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Original article

The relation between meal frequency and obesity in adults

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Summary. *Objective:* To determine the relation between meal frequency and obesity in adults. *Methods:* A cross-sectional study was done among 1829 volunteer (520 men, 1309 women) selected through a multi-stage stratified random sampling method during 2015/2016. A standardized, confidential data collection sheet was used. It included socio-demographic factors, dietary behaviors, anthropometric measurements and energy-macro and micronutrient intakes. *Results:* The median meal frequency of women and men were 4 and 3, respectively. Approximately 57% of men and 61% of women have skipped meals and 76.8% of them were skipped their lunch. In addition, the individuals whose BMI were under and over 25 kg/m^2 (72.4%, 78.3%, respectively) often skipped lunch. The meal frequency positively correlated with waist to hip ratio in women ($p<0.05$). Additionally, there were positively significant correlations between meal frequency and saturated fatty acids, fiber, vitamin A, vitamin C, calcium and iron intake ($p<0.05$). *Conclusion:* This study indicated that increased meal frequency may have a beneficial effect on micronutrients intakes and some anthropometric measurements among adults.

Keywords: meal frequency, meal skipping, obesity

Authors' Contributions

SM, MÖ and MS: conceived, did data collection and statistical analysis and designed manuscript.
MAO did statistical analysis.
EK, SB, EY, BK, PT and AE did data collection.
EA, MT and GK did editing and finally approved manuscript.

Introduction

Obesity is one of the most common multifactorial (genetic, metabolic, environmental, socioeconomics and behavioural factors) and epidemic disorders that imposes direct medical and indirect economic costs on society (1).Obesity is thought to be an imbalance between energy consumed and expended (2).For this reason, changes in dietary habits and physical activity have been implicated as potential causes of obesity. Therefore, effective strategies must be developed for the prevention of obesity (3). One of these strategies could be the meal frequency or meal skipping rates.

Several characteristics of dietary behavior such as eating frequency, temporal distribution of the meals throughout the day, skipping meal particularly breakfast and the frequency of having meals outside ('eating out') may influence body weight (4,5).However, studies about the influence of these factors on obesity is not conclusive: whereas some studies reported no association between frequency of meals and obesity, others reported an inverse association between meal frequency and the prevalence of obesity in adults and children (6-10).

Additionally, obese individuals are often considered to skip breakfast, consume little or no lunch and compensate by overeating during late afternoon and night (11,12).The present study aims to evaluate the associations between meal frequency or meal skipping and obesity levels among adults.

Methods

Study population

This study was carried out in 2015 with 1829 volunteer adults, 520 men and 1309 women, aged between 40 and 64 years who applied a family health center with any reason in Ankara, Turkey. Inclusion criterias were age between 40 and 64 years, diagnosis of any chronic disease and ability to complete a questionnaire. The participants declare their consent through a written form. This study was approved by Baskent University Institutional Review Board (Project no: 94603339/18.050.01.08.01-699).

Data collection tools

A detailed questionnaire on socio-demographic factors and dietary behaviors including meal frequency and food frequency was used to data collection.

Anthropometric measurements

Weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively, with the patient wearing lightweight clothing and no shoes. Body Mass Index (BMI) was calculated as the individual's weight in kilograms divided by the square of their height in meters. Waist circumference (WC) was measured (to the nearest 0.1 cm) using a non-elastic tape at the umbilicus at the end of a normal expiration, with the participant in a standing posture. Hip circumference (HC) was measured at the most protruding part of the hips at the level of the greater trochanter of the femur. Waist-to-hip ratio (WHR) was calculated by dividing WC (cm) by HC (cm) (13,14). The participants' nutritional status was evaluated through the body mass index (BMI), waist and hip circumference -for-age and gender. BMI values under 25 kg/m^2 was accepted as normal and greater than or equal to 25 kg/m^2 was accepted as overweight and obese. As a risky WHR was defined as more than to 0.85 in women and as more than to 1.0 in men; waist circumference was defined as more than 88 cm in women and as more than 102 cm in men and waist to height ratio was defined as more than to 0.5 (13,14). In order to determine the nutritional status of individuals, Food Frequency Questionnaire (FFQ) including 70 items was used (15). Energy, macro and micro nutrients obtained by food frequency questionnaire, were analyzed using the Nutrient Data Base Program (16).

Data analysis

All continuous variables were presented as mean ± standard deviation. Frequencies and percentages were used for the presentation of categorical qualitative variables. Pearson Chi-Square (χ^2) test was used in order to evaluate categorical variables. The normality of the distribution of data was evaluated by the one sample Kolmogorov–Smirnov test. A non-parametric Kruskal-Wallis tests were performed upon the data to establish if any differences were present between conditions. The linear correlations between variables were investigated with Pearson bivariate correlation for normal distributed data and Spearman bivariate correlation for non-normal distribution data. For the calculation of correlations between meal frequency and anthropometric measurements of the individuals participating in the study, "Partial Correlation Coefficient" was used to adjust the effects of energy, carbohydrate, protein, fat and fiber on these variables. Significant values of $p<0.05$ were considered to be statistically significant. The study data was analyzed using SPSS software (version 17.0, SPSS Inc., Chicago, IL).

