatory, anti-depressant, anti-diabetic, or anti-obesity drugs, vitamin D or calcium supplement use and hormone therapy within the previous 6 months were not included (Sayyed Saeed Khayyatzadeh et al., 2018). The ethical committee of Mashhad University of Medical Sciences, Mashhad, Iran, approved the study and all participants and their parents completed informed written consent.

Eating behaviors assessment

Data on eating behaviors including frequency of main meal (1, 2 or 3 times) and snacking (never, 1–2 or ≥ 3 times) intake, regular meal consumption (never, sometimes, almost or always), breakfast consumption (never or 1 day, 2–4 day, 5–6 day or every day), rate of food chewing (low, moderate or high), intra-meal fluid intake (never, sometimes, almost or always), frequency of fried (never, 1–3 in week, 4–6 in week or every day) and spicy (never, 1–3 in week, 4–6 in week or every day) food consumption were evaluated using a standard questionnaire (Sayyed Saeid Khayyatzadeh et al., 2018).

Assessment of sleep disorders

A Persian translation of the Epworth Sleepiness Scale (ESS) was used for the assessment of daytime sleepiness, and its reliability and validity has been published previously (Sadeghniiat Haghighi et al., 2013). This questionnaire asks respondents to rate their sleepiness in eight daily situations from 0 to 3 giving a total score of 0 (no daytime sleepiness) to 24 (the most excessive daytime sleepiness). EDS was defined as an ESS ≥ 10 (Hayley et al., 2014).

Biochemical assessments

Fasting blood samples were obtained between 8 and 10 a.m after an overnight fast by a nurse. A electrochemi-luminescence method was used for the measurement of serum 25-OH vitamin D (ECL, Roche, Basel, Switzerland). Fasting blood glucose (FBG), triglyceride (TG), total cholesterol (TC), high density lipoprotein-cholesterol (HDL-C), high-sensitive C-reactive protein (hs-CRP), calcium and phosphorus concentrations were measured by enzymatically method with the use of commercial kits (Pars Azmun, Karaj, Iran) and the BT-3000 auto-analyzer machine (Biotechnica, Rome, Italy). Low density lipoprotein-cholestrol (LDL-C) was calculated using the Friedewald formula if serum TGs concentrations were lower than 4.52 mmol/L (Castelli et al., 1986).

Demographic and anthropometric assessments

General Demographic information (age, menstruation and second hand smoke) was collected by face-to-face interview, using a standard questionnaire. Physical activity was assessed through validated Modifiable Activity questionnaire (Delshad et al., 2015) and provided as metabolic equivalentsmets in hours per day. To estimate energy intake, the reported portion size in validated FFQ (Mirmiran, Esfahani, Mehrabi, Hedayati, & Azizi, 2010) were converted to grams using household measures and then were entered to the Nutritionist IV software. Body weight, height, waist circumference (WC) and waist-to-height ratio (WHtR) were measured by a trained technician using standard protocols. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured by an experienced nurse using standard protocol (Khayyatzadeh et al., 2017). General obesity is defined as a body mass index (BMI) equal to or greater than the 95th percentile for age and gender (Raj & Kumar, 2010). Abdominal obesity was defined as waist-to-height ratio (WHtR) ≥ 0.50 and sex and age specific WC $\geq$ 90th percentile (Schröder et al., 2014).

Statistical analyses

All statistical analyses were performed using statistical Package for Social Sciences version 17 (SPSS Inc., Chicago, Illinois, USA). Independent sample t-test was used to detect differences in general characteristics (age, physical activity, energy intake, SBP and DBP) and biochemical assessments (vitamin D, calcium, phosphorus, hs-CRP, FBG, HDL-c, LDL-c, TC, Hg and HCT) between individuals with and without EDS. TG was not normally distributed; therefore the Mann-Whitney test was used to compare differences between the EDS groups. Chi-square test was used to compare the categorical characteristics (menstruation, second hand smoke, general and abdominal obesity) of the study population. To determine the association between eating behaviors and EDS, logistic regression with three different models, 1) crude model and 2) adjusted for age, physical activity, menstruation and second hand smoke, 3) model 2 plus general obesity. P-value < 0.05 was considered statistically significant.

