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# Distribution of Nutrients in Breakfast and Midmorning Snacks among Overweight or Obese Adolescents of Yazd, Iran

**Majid Karandish; PhD[1], Hassan Mozaffari-Khosravi; PhD[2], Ali Mohammad Hadianfard; PhD[3], Maryam Azhdari; MSc*[4,5], Rezvan Amiri; MSc[4], Farhang Mirzavandi; MSc[2,6], Siavash Babaie; MSc[2,6], Mahtab Tabatabaie; MSc[2,6] & Shamim Shams-Rad; MSc[2,6]**

[1] *Health Research Institute, Diabetes Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.*
[2] *Department of Nutrition, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.*
[3] *Department of Health Information Technology, School of Paramedical Sciences, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.*
[4] *Nutrition and Metabolic Diseases Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.*
[5] *Nutrition Department, School of Paramedicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.*
[6] *Nutrition and Food Security Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.*

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***Corresponding author:***
azhdari_mar@yahoo.com
PhD candidate (Nutritional Sciences), Nutrition and Metabolic Diseases Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.

***Postal code:*** 61357-15794
***Tel:*** +98 9131571909

***ABSTRACT***

**Background:** The important risk factors in obesity are related to unhealthy nutritional habits. The aim of this study was to estimate and compare the macro- and micro-nutrients' intake in breakfast and midmorning snacks. **Methods:** This cross-sectional study was conducted among 569 students (12-16 years) by the multistage cluster sampling method. The demographic data were gathered by interview. Anthropometric data and breakfast habits (breakfast frequency and time as well as nutrients' intake at breakfast or snacks) were measured using standardized instruments by asking some questions. **Results:** The results showed that the high prevalence of irregular breakfast eating (IRBE) and overweight or obesity. No significant difference was found between breakfast frequency and time according to the students' gender or body mass index (BMI). The mean BMI had a significant increase in females; whereas, the percentage of energy from breakfast ($E_B$%), snack ($E_S$%), or both breakfast and snacks ($E_{BS}$%) were shown no significant difference between genders. A significant increase was found in $E_B$%, $E_B$%, and $E_{BS}$%; whereas, the daily energy intake (DEI) was lower in normal-weight students. However, other nutrients at breakfast or snacks had no significant difference. The level of higher DEI was reported in IRBE adolescents. **Conclusions:** An inappropriate breakfast habit can cause irreparable consequences in adolescents. Although breakfast plays an undeniable role, other factors are also effective in one's health. Further studies are required for more comprehensive results.

**Keywords:** *Breakfast; Midmorning snacks; Nutrients; Adolescents; Overweight; Obesity*

## Introduction

The prevalence of overweight and obesity is gradually increasing among adolescents around the world (Gortmaker *et al.*, 2011). The overweight or obesity rate was reported as 18% in 2016 based on the World Health Organization (WHO) report. The increasing rate was similar in

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males and females (World Health Organization, 2018). The prevalence of obesity and overweight was reported relatively remarkable among Iranian adolescents and children (Ahadi *et al.*, 2015, Maddah, 2007);(Rashidi *et al.*, 2007).

Given that childhood obesity is related to hypertension, (Malhotra and Nistane, 2016), insulin resistance, (Caprio *et al.*, 2017), and cardiovascular risk factor (Raj and Kumar, 2010), it is considered as one of the serious concerns (Malhotra and Nistane, 2016). Some factors associated with overweight and obesity include lifestyle habits (low physical activity, and food intake behaviors (Ahadi *et al.*, 2015) such as increased fast food consumption and breakfast skipping) (Alimoradi *et al.*, 2017).

Breakfast skipping is common among children and adolescents and its prevalence is increasing with age (Rampersaud *et al.*, 2005). It is associated with inappropriate levels of blood glucose, lipids (such as triglycerides and very-low-density lipoprotein cholesterol) (Kesztyüs *et al.*, 2017), unhealthy lifestyle (Kang and Park, 2016, Monzani *et al.*, 2019), lower diet quality, increased risk for chronic diseases, and lower overall health. However, selecting every kind of food for breakfast cannot provide energy and essential nutrients; so, the quality of breakfast is important (O'Neil and others 2014). Breakfast provides about 15-25 % of the daily energy needs of children (Gibney *et al.*, 2018, O'Neil *et al.*, 2014). Although snacks can provide some key nutrients, the frequency and quality of the consumed foods in snacks are important. Furthermore, we are faced with paucity of information regarding the effect of snacks on weight status in young people (Larson and Story, 2013).

