Dietary behaviors Are Associated with Excessive Daytime Sleepiness

majid ghayour-mobarhan (ghayourmobarhan@yahoo.com)
Mashhad University of Medical Sciences

Sayyed Saeid Khayyatzadeh
Shahid Sadoughi University of Medical Sciences and Health Services

Farzad Rahmani
Mashhad University of Medical Sciences

Maryam Masoudifar
Sabzevar University of Medical Sciences

Gordon A Ferns
Brighton and Sussex Medical School

zahra abasalti
Mashhad University of Medical Sciences

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Abstract

Background Excessive daytime sleepiness (EDS) is a common sleep abnormality among adolescents, and is reported to be associated with increased risk of morbidity and mortality. Multiple factors have been associated with EDS, especially life style. This study aimed to explore the relationships between dietary behaviors and EDS.

Methods A total of 988 Iranian adolescent girls aged between 12-18 years old were recruited this cross-sectional study. A Persian translation of the Epworth Sleepiness Scale (ESS) was used to determine the presence of EDS. A pre-validated questionnaire was used for the assessment of dietary behaviors. To investigate the association between diet-related practices and the prevalence of EDS, we applied logistic regression analysis.

Results The subjects who consumed a major meal three times daily had a 0.56 lower odds for EDS than the individual who consumed a single major meal (OR: 0.44; P = 0.01). Individuals with a 'high-rate of food chewing' were less likely to have EDS (OR: 0.55; P = 0.03). Compared with those who consumed fried or spicy foods daily, individuals who never consumed fried (OR: 1.8; P = 0.02) or spicy foods (OR: 1.71; P = 0.01) had a greater risk for EDS. In addition, there were direct associations between meal regularity and intra-meal fluid intake with EDS in an 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.

Conclusions The findings of our study show the importance of diet-related practices in determining EDS. Prospective intervention studies are required to confirm these results.

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 [1]. Daytime sleepiness 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 [2]. Daytime sleepiness can have detrimental long-term effects, including a poor quality of life, reduced work efficiency, depressive disorders, cognitive impairment, decreased alertness, injury at home or work and car accidents [1, 3, 4] . In addition, several studies have reported that daytime sleepiness is associated with obesity, metabolic syndrome, type 2 diabetes, hypertension and cardiovascular disease [5, 6]. Sleepiness is highly prevalent among school children [7]. Poor sleep quality is related to lack of attention in class, impairment of learning, poor school performance and lower overall productivity among school-children [8] especially in adolescent girls who also experience puberty-related biopsychosocial changes and menstrual periods [9].

Diet along with psychological disorders, media use, obesity and physical activity play an important role in the etiology of sleep-related disorders [10]. Alcohol consumption, a diet that is high in fat and refined

carbohydrates and sugary drinks, low consumption fruit and vegetables have been reported to be positively associated with sleep quality and health [11-13].

Epidemiological studies have reported that poor dietary habits can lead to metabolic disorders, obesity and functional gastrointestinal disorders [14-17], but little information is available about the relationship between eating behaviors and sleep-related disorders. Having a regular breakfast intake was found to be related to good sleep in Japanese female students [11], whereas a high-fat dinner was associated with poor sleep quality [13]. The role of dietary behaviors that may contribute to daytime sleepiness has received little attention in epidemiological studies, and there is no information on the association between dietary behaviors and daytime sleepiness. Given the detrimental effects of sleep quality and potential importance of eating behaviors, we aimed to evaluate the association between the some of diet-related behaviours and excessive daytime sleepiness (EDS) 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 girl students girls aged 12-18 years. The study population was recruited using a random cluster sampling method from several schools in different areas of city. We excluded 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. In addition, girls 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. The ethical committee of Mashhad University of Medical Sciences, Mashhad, Iran, approved the study and all participants and their parents completed informed written consent.

Demographic and anthropometric assessments

General Demographic information was collected by face-to-face interview, using a standard questionnaire. Physical activity was assessed through validated Modifiable Activity questionnaire [18] and provided as metabolic equivalentsmets in hours per day. To estimate energy intake, the reported portion size in FFQ were converted to grams using household measures and then were entered to the Nutritionist IV software. Body weight, height and waist circumference were measured by a trained technician using standard protocols. Body Mass Index was calculated as weight in kilograms divided by height in meters squared. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured by an experienced nurse using standard protocol.

Biochemical assessments

Fasting blood samples were obtained between 8 and 10 a.m after an overnight fast. A electrochemi-luminescence method (ECL, Roche, Basel, Switzerland) was used for the measurement of serum 25-OH

vitamin D. 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 by using Friedewald formula if serum TGs concentrations were lower than 4.52 mmol/L[19].

Dietary behaviors assessment

Data on diet-related practices including frequency of main meal (1, 2 or 3 times) and snack (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.

Assessment of sleep disorders

A Persian translation of the Epworth Sleepiness Scale (ESS) was used for the assessment of daytime sleepiness [20], and its reliability and validity has been published previously [21]. 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 [22].