Results

General characteristics of the study participants by EDS status are presented in Table 1. The prevalence of EDS was 24.3% (n = 241 of 747 girls). Participants with EDS were slightly older. Menstruation, smoking status, physical activity, energy intake, SBP, DBP, general and abdominal obesity were not significantly different between girls with and without EDS (all p > 0.05, Table 1). Clinical and biochemical paramters were summarized in Table 2. We found no significant difference in clinical and biochemical paramters between the two groups (all p > 0.05, Tables 1 and 2).

Table 1
Descriptive characteristics of study participants by presence of daytime sleepiness.

	Daytime sleepiness presence		**P-value†**
	No (n = 747)	**Yes (n = 241)**	
Age (y) *	14.5 ± 1.56	14.8 ± 1.49	0.02
Menstruation (%) (yes)	87.8	85.1	0.54
Passive smoker (%) (yes)	34.5	41.1	0.24
General obesity (%) (yes)	8.5	7.3	0.58
Abdominal obesity (%) (yes)	9.7	9.3	0.85
Physical activity (MET.h/day)	45.3 ± 3.55	45.5 ± 3.68	0.42
Systolic blood pressure (mmHg)	96.6 ± 13.8	96.7 ± 14.5	0.93
Diastolic blood pressure (mmHg)	62.7 ± 13.4	62.1 ± 13.3	0.54
Energy intake (Kcal)	2722 ± 817	2703 ± 902	0.79
†Independent samples t-test for continuous variables and Chi-squared test for categorical variables			

Table 2
Biochemical characteristics of study participants by presence of daytime sleepiness.

	Daytime sleepiness presence		P-value†
	No (n = 747)	Yes (n = 241)	
Vitamin D (ng/dl)	8.9 ± 8.2	10.4 ± 10.3	0.06
Calcium (mg/dl)	9.4 ± 0.66	9.4 ± 0.58	0.34
Phosphorus (mg/dl)	3.9 ± 0.47	4 ± 0.45	0.23
hs-CRP (mg/dl)	1.52 ± 1.79	1.4 ± 1.55	0.43
Fasting blood glucose (mg/dl)	86.2 ± 12.07	85.6 ± 10.5	0.55
HDL-c (mg/dl)	47.8 ± 8.48	48.4 ± 10.1	0.12
LDL-c (mg/dl)	98.6 ± 24.2	100.06 ± 27.8	0.53
Total cholesterol (mg/dl)	160.9 ± 27.8	162.5 ± 31.7	0.5
Triglyceride (mg/dl)	85.8 ± 41.5	81.08 ± 32.3	0.08
Hemoglobin (mg/dl)	14 ± 2.1	14.01 ± 2.5	0.96
Hematocrit	43.5 ± 6.3	43.7 ± 6.1	0.74

†Obtained from Independent samples t-test.

HDL-c: High density lipoprotein-cholesterol, LDL-c: Low density lipoprotein-cholesterol