Given the importance of this issue and lack of related studies, this research was aimed to estimate and compare breakfast habits (the macro- and micro-nutrients intake of breakfast and midmorning snacks, as well as breakfast frequency and time) among high school students in Yazd City, Iran.

## Materials & Methods

***Study design and sample gathering:*** This cross-sectional study was conducted among 12-16 years old high school students of Yazd, located in the center of Iran. A random multistage cluster sampling method was performed to select the students. The eligibility criteria for the participating students included submitting written consent (the students and their parents) to cooperate in the study; living in Yazd for more than six months; having no diseases such as Hormonal impairment (thyroid, insulin, sex hormone and etc.), cardiovascular disorders, digestive diseases, pulmonary disease, kidney disease, megalomaniac, anxiety, and depression; having no history of hospitalization in the last 6 months for any reason (e.g., fractures, injuries, etc.); not being exposed to unpleasant events the last year (death of parents, parental divorce, death of family members); living with one of the parents or relatives for any reason; and using no drugs including narcotic and psychotropic drugs. All information was recorded by the trained research assistants.

***Demographic characteristics:*** The demographic data (gender, age, household size, and grade) were gathered by interviews and then the collected data were checked based on the students' records.

***Anthropometric data:*** Anthropometric data, such as weight, height, body mass index (BMI) and waist circumstance (WC)) were measured using standardized instruments. The measurements of weight and height were conducted by a pre-calibrated electronic scale (Seca, Germany) to the nearest 0.1 kg and a stadiometer to the nearest 0.1 cm on a scale placed on flat ground. The participants' BMI was calculated by dividing weight in kilogram by height squared in meter. Moreover, BMI for age was calculated by z-score (-2 to +2 in increments of two-thirds of a z score) (Cole, 1994). The calculated BMI z-scores were categorized into three groups; thin (BMI ≤-2SD), normal (BMI between 1SD to -2SD), and overweight or obesity (BMI ≥1SD) (Onis *et al.*, 2007). The WHO website has provided the BMI z-score tables (World Health



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Organization, 2016). A non-elastic strip was used to measure WC with a precision of 0.01 cm (Knowles *et al.*, 2011).

***Breakfast habits:*** Breakfast habits (breakfast timing and frequency, midmorning snacks intake) were collected by asking some questions. For example,

1) ‘‘How many times per week do you consume breakfast?” Response categories: irregular breakfast eating (IRBE) (0-4 times/week), regular breakfast eating (RBE) (5-7 times/week) (Hassan *et al.*, 2018); 2) what time do you have breakfast during the week? Response categories: a) before 9:30 (H: min), b) after 9:30 (H: min) (Grieger and Cobiac, 2012); 3) “Do you have a midmorning snacks daily?” Yes or No. 4) Where do you get your breakfast? Response categories: a) home, b) out of home (buying food from the school’s buffet/at shops away from school or eating at a restaurant) (Maddah *et al.*, 2009).

***Calculation of total energy expenditure and Basal metabolic rate:*** The total energy expenditure (TEE) was calculated by the following formula (James and Schofield, 1990):

TEE= Basal metabolic rate (BMR) × physical activity level (PAL)