Results

The study included 1829 participants (28.4% men,71.6% women). The mean age was 53.0±7.46 years. Among participants, 24.9% of them had a BMI value of <25 kg/m^2, 75.1% of them had a BMI value of ≥25 kg / m^2 (The mean BMI value was 28.6±5.07 kg/m^2). It was determined that 94.0% of individuals were obese according to waist circumferences (>102 cm for men, >88 cm for women, respectively) and 95.5% of men and 89.5% of women had WHR above >0.5. Most of the participants consumed 3 or more meals (87.3% of men and 88.5% of women). The most skipped meal to both gender 71.7% of men and 78.7% of women was lunch. In underweight and normal BMI group, 88.7% of them had three or more meals per day. Similarly overweight and obese BMI groups, the frequency of consuming three or more meals per day was 88.1% ($p>0.05$).The study results showed that the individuals whose BMI value were under and over 25 kg/m^2 (72.4%, 78.3%, respectively) often skipped lunch.

The relationship between age and anthropometric measurements of the individuals and the frequency of meal was given in Table 1. According to Table 1, there was a linear correlation between meal frequency and WHR in women (r=0.055; p=0.049). In addition, there was a inverse correlation between meal frequency and weight and HC for men (p>0.05) (Table 1).

Statistically significant Spearman correlation coefficients between meal frequency and energy, macro and micro nutrients consumption are shown in Table 2. The strongest correlation was between meal frequency and saturated fatty acids (r=0.090,p=0.001), fiber (r=0.105,p=0.000), vitamin A (r=0.119, p=0.000), vitamin C (r=0.093, p=0.001), calcium (r=0.151, p=0.000) and iron (r=0.077,p=0.006) in women. In addition, there was statistically significant correlation between

Table 1. The relationship between age and anthropometric measurements of the individuals and the frequency of meals♯

	Meal Frequency			
	Men (n:520)		Women (n:1329)	
Age and Anthropometric Measurements	r	p	r	p
Age (years)	0.047	0.305	0.050	0.072
Weight (kg)	-0.016	0.720	0.020	0.482
BMI (kg/m^2)	0.049	0.284	0.019	0.500
Waist circumference (cm)	0.020	0.664	0.049	0.082
Hip circumference (cm)	-0.007	0.876	0.022	0.440
Waist to hip ratio	0.032	0.481	0.055	0.049*
Waist to height ratio	0.036	0.429	0.050	0.075

*p<0.05
♯ Adjusted for energy, carbohydrate, protein, fat and fiber.

Table 2. Correlations between meal frequency of the individuals and energy, macro and micro nutrients consumption

	Meal Frequency					
	Men (n:520)		Women(n:1329)		Total (n:1829)	
Energy and Nutrients	r	p	r	p	r	p
Energy (kcal/day)	-0.015	0.733	0.062	0.026*	0.016	0.490
Carbohydrate (TE %)	0.023	0.606	-0.023	0.403	-0.017	0.482
Protein (TE %)	0.011	0.807	0.034	0.217	0.018	0.443
Total fat (TE %)	-0.023	0.610	0.007	0.804	0.010	0.672
Saturated fatty acids (%)	0.036	0.429	0.090	0.001*	0.063	0.007*
Mono unsaturated fatty acids (%)	-0.010	0.825	0.070	0.012*	0.036	0.126
Poli unsaturated fatty acids (%)	-0.004	0.935	0.017	0.550	0.004	0.872
Fiber (g)	0.096	0.034*	0.105	0.000*	0.089	0.000*
Vitamin A (μg/RE)	0.109	0.016*	0.119	0.000*	0.116	0.000*
Vitamin E (mg)	-0.015	0.740	0.002	0.940	-0.010	0.683
Folate (mcg)	0.084	0.062	0.092	0.001*	0.065	0.006*
Vitamin B_{12} (mcg)	-0.025	0.586	0.086	0.002*	0.043	0.067
Vitamin C (mg)	0.076	0.090	0.093	0.001*	0.084	0.000*
Calcium (mg)	0.062	0.167	0.151	0.000*	0.116	0.000*
Iron (mg)	0.062	0.168	0.077	0.006*	0.056	0.018*

*p<0.05

meal frequency and fiber (r=0.096, p=0.034), vitamin A (r=0.109, p=0.016) in men.

Table 3 was shown that the distribution of meal skipping according to consumption of energy, macro and micro nutrient values of the individuals. Meal skippers had significantly higher intakes for carbohydrate and vitamin E than non-meal skippers ($p<0.05$). On the other hand, meal skippers had significantly lower intakes for protein, vitamin B_{12} and calcium than non-meal skippers ($p<0.05$).