Statistical analyses

Kolmogrov-Smirnow test was applied to assess the distribution of variables. Independent sample t-test was used detect differences in general characteristics (age, physical activity, energy intake, SBP and DBP) and biochemical assessments between individuals with and without EDS. Chi-square test was used to compare the categorical characteristics (menstruation, passive smoker, general and abdominal obesity) of the study population. To determine the association between diet-related practices and EDS, we used logistic regression in different models. Firstly, using an crude model, and then adjusted for age, physical activity, menstruation and passive smoking. Further adjustments were performed for general obesity. P-value <0.05 was considered statistically significant. All statistical analyses were performed using statistical Package for Social Sciences version 17 (SPSS Inc., Chicago, Illinois, USA).

Results

The prevalence of EDS was 24.3% (n= 241 of 747 girls) in our population sample. General characteristics of study participants by EDS status are presented in Table 1. The subjects with EDS were slightly older (p=0.02). No significant differences were obtained for menstruation, smoking status, physical activity, energy intake, SBP, DBP, general and abdominal obesity between girls with and without EDS. Biochemical

assessments of study participants including vitamin D, calcium, phosphorus, hs-CRP, fasting blood glucose, HDL-C, LDL-C, TC, TG, hemoglobin and hematocrit are summarized in Table 2. There were not any difference in biochemical parameters between two groups. Multivariate-adjusted odds ratios for EDS across categories of diet-related practices are indicated in Table 3. The subjects who consumed main meal for three times per day had 0.56 lower odds for EDS than the individual who consumed one main meal (OR: 0.44; 95% CI: 0.21- 0.91; P= 0.01); this association was significant after adjustment for confounding factors. 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, this relationship remained significant. Compared with those who consumed fried or spicy foods daily, individuals who never consumed fried (OR: 1.8; 95% CI: 0.55- 5.86; *P*= 0.02) or spicy food (OR: 1.71; 95% CI: 0.55- 5.29; P= 0.01) had a greater risk for EDS; Also, after controlling for confounders, these relationships remained significant. At first, there was no significant association between the greater adherence to regular meal consumption and risk of EDS, but after adjustment for confounding variables, we found that an 'always-regular meal consumption' was significantly associated with a lower risk of EDS (OR: 0.54; 95 % CI: 0.3–0.97; P= 0.04).

We did not find a significant relation between intra-meal fluid intake and risk of EDS in the crude model; but after adjustments for general obesity, the participants with a greater fluid intake of intra-meal had higher odds to have EDS (OR: 3; 95 % CI: 1.2– 7.3; P= 0.04). Neither in the crude nor in the adjusted models, there were significant associations between breakfast intake (OR: 0.71; 95 % CI: 0.45– 1.12; P= 0.11) and frequency of snack consumption (OR: 1.53; 95 % CI: 0.7– 3.35; P= 0.2) with EDS.

Discussion

EDS is a common complaint, which is described as the tendency to fall asleep during the day when subject means to remain awake [23]. Deleterious outcomes of EDS include physical and mental disorders that limit subject's function and quality of life [10]. In addition, irregular sleep patterns can have adverse long-term clinical conditions which may be associated with disability and mortality [24]. The prevalence of EDS is increased in the adolescent period due to hormonal changes-related to puberty and environmental factors [25]. With regard to important consequence of sleep health on quality of life, it is necessary to identify major factors, which may be effective on 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 to have 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 examine the association between diet-related practices and EDS. These findings indicated that dietary 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 the regular breakfast and dinner intakes seems to correlate with good sleep [11]. Meal timing and regularity can be related to modulated circadian clock gene expression [26]. On the other hand, amounts of dietary nutrient intakes are affected by frequency of meals, which can be associated with alteration in circadian rhythm. Several reports from previous studies have indicated meal nutrient composition especially before dinner may alter circadian regulation [13, 27, 28]. Also, irregular meal pattern may be associated with increased odds EDS through obesity [16] and cardiometabolic risk factors [29].

A positive association was found between habitual intake of fatty food and prevalence of EDS. As earlier reports showed, the individuals with sleep-related disorders have higher percentages of energy from fat [30, 31]. This finding was in line with two epidemiological studies, which suggested direct relationship between fat intake and short sleep in both children and adults [30, 31]. On the other hand, in the Jiangsu Nutrition Study, subjects with less than 7 h sleep consumed more percentage of calorie from fat [30]. More adherence to high fat diet revealed which alter the mammalian circadian clock. In addition, the individuals with ESD or other sleep-related disorders have increased desire for food intake, which associated with development to obesity [32]. There is increasing evidence for the role of gut microbiome in sleep health [33]. Alteration in gut microbiome, which was done by feeding by high fat, can modulate circadian clock gene expression in mice [34]. Serum concentrations of ghrelin and leptin is associated with regulation of sleep rhythm. It is proposed that dietary fat intake alter levels of leptin and ghrelin [35]. 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 [36-38].

We observed an association between a high intake of intra-meal fluid and low rate of food chewing with increased risk of EDS. No information is available on whether intra-meal fluid intake and food chewing rate is 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 [14, 39]. There is growing evidence, which FGIDs are accounted as an important risk factor for incidence of EDS [40]. Another mechanism by which intra-fluid intake and chewing insuffiency elevate the prevalence of EDS may be related to increased risk of obesity [16, 41, 42].