BMR for boys: 17.5 × weight + 651

BMR for girls: 12.2 × weight + 746

***Nutrient contributions:*** Breakfast and morning snacks intake were obtained from a 7-day food record (24-hour dietary recalls for 7 consecutive days). The research assistants were required to train the students on how to complete food records. The students were required to deliver the completed forms daily. To this end, a research assistant was at the school every morning for 2 hours (to check the students' forms). Nutritionist 4 software (version I) was run to estimate the daily energy intake (DEI) (Kcal), the amount of macro- and micro-nutrients of breakfast and morning snacks: the energy intake at breakfast ($E_B$), the energy intake at midmorning snacks ($E_S$), or overall breakfast and midmorning snacks ($E_{BS}$) (Kcal), protein (g), total carbohydrate (g), total fat (g), saturated fat (g), total fiber (g), fat-soluble vitamins (A, D, K (µg), and E (mg)), water-soluble vitamins B complex and C (mg), zinc (mg), iron (mg), calcium (mg), sodium (mg), and caffeine (mg). Also, the proportion of energy intake at breakfast, midmorning snacks or both of them were calculated by the following formula.

$E_B$ % or $E_S$ % = the ratio of breakfast or midmorning snacks to overall energy intake

$E_B$ % or $E_S$ % = ($E_B$ or $E_S$/ DEI) × 100

$E_{BS}$ % = the ratio of breakfast and midmorning snacks to overall energy intake

$E_{BS}$ % = ($E_{BS}$/ DEI) × 100

***Data analysis:*** The mean ± standard deviation (SD) and percentages were used to describe the variables. The normality distribution was tested by the Kolmogorov-Smirnoff test to distinguish the parametric or non-parametric test. Independent *t-test* was used to compare the continuous variables. Analysis of covariance (ANCOVA) was applied to compare the nutrients intake between genders. Moreover, the analysis was adjusted for the confounding variables (TEE and DEI). All data were analyzed by SPSS version 22 (SPSS, Inc, Chicago, Illinois, USA). Statistical tests were analyzed at the significant level of < 0.05.

***Ethics considerations:*** The students and their parents filled out written consent forms to participate in this study. The study protocol was approved by the Research Ethical Committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1396.1087).

## Results

Among 569 adolescents, 52.2% and 47.8 % were boys and girls, respectively. The mean of students’ age, BMI, and WC were 14.24 ± 0.88 years, 21.66 ± 4.74 (kg/m$^2$), and 72.98 ±11.15 (cm), respectively. The baseline descriptive characteristics of the students are illustrated in **Table 1**. The prevalence of IRBE was 61.9% among the students. The midmorning snacks intake was reported among 85.6% of adolescents. The breakfast of 96.3% of the students was prepared from home.

The distribution of the macro- and micro-nutrients intake at breakfast and midmorning



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snacks is shown in **Table 2**. Significantly, the students showed a higher intake for energy, total carbohydrate, total fat ($P < 0.01$), energy, saturated fat, and zinc ($P < 0.05$) in midmorning snacks. However, the mean of protein, caffeine, iron, and calcium were significantly higher at breakfast ($P < 0.01$). The intake of total fiber, sodium, some of fat-soluble vitamins (A, D, E, K), and water-soluble vitamins (B complex, C) did not reveal a significant difference between midmorning snacks and breakfast ($P > 0.05$).

The comparison of breakfast frequency and time (mean ± SD) did not show a statically significant difference based on gender, (3 ± 2.85 vs. 2.6 ± 2.5; 09:10 ± 00:43 vs. 09:02 ± 01:02 (boy vs. girl students, $P > 0.05$), respectively. Adjusted BMI (mean ± SD) for age had a significant increase in females (20.434 ± 4.67 (male) vs. 23.030 ± 4.8 (female), $P < 0. 01$).

The TEE and DEI (mean ± SD) were significantly higher among the male students (2730.39 ± 411.46 vs. 2433.15 ± 326.79, 2593.04 ± 496.88 vs. 2311.15 ± 409.38, $P < 0.01$); but the ratio of DEI to TEE did not show a significant difference between genders (0.95 ± 0.13 (male) vs. 0.95 ± 0.10 (female), $P > 0.05$).

Significantly, $E_B$% (adjusted mean ± SD) was higher in males ($P < 0.05$); but no significant difference (adjusted mean ± SD) was observed regarding $E_S$%, $E_{BS}$ %, and $E_{BS}$ between both genders ($P > 0.05$) (data were not listed in the tables). The comparison of the macro- and micro-nutrients intake at breakfast and midmorning snacks between genders is presented in **Table 3**.

