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# Breakfast intake is associated with higher dietary diversity score, weight satisfaction and lower body mass index in girl adolescents

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A B S T R A C T

**Background:** To evaluate the association of breakfast intake with micro and macro nutrients intake, dietary diversity score (DDS), food group consumption and body mass index (BMI) in girl students.

**Methods:** A total of 384 female students (aged 15 to 19 years) were recruited from high-schools of Tehran using stratified sampling. Information regarding frequency of breakfast consumption was collected by asking questions on a three-point scale of "always", "sometimes" and "never". Physical activity and DDS were measured by International Physical Activity Questionnaire (IPAQ), Dietary Diversity Questionnaire (FAO-2013), respectively. In addition, weight, height and waist circumference (WC) were measured and body mass index (BMI) was calculated as weight (kg) per height squared (m2).

**Results:** In the present study, 49.5% of girls always consumed breakfast; 34.4% sometimes and 16.1% never consumed breakfast. Skipping breakfast was significantly associated with higher BMI and weight dissatisfaction (p=0.02). Adolescents who were daily consumers of breakfast had higher intake of energy and carbohydrate (p=0.050). They had also higher intake of saturated fatty acids (p=0.03), cholesterol (p=0.01), linoleic acid (p <0.001), folate (p=0.03), manganese (p=0.005) and fluoride (p <0.001) after adjustment for energy intake. After adjustment for energy and BMI, DDS was significantly higher for adolescents with daily breakfast consumption compared to other groups (p=0.03). Further, percentage of participants consuming egg (p=0.03), milk and dairy (p=0.04), fruits and vegetables rich in vitamin A (p=0.02) was higher in daily breakfast eaters compared to other groups.

**Conclusion:** Eating breakfast may be associated with higher diet quality as well as weight control in female adolescents.

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## Introduction

Breakfast is the most commonly skipped meal and is attributed to lack of time, not being hungry in the morning, being dissatisfied with body shape and dieting to lose weight (1). Different cross-sectional and longitudinal studies have reported a higher risk of overweight and obesity among adolescent skipping breakfast frequently compared with those regularly have it (2-4). Some studies in adolescences have shown that breakfast skippers have poor nutrient intakes (5,6) and those who eat breakfast regularly have greater intake of fiber and most vitamins and minerals such as calcium, iron, and vitamin C and lower intake of fat, cholesterol, and sodium (7-10).

Despite the importance of healthy eating during adolescence, a systematic review in Iranian youth including adolescents has shown that dietary intakes and habits was not favorable and they consumed low whole grains, fruits, vegetables, dairy and unsaturated fatty acids and their intake of calcium, phosphorus, folate and iron is insufficient and they have low diverse diet (11).

Dietary diversity score (DDS) is a good indicator of the nutritional adequacy of diets in adolescent (12). All people need a variety of foods to meet requirements for essential nutrients. The value of a diverse diet in adolescences is more important because adolescence is a crucial period of biological change and developmental potential and along childhood are key phases for easily modifying eating habits, as opposed to adulthood when such habits tend to be more strict (13).

Studies on assessing the quality of breakfast and its effects on health indices have been published in the recent years. However, a few studies have evaluated the association between breakfast intake patterns with diet quality (14). Thus by emphasizing on the different dietary patterns in various countries, it is important to search for possible associations between breakfast consumption as a principal meal with dietary quality indices including dietary diversity as well as various food groups in adolescents. However we are not aware of any study in this regard in Iranian adolescent. For the first time in Iran, we determined the association of breakfast intake with micro and macro nutrients intakes, DDS, food group consumption and BMI in girl students.

## Subjects and methods

### *Subjects*

The present study is a descriptive-analytical cross-sectional study in high-school girl students in Tehran, 2014. Using stratified sampling, a total of 384 female students (15 to 19 years of age) from high-schools of Tehran were included in the study. Fourteen high-schools were randomly selected from 5 education districts of Tehran. Within each high-school students of every grades (grade 1, grade 2, grade 3) were also selected randomly.

### *Anthropometric measurements*

Participants' weight was measured using a digital scale (Hamilton-SH-217) to the nearest 100 grams, with light clothing and without shoes. Daily calibration was carried out with 1 and 2 kg weights before measurements. Height was measured by a wall-mounted stadiometer to the nearest 0.5 centimeters, the individuals were asked to stand without shoes, heels together touching the wall and looking straight forward.