The likelihood of EDS across categories of dietary behaviours evaluated by Multiple-adjusted are summerized in Table 3. Subjects who consumed their main meal for three times per day had 0.56 lower odds of EDS than the individual who consumed one main meal per day (OR: 0.44; 95%CI: 0.21–0.91; P = 0.01); this association was significant after adjustment for confounding factors in Model I (age, physical activity, menstruation, and second hand smoking) (OR: 0.44; 95%CI: 0.21–0.92; P = 0.03) and II (age, physical activity, menstruation, second hand smoking, and general obesity) (OR: 0.42; 95%CI: 0.2–0.88; P = 0.02). Individuals with a ‘high-rate of food chewing’ were less likely to have EDS (OR: 0.55; 95%CI: 0.29–1.04; P = 0.03); after adjustments for potential confounders in Model I (OR: 0.51; 95%CI: 0.27–0.98; P = 0.02) and II (OR: 0.52; 95%CI: 0.27–1.01; P = 0.03), this relationship remained significant. Compared with those who consumed fried or spicy foods daily, individuals who consumed fried every day (OR: 1.8; 95%CI:0.55–5.86; P = 0.02) and spicy food (OR: 1.71; 95%CI: 0.55–5.29; P = 0.01); had a greater chance of EDS. In adjusted models for consumption of fried foods (Model I (OR: 2.59; 95%CI: 0.71–9.39; P = 0.008)) and II (OR: 2.25; 95%CI: 0.61–8.23; P = 0.01)) and also for spicy foods (Model I (OR: 1.61; 95%CI: 0.51–5.03; P = 0.02) and II (OR: 2.09; 95%CI: 0.58–7.5; P = 0.02)) these relationships remained significant. The crude model revelaed no significant association between greater adherence to regular meal consumption and risk of EDS (P = 0.06); however, in Model I and II, ‘always-regular meal consumption’ category was significantly associated with a lower risk of EDS (OR: 0.54; 95 % CI: 0.3–0.97 ; P = 0.04).

Table 3

Multivariable-adjusted odds ratio of the association between dietary behavior and daytime sleepiness.

Type of dietary habit	Crude Model	Model I	Model II
Consumption of main meal			
1 time	1	1	1
2 times	0.57 (0.27–1.2)	0.55 (0.25–1.17)	0.53 (0.24–1.14)
3 times	0.44 (0.21–0.91)	0.44 (0.21–0.92)	0.42 (0.2–0.88)
P trend ¶	0.01	0.03	0.02
Snack consumption			
Never	1	1	1
1–2	1.17 (0.54–2.53)	1.26 (0.57–2.8)	1.24 (0.55–2.75)
≥ 3	1.53 (0.7–3.35)	1.67 (0.74–3.73)	1.59 (0.71–3.59)
P trend	0.2	0.06	0.09
Regular meal consumption			
Never	1	1	1
Sometimes	0.68 (0.41–1.13)	0.66 (0.4–1.1)	0.63 (0.38–1.06)
Almost	0.64 (0.38–1.07)	0.59 (0.34–0.99)	0.55 (0.32–0.94)
Always	0.55 (0.31–0.79)	0.54 (0.3–0.97)	0.53 (0.29–0.95)
P trend	0.06	0.04	0.04
Rate of food chewing			
Low	1	1	1
Moderate	0.59 (0.38–0.9)	0.59 (0.38–0.91)	0.6 (0.38–0.92)
High	0.55 (0.29–1.04)	0.51 (0.27–0.98)	0.52 (0.27–1.01)
P trend	0.03	0.02	0.03
Breakfast consumption			
Never or 1 day	1	1	1
2–4 day	0.97 (0.6–1.56)	1.02 (0.63–1.67)	1.05 (0.64–1.74)
5–6 day	1.41 (0.84–2.36)	1.49 (0.88–2.53)	1.43 (0.83–2.47)
Every day	0.71 (0.45–1.12)	0.78 (0.48–1.25)	0.8 (0.49–1.29)

Type of dietary habit	Crude Model	Model I	Model II
P trend	0.11	0.24	0.26
Intake of fluids with meal			
Never	1	1	1
Sometimes	2.14 (0.92–4.96)	2.19 (0.94–5.08)	2.51 (1.02–6.1)
Almost	2.28 (0.98–5.33)	2.29 (0.98–5.37)	2.6 (1.06–6.51)
Always	2.58 (1.11–5.98)	2.64(1.13–6.1)	3 (1.2–7.3)
P trend	0.05	0.05	0.04
Consumption of fried foods			
Never	1	1	1
1–3 in week	1.15 (0.42–3.17)	1.47 (0.48–4.52)	1.36 (0.44–4.2)
4–6 in week	1.67 (0.59–4.68)	2.17 (0.69–6.79)	2.05 (0.65–6.4)
Every day	1.8 (0.55–5.86)	2.59 (0.71–9.39)	2.25 (0.61–8.23)
P trend	0.02	0.008	0.01
Consumption of spicy foods			
Never	1	1	1
1–3 in week	1.04 (0.33–3.27)	1 (0.31–3.1)	1.32 (0.36–4.79)
4–6 in week	1.54 (0.5–4.73)	1.5 (0.48–4.65)	1.98 (0.55–7.06)
Every day	1.71 (0.55–5.29)	1.61 (0.51–5.03)	2.09 (0.58–7.5)
P trend	0.01	0.02	0.02