At breakfast, adjusted mean total carbohydrate, total fat, saturated fat, fat-soluble vitamins, vitamin B complex, vitamin C, and caffeine were significantly higher among the male students ($P < 0.05$). Given the midmorning snacks, boys consumed significantly higher adjusted mean total carbohydrate, protein, saturated fat, vitamin C, zinc, calcium, and iron than girls. However, the other nutrients did not show a significant difference between genders.

Considering the BMI categories (normal weight group, overweight or obesity groups), no significant difference was observed for mean ± SD of the breakfast time and frequency (9:05 ± 00:59 vs. 9:06 ± 00:43 and 2.63 ± 2.5 vs. 3 ± 2.85, $P > 0.05$). Moreover, no significant difference was observed between $E_{BS}$ (Kcal) and the normal weight and overweight or obesity adolescents ($P > 0.05$), but $E_{BS}$ %, $E_B$ %, and $E_S$ % were greater in the normal weight students compared to the overweight or obesity group ($P < 0.05$). A significant increase was found in DEI among the overweight or obese adolescents compared to the normal-weight adolescents (2301.69 ± 386.00 vs. 2778.57 ± 446.03, $P < 0.01$). Data are not shown in the table.

According to **Table 1**, only 3.5% of the students were thin; so, distribution of the macro- and micro-nutrients intake was compared between the two study groups (the normal weight group and overweight or obesity group). **Table 4** illustrates comparison of the nutrients' intake at breakfast and midmorning snacks between normal weight and overweight or obesity students. The comparison of nutrients intake did not represent a significant difference between the normal-weight group and overweight or obesity group at breakfast or midmorning snacks ($P > 0.05$).

According to the breakfast frequency, mean of BMI was not significantly different between the IRBE and the RBE groups (21.57 ± 4.82 VS. 21.81 ± 4.65; $P > 0.05$). However, DEI was significantly higher in the IRBE group than the RBE group (2535.37 ± 27.75, 2359.95 ± 27.74; $P < 0.01$).

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**Table 1.** The baseline descriptive characteristics of the students

| Variables | N | % |
|---|---|---|
| Gender | | |
| Boy | 297 | 52.2 |
| Girl | 272 | 47.8 |
| Grade | | |
| Seventh | 143 | 25.1 |
| Eighth | 181 | 31.8 |
| Ninth | 245 | 43.1 |
| Weight status | | |
| Thin | 30 | 5.5 |
| Normal | 306 | 56.7 |
| Overweight or obesity | 203 | 37.6 |
| Household size | | |
| Less than 4 | 290 | 55.8 |
| More than 4 | 230 | 44.2 |
| Breakfast frequency | | |
| Irregular breakfast eating (0-4 times/wk) | 352 | 61.9 |
| Regular breakfast eating (5-7 times/wk) | 217 | 38.1 |
| Breakfast time | | |
| Before 9:30 AM | 279 | 90.6 |
| After 9:30 AM | 29 | 9.4 |
| Midmorning snacks | | |
| No | 82 | 14.4 |
| Yes | 487 | 85.6 |
| The place of breakfast preparation | | |
| Home | 335 | 96.3 |
| Out of home | 13 | 3.7 |