BMI was calculated as weight (kg) divided by height squared (m2). Waist circumference (WC) measured at a point midway between the iliac crest and lower rib margin with a non-elastic tape to the nearest 0.5 cm. To minimize the individual error, all measurements were performed by one trained expert.

### *Breakfast intake*

In this study, breakfast intake was defined as "consuming any type of food and drink (except water) in home or before class initiation at school". Information regarding frequency of breakfast consumption was collected on a three-point scale of "always", "sometimes" and "never".

### *Physical activity*

Physical activity was assessed using International Physical Activity Questionnaire short form (IPAQ-SF) which was previously confirmed for its validity and reliability among Iranian adolescents (15). Using the questionnaire, three levels of activity (severe, moderate and jogging) were assessed to measure Metabolic Equivalents Task (MET)-minutes/week. The MET score was calculated through multiplying the time engaging in any levels of physical activity (in minutes) by the frequency of engaging in activities during the past week as well as by the constants of 8, 4 and 3.3, respectively. The overall MET was calculated as the sum of three activity levels for each individual with respect to IPAQ guidelines (16).

### *Dietary intake and dietary diversity*

A 24-h dietary recall questionnaire was completed for each participant in a face-to-face

**Table 1- Comparisons of general variables of participants in terms of breakfast consumption pattern**

| | Breakfast intake | | | |
|---|---|---|---|---|
| | Never n=62 | sometimes n=132 | daily n=190 | **p-value[a]** |
| | **mean ± SD** | | | |
| Age (year) | 15.9± 0.88 | 15.95± 0.83 | 15.93 ±0.86 | **0.9** |
| Waist circumference (cm) | 77.6± 8.4 | 78.02± 9.01 | 76.95± 8.7 | **0.1** |
| BMI (kg/cm$^2$) | 23.29± 4.7 | 23.42± 5.05 | 22.72± 4.7 | **0.02** |
| | **n (%)** | | | **p-value[b]** |
| **High-school grade** | | | | **0.5** |
| First | 30 (48.8) | 50 (37.9) | 76 (40) | |
| Second | 17 (27.4) | 46 (34.8) | 55 (28.9) | |
| Third | 15 (24.2) | 36 (27.3) | 59 (31.1) | |
| **Socio-economic status [c]** | | | | **0.3** |
| Low | 25 (40.3) | 40 (30.3) | 61 (32.1) | |
| Middle | 15 (24.2) | 44 (33.3) | 70 (36.8) | |
| High | 22 (35.5) | 48 (36.4) | 59 (31.1) | |
| **Physical activity level [d]** | | | | **0.7** |
| Low-intensity | 41 (66.1) | 86 (65.2) | 123 (64.7) | |
| Moderate | 18 (29) | 37 (28) | 49 (25.8) | |
| High-intensity | 3 (4.8) | 9 (6.8) | 18 (9.5) | |
| **weight satisfaction** | | | | **0.050** |
| satisfied | 14 (22.6) | 32 (24.2) | 68 (35.8) | |
| somewhat satisfied | 21 (33.9) | 40 (30.3) | 62 (32.6) | |
| dissatisfied | 27 (43.5) | 60 (45.5) | 60 (31.6) | |
| **Vitamins and minerals supplement intake** | | | | **0.1** |
| Yes | 17 (27.4) | 49 (37.1) | 77 (40.5) | |
| No | 45 (72.6) | 83 (62.9) | 113 (59.5) | |

[a] Analysis of variance

[b] Chi-square test

[c] SES, What is conducted from Principal Component Analysis (PCA) Low: first tertile, middle: second tertile, high: third tertile

[d] Low-intensity: If the participant didn't meet the criteria to consider as moderate or high-intensity; Moderate: If the participant met the following criteria, [a) 3 or more days of vigorous-intensity activity of at least 20 minutes per day. OR b) 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day OR c) 5 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum Total physical activity of at least 600 MET-minutes/week]; High-intensity: If the individual met the following criteria, [a) vigorous-intensity activity on at least 3 days achieving a minimum Total physical activity of at least 1500 MET-minutes/week. OR b) 7 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum Total physical activity of at least 3000 MET-minutes/week].