* Adjusted for age, physical activity, menstruation, and second hand smoking.

** Additionally adjusted for general obesity.

¶ Resulted from Mantel-Haenszel extension c2 test.

While no significant relation between intra-meal fluid intake and risk of EDS was found, after controlling for general obesity those with a greater intra-meal fluid intake had higher odds of EDS (OR: 3; 95 %CI: 1.2– 7.3; P = 0.04). Of note, breakfast intake (OR: 0.71) and snack consumption (OR: 1.53) were not statistically associated with chance of EDS (Table 3).

Discussion

EDS is a common complaint, which is described as the tendency to fall asleep during the day with intentions to remain awake (Johns & Hocking, 2009). Deleterious outcomes of EDS include physical and mental disorders that limit the subject's function and quality of life (Gaina et al., 2007). In addition, irregular sleep patterns can have adverse long-term clinical conditions which may be associated with disability and mortality (Ohayon, 2012). The prevalence of EDS is increased in the adolescent period due to hormonal changes-related to puberty and environmental factors (Fallone, Owens, & Deane, 2002). With regards to the important consequence sof sleep health on quality of life, it is necessary to identify the major factors that may be effective on the management or treatment of sleep-related disorders.

We found that irregular meal consumption, low rate of food chewing and higher intakes of intra-meal fluid were directly associated with EDS among adolescent girls. Higher intakes of spicy and fried foods were positively related to EDS. In addition, a greater frequency of main meal consumption was also associated with decreased odds of EDS. No significant relationships were found between frequency of snack consumption or breakfast intake and EDS in the present study. To the best of our knowledge, this is the first epidemiological study to investigate the association between dietary behaviours and EDS. These findings indicated that eating behaviors should be reviewed in relation to EDS.

We found that meal frequency and regular meal consumption were related to the reduced risk of EDS. The effects of food regularity and frequency on sleep have rarely been investigated. Nakade et al. showed that regular breakfast and dinner intakes correlate with good sleep (Nakade et al., 2009). Meal timing and regularity can be related to modulation of circadian clock gene expression (Stephan, 2002). On the other hand, the amounts of dietary nutrient intakes are affected by frequency of meals, which can be associated with alteration in the circadian rhythm. Several reports from previous studies have indicated that meal nutrient composition, especially before dinner, may alter circadian regulation (Cao et al., 2016; Keim, Van Loan, Horn, Barbieri, & Mayclin, 1997; Mendoza, Pévet, & Challet, 2008). Also, irregular meal patterns may be associated with increased odds of EDS through obesity (Saneei, Esmaillzadeh, et al., 2016) and cardiometabolic risk factors (St-Onge et al., 2017).

A positive association was found between habitual intake of fatty food and the prevalence of EDS. As earlier reports showed, the individuals with sleep-related disorders have higher percentages of energy from fat (Imaki, Hatanaka, Ogawa, Yoshida, & Tanada, 2002; Shi, McEvoy, Luu, & Attia, 2008). This finding was in line with two epidemiological studies, which suggested a direct relationship between fat intake and short periods of sleep in both children and adults (Imaki et al., 2002; Shi et al., 2008). In agreement, in the Jiangsu Nutrition Study, subjects with less than 7 h sleep consumed more percentage of calorie from fat (Shi et al., 2008). More adherence to high fat diet revealed may alter the mammalian circadian clock. In addition, the individuals with ESD or other sleep-related disorders have an increased desire for food intake, which is associated with the progression to obesity (Kohsaka et al., 2007). There is increasing evidence for the role of the gut microbiome in sleep health (Ehrlich, 2016). Alterations in the gut microbiome, which was done by feeding by high fat, modulated the circadian clock gene expression in mice (Leone et al., 2015). Furthemore, serum concentrations of ghrelin and leptin are associated with regulation of sleep rhythm. It is proposed that dietary fat intake alters levels of leptin and ghrelin