**Table 2.** Comparison of mean (±SD) of the macro- and micro-nutrients' intake between breakfast and midmorning snacks

| Nutrients | Breakfast (N= 340) | Midmorning snacks (N= 487) | P-value[a] |
|---|---|---|---|
| Energy (Kcal) | 355.68 ±140.21 | 549.80 ± 38.52 | 0.002 |
| Energy (%)[b] | 14.50 ± 8.67 | 20.05 ± 11.10 | <0.001 |
| Total carbohydrate (g) | 43.39 ± 24.57 | 61.34 ± 5.39 | 0.005 |
| Total Fiber (g) | 6.67 ± 4.79 | 5.36 ± 0.44 | 0.3 |
| Protein (g) | 87.21 ± 37.67 | 7.55 ± 0.91 | 0.003 |
| Total Fat (g) | 16.00 ± 3.86 | 32.40 ± 1.90 | 0.001 |
| Saturated Fat (g) | 4.39 ± 1.32 | 10.31 ± 0.73 | 0.01 |
| Vitamin A (µg) | 54.06 ±19.36 | 75.75 ± 23.48 | 0.004 |
| Vitamin E (mg) | 3.29 ±1.09 | 12.79 ± 0.51 | 0.5 |
| Vitamin D (µg) | 0.32 ± 0.12 | 0 | - |
| Vitamin K (µg) | 9.08 ± 2.00 | 25.54 ± 1.71 | 0.05 |
| Vitamin C (mg) | 6.10 ± 0.92 | 47.37 ± 10.70 | 0.2 |
| Vitamin B complex (mg) | 6.36 ± 3.37 | 5.37 ± 0.28 | 0.4 |
| Zinc (mg) | 1.96 ± 0.96 | 15.54 ± 4.92 | 0.02 |
| Iron (mg) | 2.73 ± 1.71 | 1.71 ± 0.16 | 0.008 |
| Calcium (mg) | 195.19 ± 50.39 | 46.48 ±12.21 | <0.001 |
| Sodium (mg) | 510.87 ±287.35 | 555.47 ± 33.36 | 0.2 |
| Caffeine (mg) | 1.54 ±4.65 | 0.56 ± 0.61 | 0.001 |

[a]: Student *t-test;* [b]:Ratio of intake of energy from breakfast and midmorning snack to total energy intake.



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**Table 3.** Comparison of mean (±SD) of the macro- and micro-nutrients intake at breakfast or midmorning snacks between genders