interview. Reported 24-hour dietary recalls by participants were modified and completed with the help of mothers via a phone call. DDS was calculated using a guideline proposed by Food and Agriculture Organization (FAO-2013) (17). The questionnaire consists of 9 food groups in individual level including: 1- cereals and white roots; 2- Dark green leafy vegetables; 3- Vitamin A-rich fruits and vegetables; 4- Other fruits and vegetables; 5- Organ meats; 6- Meats; 7- Eggs; 8- Legumes, grains and nuts; 9- Milk and dairy products. Using the guideline (FAO-2013), if the individual consumes at least a half portion of a food from any food groups she is considered as a consumer of that food group. Based on "My Plate", one cup of fruits, vegetables, milk and dairy products and one once of grains and meats were regarded as one portion (18). The 24-hour dietary recall questionnaire was analyzed using Nutritionist 4 (N4) software to calculate nutrients and energy intakes.

*Socio-economic status*

Socio-economic information was collected by interviewing questions about type of school (private or public), parents' education level, job and salary.

Using Principal Component Analysis (PCA)

the variables integrated into a new factor indicating socio-economic status (SES). SES was categorized into tertiles. The first tertile was considered as a low SES, second tertile as a middle and third tertile as a high.

*Statistical analysis*

SPSS software (version 16) was used for the purpose of data analysis. Comparisons between three breakfast consumer categories for general quantitative variables and general qualitative variables were assessed by ANOVA and chi-square tests, respectively.

Moreover, energy and macronutrients among breakfast consumer groups were assessed by ANOVA, while micronutrients were analyzed by ANCOVA adjusting for energy. ANCOVA, by adjusting for energy and BMI, was also used to assess the association between DDS and breakfast consumption pattern. ANOVA was used to compare three groups of breakfast consumers for eating 9 food subgroups included in dietary diversity. Differences were considered significant if $P \leq 0.05$.