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 association between spicy foods intake and sleep-related disorders. There are strong evidences that the individuals with higher intake of spices experience more intense symptoms of FGIDs [14, 15]; therefore, an increased incidence of sleep-related disorder is seen 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 diet-related practices 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. Major limitation is related to cross-sectional design of the study; therefore, we do not describe a causal association. In addition, it is more likely to exist unmeasured confounders in our study, which we are unable to control them.

Conclusion

In summary, there are direct associations between more frequency of main meal consumption, meal regularity and high rate of food chewing with EDS prevalence. Greater intra-fluid intake and higher consumptions of spicy and fried foods were associated with EDS presence. 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 dietary 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 and MGM formulated the research questions, designed the study and wrote the first draft of manuscript. FR, ZA and MM collected the data and revised the manuscript. GF, ZA 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.

Author details

[1]Nutrition and Food Security Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran. [2]Department of Nutrition, Faculty of Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran. [3]Metabolic syndrome Research Center, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. [4]Department of Nutrition, Provincial Health Center, Mashad University of Medical Sciences, Mashad, Iran. [5]Vice Chancellery of Public Health, Sabzevar University of Medical Sciences, Sabzevar, Iran. [6]Brighton & Sussex Medical School, Division of Medical Education, Falmer, Brighton, Sussex, UK. [7]Department of Modern Sciences and Technologies, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.

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Tables

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

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

†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.

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

†Obtained from Independent samples t-test.

Table 3. Multivariable-adjusted odds ratio of the association between dietary habits and daytime sleepiness.

Model II	Model I	Crude	Type of dietary habit
Consumption of main meal			
1	1	1	1 time
0.53 (0.24-1.14)	0.55 (0.25-1.17)	0.57 (0.27-1.2)	2 times
0.42 (0.2-0.88)	0.44 (0.21-0.92)	0.44 (0.21-0.91)	3 times
0.02	0.03	0.01	*P trend* ¶
Snack consumption			
1	1	1	Never
1.24 (0.55-2.75)	1.26 (0.57-2.8)	1.17 (0.54-2.53)	1-2
1.59 (0.71-3.59)	1.67 (0.74-3.73)	1.53 (0.7-3.35)	≥3
0.09	0.06	0.2	*P trend*
Regular meal consumption			
1	1	1	Never
0.63 (0.38-1.06)	0.66 (0.4-1.1)	0.68 (0.41-1.13)	Sometimes
0.55 (0.32-0.94)	0.59 (0.34-0.99)	0.64 (0.38-1.07)	Almost
0.53 (0.29-0.95)	0.54 (0.3-0.97)	0.55 (0.31-0.79)	Always
0.04	0.04	0.06	*P trend*
Rate of food chewing			
1	1	1	Low
0.6 (0.38-0.92)	0.59 (0.38-0.91)	0.59 (0.38-0.9)	Moderate
0.52 (0.27-1.01)	0.51 (0.27-0.98)	0.55 (0.29-1.04)	High
0.03	0.02	0.03	*P trend*
Breakfast consumption			
1	1	1	Never or 1 day
1.05 (0.64-1.74)	1.02 (0.63-1.67)	0.97 (0.6-1.56)	2-4 day
1.43 (0.83-2.47)	1.49 (0.88-2.53)	1.41 (0.84-2.36)	5-6 day
0.8 (0.49-1.29)	0.78 (0.48-1.25)	0.71 (0.45-1.12)	Every day
0.26	0.24	0.11	*P trend*
Intake of fluids with meal			
1	1	1	Never
2.51 (1.02-6.1)	2.19 (0.94-5.08)	2.14 (0.92-4.96)	Sometimes
2.6 (1.06-6.51)	2.29 (0.98-5.37)	2.28 (0.98-5.33)	Almost
3 (1.2-7.3)	2.64(1.13-6.1)	2.58 (1.11-5.98)	Always
0.04	0.05	0.05	*P trend*
Consumption of fried foods			
1	1	1	Never
1.36 (0.44-4.2)	1.47 (0.48-4.52)	1.15 (0.42-3.17)	1-3 in week
2.05 (0.65-6.4)	2.17 (0.69-6.79)	1.67 (0.59-4.68)	4-6 in week
2.25 (0.61-8.23)	2.59 (0.71-9.39)	1.8 (0.55-5.86)	Every day
0.01	0.008	0.02	*P trend*
Consumption of spicy foods			
1	1	1	Never
1.32 (0.36-4.79)	1 (0.31-3.1)	1.04 (0.33-3.27)	1-3 in week
1.98 (0.55-7.06)	1.5 (0.48-4.65)	1.54 (0.5-4.73)	4-6 in week
2.09 (0.58-7.5)	1.61 (0.51-5.03)	1.71 (0.55-5.29)	Every day
0.02	0.02	0.01	*P trend*

* Adjusted for age, physical activity, menstruation and passive smoking.
** Additionally adjusted for general obesity.
¶ Resulted from Mantel-Haenszel extension c2 test.