| Nutrients | Unadjusted | | | Adjusted | | |
|---|---|---|---|---|---|---|
| | Male | Female | P_value[a] | Male | Female | P_value[b] |
| **Breakfast** | | | | | | |
| Energy (kcal) | 372.4 ± 135.1 | 335.9 ± 143.9 | 0.01 | 374.6 ± 134.2 | 330.7 ± 144.8 | 0.01 |
| Total carbohydrate (g) | 45.69 ± 23.67 | 40.69 ± 25.41 | 0.06 | 46.11 ± 23.74 | 39.86 ± 25.6 | 0.04 |
| Total Fiber (g) | 6.99 ± 4.74 | 6.33 ± 4.84 | 0.2 | 7.07 ± 4.16 | 6.16 ± 4.99 | 0.1 |
| Protein (g) | 90.18 ± 35.55 | 84.00 ± 39.9 | 0.1 | 90.64 ± 36.76 | 82.85 ± 39.46 | 0.1 |
| Total Fat (g) | 16.76 ± 3.9 | 15.10 ± 3.62 | <0.001 | 16.77 ± 3.66 | 14.95 ± 3.87 | <0.001 |
| Saturated Fat (g) | 4.64 ± 1.37 | 4.11 ± 1.22 | <0.001 | 4.46 ± 1.22 | 4.05 ± 1.37 | 0.001 |
| Vitamin A(µg) | 1549.8 ± 321.4 | 1430.1 ± 255.8 | <0.001 | 57.52 ± 18.58 | 49.36 ± 19.98 | 0.003 |
| Vitamin E (mg) | 3.52 ± 1.17 | 3.03 ± 1.0 | <0.001 | 2.11 ± 0.54 | 1.81 ± 0.62 | <0.001 |
| Vitamin D (µg) | .34 ± 0.12 | 0.30 ± 0.13 | 0.01 | 0.34 ± 0.13 | 0.3 ± 0.12 | 0.02 |
| Vitamin K (µg) | 9.4 ± 2.14 | 8.62 ± 1.7 | <0.001 | 9.45 ± 1.89 | 8.56 ± 1.99 | <0.001 |
| Vitamin C (mg) | 6.30 ± 1.03 | 5.85 ± 0.69 | <0.001 | 6.27 ± 0.81 | 5.84 ± 0.87 | <0.001 |
| Vitamin B complex | 6.65 ± 3.25 | 6.02 ± 3.48 | 0.08 | 6.68 ± 3.39 | 6.01 ± 3.37 | 0.08 |
| Zinc (mg) | 2.04 ± 0.92 | 1.86 ± 0.99 | 0.09 | 2.05 ± 0.81 | 1.86 ± 0.99 | 0.08 |
| Iron (mg) | 2.88 ± 1.65 | 2.56 ± 1.77 | 0.09 | 2.90 ± 1.76 | 2.51 ± 1.74 | 0.07 |
| Calcium (mg) | 198.7 ± 48.3 | 190.9 ± 52.5 | 0.1 | 200.2 ± 48.8 | 188.8 ± 52.4 | 0.1 |
| Sodium (mg) | 529.1 ± 277.5 | 489.3 ± 297.9 | 0.2 | 535.2 ± 279.4 | 480.5 ± 301.0 | 0.1 |
| Caffeine (mg) | 2.25 ± 6.15 | 0.70 ± 1.16 | 0.001 | 2.13 ± 4.47 | 0.67 ± 4.74 | 0.007 |
| **Midmorning Snacks** | | | | | | |
| Energy (Kcal) | 554.5 ± 39.72 | 545.0 ± 36.76 | 0.006 | 554.2 ± 31.19 | 544.3 ± 40.61 | 0.01 |
| Total carbohydrate (g) | 62.30 ± 5.72 | 60.39 ± 4.87 | <0.001 | 62.18 ± 5.14 | 60.32 ± 5.62 | <0.001 |
| Total Fiber (g) | 5.40 ± 0.52 | 5.32 ± 0.34 | .03 | 5.40 ± 0.46 | 5.32 ± 0.46 | 0.05 |
| Protein (g) | 7.72 ± 1.0 | 7.38 ± 0.78 | <0.001 | 7.70 ± 0.77 | 7.35 ± 0.93 | <0.001 |
| Total Fat (g) | 32.47 ± 1.89 | 32.34 ± 1.91 | 0.4 | 32.49 ± 1.74 | 32.30 ± 2.03 | 0.4 |
| Saturated Fat (g) | 10.30 ± 0.72 | 10.32 ± 0.74 | 0.7 | 10.32 ± 0.62 | 10.31 ± 0.78 | 0.8 |
| Vitamin A (µg) | 76.15 ± 23.38 | 75.35 ± 23.43 | 0.1 | 75.82 ± 21.86 | 75.81 ± 24.99 | 0.3 |
| Vitamin E (mg) | 12.77 ± 0.51 | 12.82 ± 0.52 | 0.2 | 4.62 ± 0.15 | 4.63 ± 0.15 | 0.2 |
| Vitamin D (µg) | 0 | 0 | - | 0 | 0 | - |
| Vitamin K (µg) | 25.52 ± 1.71 | 25.55 ± 1.56 | 0.8 | 25.54 ± 0.15 | 25.56 ± 0.11 | 0.8 |
| Vitamin C (mg) | 49.31 ± 12.77 | 45.43 ± 7.91 | <0.001 | 48.94 ± 15.43 | 45.54 ± 14.52 | 0.001 |
| Vitamin B complex | 5.40 ± 0.31 | 5.35± 0.26 | .07 | 5.4 ± 15.43 | 5.36 ± 0.15 | 0.1 |
| Zinc (mg) | 16.49 ± 5.58 | 14.59 ± 3.95 | <0.001 | 16.34 ± 72.17 | 14.49 ± 5.15 | 0.03 |
| Iron (mg) | 1.74 ± 0.17 | 1.68 ± 0.13 | <0.001 | 1.73 ± 0.15 | 1.68 ± 0.15 | <0.001 |
| Calcium (mg) | 48.20 ± 13.66 | 44.76 ± 10.31 | .002 | 48.18 ± 11.69 | 44.42 ± 12.8 | .02 |
| Sodium (mg) | 557.9± 35.4 | 553.0 ± 30.9 | 0.1 | 557.9 ± 34.7 | 553.0 ± 34.8 | 0.1 |
| Caffeine (mg) | 0.58 ± 0.64 | 0.54 ± 0.59 | 0.5 | 0.57 ± 0.62 | 0.553 ± 0.62 | 0.7 |