**Table 2. Comparisons for mean ± SD of macronutrients and micronutrients in terms of breakfast consumption pattern**

| | Breakfast intake | | | p-value[a] |
|---|---|---|---|---|
| | Never n=62 | sometimes n=132 | daily n=190 | |
| | Mean ± SD | | | |
| **Energy (kcal)** | 1692.6± 873.6 | 2019.3± 873.5 | 2074.6± 866.2 | 0.01 |
| **Carbohydrate (g)** | 222.2± 110.7 | 265.8± 114.4 | 286.07±126.1 | 0.01 |
| **Protein (g)** | 58.1± 33.3 | 66.5± 33.04 | 67.9± 28.9 | 0.8 |
| **Fat (g)** | 65.6± 42.6 | 80.02± 45.4 | 76.4± 42.9 | 0.03 |
| **Percentage energy from carboh ydrate (%)** | 54.3± 11.01 | 53.7± 11.1 | 55.5± 9.3 | 0.3 |
| **Percentage energy from proteins (%)** | 13.9± 4.6 | 137± 7.2 | 13.4± 3.5 | 0.8 |
| **Percentage energy from fat (%)** | 33.06± 10.4 | 35.34± 11.5 | 32.4± 9.8 | 0.050 |
| **Saturated Fat (g)** | 14.6± 9.5 | 19.6± 12.6 | 22.2± 14.7 | 0.03[b] |
| **Cholesterol (mg)** | 136.2± 125.6 | 167.8± 141.1 | 214.4± 183.05 | 0.014 [b] |
| **PUFAs (mg)[c]** | 22.07± 16.8 | 27.5± 20.4 | 21.7± 16.1 | < 0.001 [b] |
| **Eicosapentaenoic acide (g)** | 0.004± 0.01 | 0.017± 0.06 | 0.004± 0.01 | 0.01 [b] |
| **Linoleic acid (mg)** | 0.64± 0.9 | 0.69± 0.9 | 0.75± 0.9 | < 0.001 [b] |
| **Iron (mg)** | 12.6± 7.8 | 14.0± 6.7 | 14.8± 7.4 | 0.4 [b] |
| **Magnesium (Mg)** | 225.9±139.06 | 253.7± 130.1 | 267.1± 123.2 | 0.6 [b] |
| **Potassium (mg)** | 2208.6± 1206.7 | 2463.7± 1309.6 | 2495.6± 1141.02 | 0.6 [b] |
| **Calcium (mg)** | 545.3± 305.04 | 700.26± 430.1 | 747.2± 367.3 | 0.08 [b] |
| **Phosphorus (mg)** | 874.8± 450.7 | 1036.1± 521.4 | 1093.7± 464.9 | 0.4 [b] |
| **Zinc (mg)** | 7.1± 4.04 | 8.3± 4.6 | 8.5± 3.9 | 0.9 [b] |
| **Manganese (mg)** | 2.4± 1.5 | 3.1± 1.6 | 3.5± 1.7 | 0.005 [b] |
| **Fluoride (Ug)** | 3501.7± 5265.3 | 4671.4± 5142.1 | 7435.09± 6447.7 | < 0.001 [b] |
| **Copper (mg)** | 1.2± 0.7 | 1.4± 0.7 | 1.4± 0.6 | 0.5 [b] |
| **Selenium (mg)** | 0.1± 0.09 | 0.08± 0.06 | 0.08± 0.08 | 0.02 [b] |
| **Vitamin A (RE)** | 622.8± 881.5 | 542.1± 769.3 | 750.2± 829.9 | 0.06 [b] |
| **Vitamin C (mg)** | 118.5± 129.07 | 111.5± 93.9 | 111.4± 99.6 | 0.4 [b] |
| **Alpha-tocopherol (mg)** | 8.9± 7.08 | 9.7± 7.3 | 8.6± 6.4 | 0.004 [b] |
| **Beta-carotene (ug)** | 751.5± 1325.02 | 480.9± 939.03 | 752.4± 1356.09 | 0.055 [b] |
| **Thiamine (mg)** | 1.5± 0.83 | 1.8± 0.79 | 1.8± 0.85 | 0.8 [b] |
| **Riboflavin (mg)** | 1.1± 0.5 | 1.4± 0.7 | 1.5± 0.7 | 0.2 [b] |
| **Pyridoxine (mg)** | 1.2± 0.8 | 1.6± 1.3 | 1.6± 1.1 | 0.9 [b] |
| **Folate (Ug)** | 265.7± 170.3 | 297.7± 173.8 | 353.3± 238.3 | 0.03 [b] |
| **Cobalamin (Ug)** | 2.2± 3.5 | 2.7± 3.6 | 2.3± 2.01 | 0.3 [b] |

[a] Analysis of variance

[b] Analysis of covariance, adjusted for energy intake

[c] PUFAs, polyunsaturated fats

**Table 3. The association between breakfast consumption pattern and DDS along with DDS subgroups**

| | Breakfast intake | | | |
|---|---|---|---|---|
| | Never n=62 | sometimes n=132 | daily n=190 | p-value |
| **DDS** [a] | 4.1 ±1.06 | 4.3 ± 1.04 | 4.6 ±1.1 | 0.03[b] |
| **Starchy staples group consumer (%)** [c] | 96.8 | 100 | 97.9 | 0.1[d] |
| **Dark green leafy vegetables group consumer (%)** | 24.2 | 29.5 | 23.2 | 0.4 [d] |
| **Other vitamin A rich fruits and vegetables group consumer (%)** | 4.8 | 1.5 | 8.4 | 0.02 [d] |
| **Other fruits and vegetables group consumer (%)** | 77.4 | 75.8 | 80.5 | 0.5 [d] |
| **Organ meat group consumer (%)** | 85.5 | 85.6 | 83.7 | 0.8 [d] |
| **Meat and fish group consumer (%)** | 1.6 | 0.8 | 0.5 | 0.7 [d] |
| **Eggs group consumer (%)** | 19.4 | 20.5 | 31.6 | 0.03 [d] |
| **Legumes, nuts and seeds group consumer (%)** | 50 | 54.5 | 63.7 | 0.09 [d] |
| **Milk and milk products group consumer (%)** | 54.8 | 64.4 | 71.6 | 0.04 [d] |

[a] DDS, Dietary Diversity Score
[b] Analysis of covariance, Adjusted for BMI and energy intake
[c] consumes at least a half portion of a food from any food groups
[d] Chi-square test

## Results

Comparisons in terms of breakfast consumption pattern for general variables are provided in Table 1. Skipping breakfast was significantly associated with higher BMI ($p<0.05$). Breakfast consumption was significantly higher in those who were "satisfied" with their weight compared to "dissatisfied" and "somewhat satisfied" participants ($p<0.05$).