Discussion

Recent studies about obesity were focused on meal frequency and meal skipping. Generally, the main approaches to defining meals are: participant-identified, time-of-day, food-based classification and neutral. These definitions, along with examples from the literature and their respective advantages and disadvantages, are discussed (11,17,18). In this study, the number of meals was directly asked participant. So, our study primarily investigated meal frequency of individuals which showed 87.3% of men and 88.5% of women consumed three or more meals in a day.

Some studies have suggested that eating patterns, which describe eating frequency, the temporal distribution of eating events across the day, breakfast skipping, and the frequency of eating meals away from home, may be related to some anthropometric measurements that are predictors of obesity (3). Especially, some studies conclude that BMI or WC decreased with the increasing meal frequency (17,18) but some studies argue that increased energy intake depending on increased meal frequency associated with higher BMI or WC (19,20). In this study, we found that meal frequency was not significantly associated with change in body mass index and also it was significantly associated with WHR in women. Thus, in a meta-analysis study on this subject, it was determined that there was no difference between meal frequency and anthropometric measurements (21).

Cross-sectional studies have shown that meal skipping is associated with increased prevalence of overweight and obesity (5,22). For example, in a study have shown that WC and BMI values were significantly higher in people who skipped breakfast when compared with people who did not skip breakfast (22). In this study, we did not found statistically significant difference between meal skipping and BMI. Also

Table 3. The distribution of meal skipping according to consumption of energy, macro and micro nutrient values of the individuals

	Meal skippers (n:1090) X̄±SD	Non-meal skippers (n:724) X̄±SD	p
Energy (kcal/day)	1962.0±593.12	1926.3±585.02	0.131
Carbohydrate (TE %)	41.7±9.03	40.3±8.75	0.004*
Protein (TE %)	16.1±3.36	16.9±3.73	0.000*
Total fat (TE %)	42.1±8.36	42.6±8.15	0.370
Saturated fatty acids (%)	33.0±12.98	35.8±13.75	0.649
Mono unsaturated fatty acids (%)	35.6±14.20	35.8±13.75	0.615
Poli unsaturated fatty acids (%)	17.6±10.13	17.0±9.89	0.125
Fiber (g)	29.6±12.18	29.6±11.84	0.714
Vitamin A (μg/RE)	1034.9±1032.58	1359.8±1002.20	0.179
Vitamin E (mg)	15.8±9.95	15.1±9.61	0.038*
Folate (mcg)	304.5±107.03	303.2±104.00	0.620
Vitamin B_{12} (mcg)	4.7±4.07	4.8±9.44	0.024*
Vitamin C (mg)	98.1±53.89	100.8±51.42	0.072
Calcium (mg)	905.6±352.49	930.6±314.47	0.009*
Iron (mg)	12.7±4.88	12.8±4.56	0.456

*p<0.05

in our study, 59.8% of individuals reported that they skipped meals. The most skipped meal of the day was lunch for both men (71.7%) and women (78.7%). Also, 59.5% of overweight individuals skipped their meal.

Meal frequency and meal skipping also appears to be an important contributor to intakes of energy, macro and micronutrients among adults. For example two large population-based studies, one in US adults and the other in Swedish adults found that those who ate six or more times per day had higher intakes of carbohydrate and fibre but lower intakes of fat and protein compared with adults who ate once or twice per day or less than three times per day, respectively. Additionally, in these studies, a higher meal frequency was also associated with higher folate, vitamin C, iron and calcium (23,24). Among Puerto Rican adults, it was found that there was a linear relationship between total energy intake and meal frequency (25). In contrast among adults, it was found that the energy was negatively associated with meal frequency (especially snacking) (26). Studies based on meal skipping were examined. Some of them were identified the influence of breakfast skipping on nutrient intakes and some of them were identified the nutritional impact of omitting the lunch or dinner meal. These results suggest that meal skipping was consistently associated with lower micronutrient intakes especially calcium, vitamin C, folate, vitamin A, magnesium (27). While all these results were evaluated, the evidence to support associations between meal frequency and nutrient intake was less consistent.

In our study, we found that higher meal frequency had significantly correlated higher saturated fatty acids, fiber, vitamin A, vitamin C, calcium and iron. Also, we examined the distribution of meal skipping according to consumption of energy, macro and micro nutrient values of the individuals. So, we found that meal skippers had significantly higher intakes for percentage of carbohydrate and vitamin E than non-meal skippers. On the other hand, meal skippers had significantly lower intakes for protein, vitamin B_{12} and calcium than non-meal skippers.

Limitations of the study

Firstly, our study population was conducted in age between 40-64 years, so the findings may not apply to other age groups. Secondly, the heterogeneity of meal definitions were a major impediment to the interpretation of findings in this study.

Conclusion

The results from our study suggest that meal frequency were associated with obesity based on waist to hip ratio. Additonally we found that meal frequency and meal skipping significiantly correlated with many macro and micronutrients intake. Further research should be conducted to examine the dietary profiles of eating patterns and their relations with obesity to encourage healthy eating and meal-based guidelines should be improved.

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