[a] Statistical analysis was performed by an independent t-test; [b] Statistical analysis was performed using ANCOVA, Adjusted for TEE (2590.86) and daily energy intake (2395.90) (kcal/day)

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**Table 4.** Comparison of mean (±SD) of the macro- and micro-nutrient intake at breakfast or midmorning snacks between normal weight and overweight or obesity group

| Nutrients | Breakfast | | | Midmorning snacks | | |
|---|---|---|---|---|---|---|
| | Normal weight [a] | Overweight or obesity [a] | P_value[a] | Normal weight [a] | Overweight or obesity [a] | P_value[a] |
| Energy (Kcal) | 363.4 ± 133.0 | 348.4 ± 150.2 | 0.3 | 548.8 ± 37.7 | 550.2 ± 40.1 | 0.7 |
| Total carbohydrate(g) | 44.86 ± 23.16 | 42.08 ± 26.61 | 0.3 | 61.15 ± 5.16 | 61.49 ± 5.82 | 0.5 |
| Total Fiber (g) | 6.9 ± 4.4 | 6.4 ± 5.3 | 0.3 | 5.34 ± 0.37 | 5.40 ± 0.55 | 0.2 |
| Protein (g) | 89.41 ± 35.96 | 85.09 ± 39.89 | 0.3 | 7.52 ± 0.87 | 7.53 ± 0.92 | 0.8 |
| Total Fat (g) | 16.09 ± 3.87 | 15.89 ± 3.88 | 0.6 | 32.40 ± 1.92 | 32.39 ± 1.92 | 0.9 |
| Saturated Fat (g) | 4.43 ± 1.28 | 4.31 ± 1.34 | 0.4 | 10.33 ± 0.76 | 10.29 ± 0.71 | 0.5 |
| Vitamin A (µg) | 54.35 ± 21.4 | 52.99 ± 16.31 | 0.1 | 75.24 ± 22.36 | 76.13 ± 24.92 | 0.4 |
| Vitamin E (mg) | 3.26 ± 1.18 | 3.34 ± 0.93 | 0.5 | 12.78 ± 0.52 | 12.83 ± 0.52 | 0.3 |
| Vitamin D (µg) | 0.32 ± .12 | 0.32 ± 0.13 | 0.7 | 0 | 0 | - |
| Vitamin K (µg) | 9.14 ± 2.22 | 9.04 ± 1.79 | 0.6 | 25.51 ± 1.73 | 25.64 ± 1.77 | 0.4 |
| Vitamin C (mg) | 6.11 ± 1.00 | 6.04 ± 0.76 | 0.4 | 46.73 ± 9.55 | 48.31 ± 12.87 | 0.1 |
| Vitamin B complex | 6.45 ± 3.25 | 6.33 ± 3.54 | 0.7 | 5.36 ± 0.27 | 5.39 ± 0.31 | 0.3 |
| Zinc (mg) | 2.01 ± .91 | 1.91 ± 1.03 | 0.4 | 15.36 ± 4.67 | 15.45 ± 4.80 | 0.8 |
| Iron (mg) | 2.82 ± 1.60 | 2.65 ± 1.86 | 0.3 | 1.70 ± 0.15 | 1.71 ± 0.16 | 0.7 |
| Calcium (mg) | 198.6 ± 47.8 | 191.8 ± 53.6 | 0.2 | 46.2 ± 11.4 | 46.1 ± 12.7 | 0.9 |
| Sodium (mg) | 528.4 ± 269.2 | 495.4 ± 310.6 | 0.3 | 554.5 ± 32.9 | 555.8 ± 33.9 | 0.6 |
| Caffeine (mg) | 1.35 ± 2.97 | 1.64 ± 6.36 | 0.5 | 0.60 ± 0.64 | 0.51 ± 0.59 | 0.1 |

