Original Article

Evaluation of the Relationship Between Meal-Based Dietary Anti-Oxidant Quality Score with Obesity in Apparently Healthy Adults Attended to Health Care Centers in Tehran

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Abstract

Background: Studying the dietary antioxidant quality (DAQ) score as a modifiable factor to lessen the negative effects of obesity on health is vital due to the rising global trend of obesity. Therefore, this study aimed to determine how adult obesity and meal-based DAQ scores correlate.

Materials and Methods: A cross-sectional study including 850 men and women in Tehran was conducted. Three 24-hour dietary recalls were used to evaluate dietary consumption. Based on the design of DAQs, the meal-based DAQ score was evaluated. Higher scores indicate better DAQ. The overall DAQ score varied from 0 to 5. To investigate the relationship between DAQs and obesity in each meal, logistic regression analysis was utilized.

Results: There was no correlation between a higher breakfast DAQ score and being overweight or obese (for overweight: OR = 0.69; 95% CI: 0.38–1.24/for obesity: OR = 0.65; CI 95%: 0.31–1.37). In the basic model, a higher lunch DAQ score was inversely related to probabilities of being overweight (OR: 0.62; 95% CI: 0.39–0.99) Such a connection remained significant after relevant confounders were considered (OR: 0.48; 95% CI: 0.27-0.84). In both the raw and fully adjusted models, there was no discernible correlation between the meal DAQ score and overweight or obesity.

Conclusion: We discovered that a higher DAQ score for lunch was substantially associated with a lower risk of being overweight but not obese. To verify our findings, additional prospective research in various populations is required.

Keywords: Breakfast, DAQ, meals, obesity, overweight

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Introduction

A high body mass index (BMI) brought on by an abundance of adipose tissue is the traditional way to describe obesity.[1] A BMI >30 kg/m^2, as defined by the WHO.[2] Between 1975 and 2014, both men and women's mean global BMI increased.[3] An obvious reduction in occupation-related activity and home management energy expenditure has been brought about by

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recent behavioral changes.[4] Obesity doubled in prevalence between 1980 and 2015.[5] In Iran, chronic diseases, especially those brought on by obesity and overweight, were responsible for around 70% of recorded fatalities in 2002[6] Obesity in adults, cancer, cardiovascular disease, and diabetes are all linked to a number of health issues.[5,7]

The prevalence of obesity and overweight is rising globally.[8] While people do not consume a single food or antioxidant, obesity has major health implications, including cardiovascular illnesses,[9] diabetes,[10] fatty liver disease,[11] and some cancers,[12-14] Addressing the multidimensional character of the diet provides superior insight due to the complexity of the diet and the interaction of the dietary components with one another. The ideal method for this is to use diet quality indices, which reflect whole dietary patterns, especially with regard to antioxidants.

Diet, sedentary behavior, physiological, neurological, biochemical, environmental, sociocultural, genetic, and psychological factors all contribute to obesity.[15] It is impossible to overestimate the significance of diet as one of the controllable elements in one's health and the fight against non-communicable illnesses.[16] In terms of the health of an individual and preventing non-communicable illnesses, diet is one of the changeable elements.[3] Numerous pieces of evidence point to a connection between obesity and various dietary factors, including energy, food types, and nutrients.[4,5,7,17] The evaluation of dietary antioxidant quality (DAQs) score is more helpful than a single nutrient in connection to obesity due to the importance of the interactions between diets and nutrients.[15]

Although meals have received scant attention, the relationship between dietary antioxidant quality score and illnesses has been extensively researched.[16] DAQ scores are intended to evaluate the whole diet and classify people according to how healthy their eating habits are.[18] One of these indicators, the diet DAQ scores, focuses on four key components of a high-quality, healthy diet: sufficiency, variety, overall balance, and moderation.[18,19]

Different conclusions have been drawn from a few studies that have been conducted with respect to the relationship between the DAQ score and obesity,[20] However, as this correlation has not before been examined at the meal level, the current study's objective was to examine the relationship between obesity and meal-based DAQs score in otherwise healthy persons referring to Tehran-area health clinics.