Comparisons for mean energy intake, macronutrients and micronutrients in terms of breakfast consumption pattern is shown in Table 2. Students with daily breakfast consumption had significantly higher intakes of energy, carbohydrate, saturated fatty acids, cholesterol, linoleic acid, folate, manganese and fluoride compared to other two groups ($p<0.05$). However, students who were occasional breakfast consumers (sometimes), had higher percentage energy from fat and higher intakes of total fat, polyunsaturated fats, eicosapentaenoic acid (EPA), selenium and α-tocopherol compared to other groups.

A significant association was observed between breakfast consumption pattern and intake of total fat, polyunsaturated fat, EPA, selenium and α-tocopherol ($p<0.05$).

Table 3 provides the association between breakfast consumption pattern and DDS along with DDS subgroups. Daily breakfast consumption was significantly related to higher DDS compared to other two groups ($p<0.05$). Percentage of subjects eating eggs, milk and dairy, fruits and vegetables rich in vitamin A were higher among daily breakfast consumers in comparison to other groups ($p<0.05$).

## Discussion

To our knowledge, this is the first study investigating an association between breakfast consumption and DDS in adolescents. The result of this study showed after adjustment for BMI and energy intake, subjects with daily breakfast intake had significantly higher DDS compared to participants who had never or sometimes breakfast intake. Furthermore, participants with daily breakfast consumption had higher intake of energy, eggs, milk and dairy, fruits and vegetables rich in vitamin A than other groups. In addition, they had significantly lower BMI and were more satisfied with their weight.

In a study by Azadbakht and colleagues, they concluded that breakfast consumption, in contrast to skipping breakfast, may be related to higher healthy eating index (HEI) score and DDS in adults (14). In line with the present findings previous studies have shown that breakfast consumption may be related to healthy eating habits such as higher intake of fresh vegetables, fresh and dried fruits and milk (19, 20). Whereas skipping breakfast may be related to higher intakes of salty snacks, soft drinks, packed fruit juice and fast foods. It has been shown adolescents who are breakfast skippers have higher total fat and cholesterol intake which are apparently due to eating fast foods (19).

Adolescents with irregular breakfast consumption had lower fruits and vegetables intake (20, 21).

The present study has shown intake of milk and dairy, eggs, fruits and vegetables rich in vitamin A was significantly higher in daily breakfast eating subjects compared to the other groups. Following consumption of these foods, intakes of minerals such as calcium, phosphorous and zinc as well as vitamins A, D, E, C, B12, B6, riboflavin and cholesterol seems to increase (22). Results from previous studies have shown that breakfast consumption in adolescents may be related to higher intake of carbohydrate, fiber, calcium, iron and vitamin C (7-9, 23). Increase in calcium intake could be due to milk and dairy consumption (24). Congruent to the present results, some studies have found no association between calcium intake and breakfast consumption (25, 26).

After adjustment for energy intake, daily breakfast consumption was also associated with higher intake of carbohydrate, saturated fatty acids, cholesterol, linoleic acid, folate, manganese and fluoride. A higher percentage of milk and dairy and egg consumers belonged to daily breakfast consuming group, this may explain high intake of saturated fatty acids, cholesterol and linolenic acid in this group (27).