[a]: Student *t-test*

## Discussion

The main findings showed the high prevalence of abnormal weight and IRBE, which is in agreement with the previous studies (Gortmaker *et al.*, 2011, Saikia *et al.*, 2016, Yang *et al.*, 2006).The $E_{BS}$%, $E_B$%, and $E_S$ % were higher in normal-weight students; whereas, the DEI was lower in normal-weight adolescents. Contrary to the study by Schusdziarra et al., increasing breakfast energy was associated with greater overall intake in normal-weight (Schusdziarra *et al.*, 2011). It seems that a healthy breakfast plays an important role to improve the daily energy balance and overall health (Affinita *et al.*, 2013, Ferrer-Cascales *et al.*, 2018). No significant difference was found between the two genders and the students' weight status with regard to the breakfast frequency and time. In agreement with the present findings, no relationship was reported between the prevalence of IRBE and weight status (Hassan *et al.*, 2018, Rodrigues *et al.*, 2016). However, some studies reported a higher prevalence of the overweight or obesity in breakfast skippers or IRBE (Boričić *et al.*, 2014, O'Neil *et al.*, 2014, Yang *et al.*, 2006). No significant discrepancy was observed in the breakfast time among students, which can be justified by the fact that the data were collected in the second educational semester. Despite a significantly higher BMI in females, no significant difference was found $E_B$%, $E_{BS}$ %, and $E_{BS}$ between the genders. It seems that other factors, such as genetics, socioeconomic status (SES), level of physical activity, using computer, sleep duration, breastfeeding duration, and levels of parental education are associated with overweight and obesity prevalence in adolescents (Abiri *et al.*, 2019, Narciso *et al.*, 2019). Furthermore, higher daily energy intake was observed in IRBE adolescents, which is supported by the study conducted by Pereira et al. (Pereira *et al.*, 2018).

Based on the results, adolescents consumed more nutritious breakfast than midmorning snacks; however, $E_S$ and $E_S$ % were greater than $E_B$ and $E_B$ %, respectively. Some studies illustrated that the quality and quantity of the breakfast had an important role in daily energy intake (Kang and Park, 2016, Schusdziarra *et al.*, 2011).

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Some health-related macro- and micro-nutrients at breakfast or midmorning snacks were better in male adolescents than females. This result was in disagreement with the study by Monteagudo et al. They reported that breakfast quality index (BQI**)** **s**cores were lower among boys in all age groups containing children and adolescents. The lowest BQI scores were observed in boys aged 14-17 years (Monteagudo *et al.*, 2013).

The present study also had some limitations. The results of a cross-sectional study should be interpreted with caution. The results can be biased due to self-reporting method of data collection. Some confounding factors existed that were not measured. Finally, we did not consider other factors such as physical activity, quality of sleep, time of dinner, quality of dinner (Karatzi *et al.*, 2017, Kesztyüs *et al.*, 2017), and family meals (Rasmussen *et al.*, 2006, Utter *et al.*, 2008). The strengths of this study include its large sample size and simultaneous assessment of the breakfast and midmorning snacks by a 7-day food record.

## Conclusions

The prevalence of overweight or obesity and IRBE were relatively high in high school students. However, breakfast frequency and time were not significantly different between male and female participants as well as the participants' BMI. According to BMI, no significant increase was found for macro- and micro-nutrients except for the percentage of energy from breakfast, midmorning snack, and both of breakfast and midmorning snacks. The IRBE adolescents consumed higher daily energy intake.

An inappropriate breakfast habit (IRBE, high or low calories, and/or an insufficient variety of nutrients) can cause irreparable consequences in this age group. Although breakfast frequency and composition are very important among adolescents, other factors such as dinner quality, healthy back-to-school breakfast, physical activity, and SES are also effective. Given the importance of a healthy diet pattern in adolescents and determination of effective factors in overweight and obese adolescents, further related studies are required in this area.

## Conflict of interests

The authors declare that they have no conflict of interest.

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## Authors' contributions

Mozaffari-khosravi H, Karandish M and Azhdari M designed the research; Shams-Rad S, Tabatabaie M, Mirzavandy F, and Babaie S were responsible for the data collection; Azhdari M and Hadianfard AM analyzed the data; Azhdari M and Amiri R were involved in drafting the paper, Mozaffari-khosravi H and Karandish had primary responsibility for the final content. All authors read and approved the final paper.

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