Materials and Methods

Study design

In this cross-sectional study, 850 healthy adult males and females between the ages of 18 and 59 were selected from Tehran's healthcare facilities using a two-stage cluster sampling technique that included advertisements, frequency distribution in public spaces, and information sessions about the purpose and advantages of the examination. The city was first divided into the north, south, east, west, and center regions. Eight healthcare facilities were picked at random from each region's list of all available healthcare facilities, resulting in a total of 40 healthcare facilities. The number of subjects at each health center was determined by dividing the sample size (n = 850) by 40. It should be emphasized that we choose our employees from Tehran's health centers that are connected to the Tehran Municipality's Health Bureau. Tehran, the capital of Iran, is home to a diverse population. Tehran's residents are regarded as a representative sample of Iranians in health research.

Considering how common obesity and overweight are among individuals in Tehran (65%), an error coefficient of d = 0.04 and atα threshold of 0.05, a sample size of 546 individuals was determined.

$$n = \frac{z^2\ p(1-p)}{d^2} = \frac{(1/96)^2 \times 0/65 \times 0/35}{(0/04)^2} = 546$$

The sample size was multiplied by 1.5 to account for the possibility of participant exclusion, resulting in a total of 850 subjects.

Exposures and outcomes

Self-administered questionnaires were used to gather data on lifestyle factors, including age (which is continuously variable), sex (male or female), marital status (married or single), smoking status (never smoking, former, or current), and physical activity, which was measured using a short version of the International Physical Activity Questionnaire that has been scientifically validated.[1]

Anthropometric assessment

Anthropometric analysis Body weight was calculated to 0.1 kg on a scale while wearing little clothing and no shoes. With a measuring tape and no shoes, the subject's height was determined with an accuracy of 0.1 centimeter. the BMI was computed By dividing body weight (kg) by the square of height (m2), The age and gender cutoff points for BMI classification were as follows: The 5th percentile is regarded as underweight, the 5th to the 85th percentiles as normal weight, and the 85th percentile as obese or overweight. A flexible tape was used to measure each circumference to 0.1 cm: neck circumference (NC), wrist circumference, hip circumference, waist circumference, and hip circumference. By dividing WC (in cm) by HC (in cm), the waist-to-hip ratio (WHR) was calculated. WC (in cm) to height (in cm) was used to compute the waist-to-height ratio (WHtR).

Dietary assessment

Three 24-recall questions about daily dietary consumption are asked of each participant on days other than consecutive ones (Monday to Sunday). The 24-hour meal reminder was organized, and breakfast was specified as part of the meal. The information for the first 24-hour memorandum was gathered through interviews; the material for the other two memorandums was gathered by telephone calls made on two random, non-consecutive study days. These surveys are used to collect data about meals and food groups.

A common five-step procedure created by the US Department of Agriculture for use in national diet monitoring is employed to carry out the 24-hour open recall used in the study. This method consists of 1) A quick list of respondents are asked to list the foods they ate or drank the day before 2) Missed foods A standard list of foods and drinks that are normally in the First they are forgotten, they are read to the child to be remembered quickly. 3) The time at which the meal is recorded is recorded. Reminder of food consumed. In this study, a trained interviewer who has at least a bachelor's degree in health and nutrition is used.

Measurement of DAQS

Selenium, vitamin A, vitamin E, zinc and vitamin C are some of the vitamins and minerals that DAQS was obtained from.[20] We compared daily nutrient intake to the RDI in order to develop a DAQS. We evaluated each of the five antioxidant intakes and then gave each component a value of 0 or 1, independently. When the intake was less than 2/3 of the RDI, it was given a value of 0 by Tur *et al.* Similar to this, a rating of 1 was assigned when the intake exceeded 2/3 of the RDI. Thus, the overall DAQS was between 0 and 5, with 5 being the highest quality.[21] We calculated the proportion of those who consumed less than the RDI as well as the percentage of the RDI, 2/3 of the RDI, and 1/3 of the RDI. The criterion used to calculate the risk was the percentage of people whose consumption fell below 2/3 of the RDI.

Statistical analysis

DAQ tertiles were used to group participants. In comparison to lower tertiles, greater DAQ tertiles show higher diet quality. The demographic characteristics and dietary intakes of study participants were compared among tertiles of DAQs using analysis of variance (ANOVA), and Chi-squared[2] was used to compare categorical data. To compare corrected BMI averages across DAQs tertiles, we utilized analysis of covariance (ANCOVA). Binary logistic regression analysis was used to assess the odds ratio (OR) and 95% confidence interval (CI) of obesity in two models. Age, physical activity, socioeconomic status, and smoking were all taken into account in Model I. Confounders from Model I were added to Model II, along with calorie intake. The Statistical Package for the Social Sciences (SPSS version 16; SPSS Inc.) was used for all statistical analysis. A *P* value of 0.05 or less was regarded as statistically significant.