(Handjieva-Darlenska & Boyadjieva, 2009). High intake of dietary fat may elevate the incidence of EDS through increasing the risk of multiple chronic diseases including obesity, diabetes type 2 and cardiovascular disease (Briggs, Petersen, & Kris-Etherton, 2017; Fobian, Elliott, & Louie, 2018; Phillips et al., 2012).

We observed an association between a high intake of intra-meal fluid and low rate of food chewing with increased risk of EDS. No previous literature is available on whether intra-meal fluid intake and food chewing rate are associated with EDS. Previous epidemiological studies demonstrated intra-meal fluid intake and chewing insuffiency can increase risk of functional gastrointestinal diseases (FGIDs) including irritable bowel syndrome, gastrointestinal reflex, constipation and dyspepsia (Sayyed Saeid Khayyatzadeh et al., 2018; Zaribaf et al., 2018). There is growing evidence that FGIDs are important risk factors for incidence of EDS (Wu et al., 2017). Another mechanism by which intra-fluid intake and chewing insuffiency elevate the prevalence of EDS may be related to increased risk of obesity (Pedroni-Pereira et al., 2016; Saneei, Esmaillzadeh, et al., 2016; Tada & Miura, 2018).

A greater consumption of spices was found to be associated with EDS in our study. We are aware that there are no previous studies investigating associations between spicy food intake and sleep-related disorders. However, there is strong evidence that higher intake of spices are associated with more intense symptoms of FGIDs (Sayyed Saeid Khayyatzadeh et al., 2018; Saneei, Sadeghi, et al., 2016); therefore, an increased incidence of sleep-related disorder may be observed in these individuals.

The current study has some strengths. To the best our knowledge, it is the first study, which has investigated the relationship between adherence to specific dietary behaviours and prevalence of EDS. Another strength was the high quality of data collection. Nevertheless, there are some limitations in our study that should be considered. The major limitation is related to the cross-sectional design of the study, which cannot confer a causal association. In addition, there are like to be other residual confounding variable, which we were unable to statistically control.

Conclusion

In summary, there are direct associations between more frequency of main meal consumption, meal regularity, and high rate of food chewing with less EDS prevalence. Greater intra-fluid intake and higher consumptions of spicy and fried foods were associated with greater EDS. We are unable to confirm any significant association between frequencies of breakfast consumption and snack intakes with EDS either in crude or adjusted models. Further studies, in particular of a prospective nature, are required to examine the associations between adherence to specific eating behaviors and risk of EDS or any sleep-related disorder.

Abbreviations

EDS: Excessive daytime sleepiness; FBG: Fasting blood glucose; TG: Triglyceride; TC: Total cholesterol, HDL-C: High density lipoprotein-cholesterol; hs-CRP: high-sensitive C-reactive protein; LDL: Low density lipoprotein-cholestrol; ESS: Epworth Sleepiness Scale; SBP: Systolic blood pressure; DBP: Diastolic blood pressure

Declarations

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Authors' contributions

SSK formulated the research questions, designed the study and wrote the first draft of manuscript. FR, SB and MM collected the data and revised the manuscript. GF, SB and MM determined the sample size, helped in designing the study, analyzing and interpretation of the data. FR and SSK performed biochemical analyses. GF revised the manuscript and interpreted the results. MGM managed the whole project and contributed in all steps. All authors reviewed the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran, approved the study (Ethic code: 931188). All participants and their parents completed informed written consent.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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