This study revealed that nearly half of the adolescents eat breakfast daily (49.5%), while 34.4% eat occasionally ("sometimes") and 16.1% never eat breakfast. Skipping breakfast ranges from 10 to 30% among American and European adolescents (28). Based on previous studies, breakfast consumption may be related to lower BMI (23, 29-32), lower body fat (29), less abdominal obesity (33) in adolescents. There are a number of hypotheses regarding breakfast consumption and weight management. Eating breakfast by increasing the quality of diet and by regulating appetite helps to control energy intake and this may lead to weight control (3, 34). Quality and type of breakfast plays an important role in generating beneficial effects on health. Previous studies have found that high protein content breakfast without affecting energy intake led to further alterations in appetitive, hormonal, and neural signals and reduced evening snacking, compared to normal-protein content breakfast (34) and reduces appetite and energy intake (35). Timlin and colleagues found a significant higher level of physical activity in breakfast consuming adolescents (3). However, in our study adolescents with daily breakfast consumption were not significantly different from other groups in terms of physical activity level. In addition, these subjects had lower BMI and higher energy intake. Some studies have confirmed our findings and have reported that frequent breakfast consumption may be associated with lower BMI even when energy intake is high (3, 28, 36). However, in some other studies, daily breakfast consumption in adolescents was associated with lower energy intake and lower BMI (5,37,38). Schusdziarra and colleagues reported that increasing ratio of breakfast to total daily energy intake is associated with a significant reduction of overall energy intake (39). In our study we have not calculated the amount of breakfast energy intake. It is possible adolescents consumed low calorie breakfast and therefore they have low ratio of breakfast energy content to overall energy intake which has not resulted to lesser daily energy intake. Other possible explanations for lower BMI in this group are: 1) breakfast consumption increases the frequency of meals consumed by the individuals and this in turn leads to less efficient utilization of energy via diet-induced thermogenesis (40); 2) it is likely that breakfast skippers who are often overweight or obese adolescents, tend to underreport their daily energy intake compared to normal weight breakfast consumers (28); 3) moreover, skipping breakfast may accompany eating more snacks as well as adopting a sedentary lifestyle (41), and higher energy intake from fats and lower from carbohydrate, and these possibly explains obesity and overweight in this population (42).

With regard to the association observed between BMI and breakfast consumption and since adolescents with weight dissatisfaction were more likely to skip their breakfast, it is not appropriate to incorporate breakfast skipping in weight management programs in adolescents. It is recommended that future research adopt prospective designs to study the mechanisms mediating the effects of breakfast consumption on weight status in adolescents, while controlling for a series of factors influencing on amount of energy intake and expenditure as well as appetite regulating factors such as type and percentage of macronutrients, amount of breakfast energy intake, food choices for breakfast, glycemic index and glycemic load, sedentary behaviors and physical activity levels.

In this study, the relationship between socioeconomic status and breakfast consumption was not significant, which is inconsistent with the previous studies that found a higher consumption of breakfast in adolescents with higher

socioeconomic level compared to low socioeconomic level (3, 30). However, the results of some studies have not shown significant association between socioeconomic status and breakfast consumption in adolescents (19, 43). This lack of association between breakfast intake with household socioeconomic level may be attributed to the lifestyle of Iranian adolescents. Phenomenon of the internet addiction does exist in some Iranian adolescents and they tend to engage with their mobile phones and internet late at nights and in turn sleeping late could have led to late morning waking-up leading to lack of time and low appetite for breakfast (44).

The guideline used to assess DDS in the current research (FAO-2013) is a standardized questionnaire of universal applicability and is not affected by certain cultures, communities or places. To minimize probable errors in adolescents' food reports, all questionnaires were completed and modified with the help of mothers. Validity and reliability of the physical activity questionnaire for the target age group had been confirmed in a population of Iranian adolescents previously (15).

This study has some limitations. First, food choices and intake of energy, macronutrients and micronutrients were not evaluated specifically in breakfast, which is suggested to be considered by future studies. Second, with respect to the cross-sectional nature of this study, it was not possible to investigate a causal relationship between breakfast consumption and DDS. Third, we had not exact definition for sometimes breakfast intake. It would be more appropriate to ask the frequency of breakfast consumption per week more precisely.

## Conclusion

Attention to the quality of breakfast as well as its frequent consumption in adolescents can help improve their quality of diet. In the present study, DDS which is a suitable index for assessing adequacy of diet in adolescents was positively associated with the frequency of breakfast consumption. Moreover, eating breakfast was associated with higher intake of energy, carbohydrate, fiber, saturated fatty acids, cholesterol, manganese and folate in female adolescents. Adolescents with daily breakfast consumption had also lower BMI. With respect to the fact that half of adolescents irregularly or never consumed breakfast, nutrition education is required to improve adolescents' knowledge about eating breakfast as well as healthier eating choices in order to increase their quality of diet.

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## Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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