Results

Table 1 displays participant demographic information and anthropometric measurements across quartiles of the meal-specific DAQ score. Between DAQ score quartiles, there were no statistically significant changes in mean age, weight, or BMI. The percentage of females was higher in the fourth quartile of the DAQ score. Also, there were statistical differences in the distribution of hypertension, severe physical activity, and university-educated across quartiles of the lunch-DAQ score.

Table 2 shows dietary consumption of specific nutrients across DAQ score quartiles. Participants who scored in the top quartile on the DAQ had higher intakes of energy (kcal), protein (g/d), carbohydrate (g/d), fat (g/d), vitamin E, vitamin A, zinc, Calcium, and vitamin C.

Also, the intakes of fiber and sugar were increased across quartiles of the lunch- and dinner-DAQ scores.

Adjusted for several factors odds ratios and 95% CIs for overweight and obesity across quartiles of the breakfast-DAQ Table 3 lists the sources. Within the crude model, although those who were in the fourth breakfast-DAQ score compared to the first quartile were less likely to be overweight and obese, there was no relationship between higher breakfast-DAQ score and overweight and obesity (for overweight: OR = 0.69; 95% CI: 0.38–1.24; for obesity: OR = 0.65; 95% CI: 0.31–1.37). After adjusting for confounders, this result remained non-significant.

Table 4 shows the multivariate-adjusted odds ratios and 95% CIs for obesity and overweight across quartiles of the lunch-DAQ score. We found that the probabilities of being overweight were inversely related to a higher lunch-DAQ score (OR: 0.62; 95% CI: 0.39–0.99) within the crude model. When potential confounders (age, gender, education, smoking, occupation, physical activity, marital status, disease history, hypertension, energy intake, fiber, calcium, and sugar in lunch meal) when they were considered, such a connection remained significant (OR: 0.48; 95% CI: 0.27–0.84). Additionally, neither the basic nor fully adjusted model in Table 5 showed a significant connection between the dinner-DAQ score and overweight or obesity.

Discussion

In the current cross-sectional study, Higher Lunch's DAQ score was substantially connected with a lower risk of overweight, but not obesity, after adjusting for relevant covariates. Moreover, no association was found between breakfast and dinner DAQ scores and odds of being overweight and obese.

This is the first investigation, as far as we are aware, on how DAQS and obesity relate to Iranian adults. Higher DAQs were not related to waist circumference, according to a cross-sectional investigation that supported our findings.[19] In children and adolescents who were overweight or underweight, DAQS was linked to various anthropometric parameters. These data imply that in underweight and normal-weight individuals; DAQS may also be a possible predictor of food quality.[22] Research conducted in various studies has revealed a correlation between specific dietary antioxidants and indicators of cardiometabolic risk factors. These risk factors encompass anthropometric characteristics, blood pressure levels, lipid profile, and markers associated with glucose homeostasis.[23-25] Correa-Rodríguez *et al*.[26] reported that vitamins A and C

Table 1: Demographic characteristics of participants across categories of dietary antioxidant quality score

Variables	T1 *n*=281	T2 *n*=281	T3 *n*=281	*P**
Breakfast score				
Age (year)	42.05±10.67	42.40±10.96	42.41±10.14	0.70
Weight (kg)	71.70±13.50	72.01±12.83	73.36±14.45	061
BMI (kg/m^2)	26.80±4.47	27.36±4.63	27.61±4.57	0.03
Female (%)	229 (81.7)	242 (86.3)	229 (81.4)	0.24
University educated (%)	100 (35.5)	102 (36.5)	98 (34.9)	0.99
Severe physical activity (%)	21 (7.6)	29 (10.5)	26 (9.2)	0.49
Unemployed (%)	15 (5.3)	17 (6.2)	12 (4.2)	0.69
Married (%)	229 (81.7)	225 (80.8)	226 (80.1)	0.92
Disease history (yes) (%)	105 (37.6)	120 (43.0)	110 (39.2)	0.43
Smokers (%)	11 (3.8)	9 (3.1)	9 (3.4)	0.94
Hypertension (%)	35 (12.6)	49 (17.3)	47 (16.9)	0.26
Lunch score	**T1 *n*=280**	**T2 *n*=284**	**T3 *n*=278**	***P****
Age (year)	43.14±10.54	41.71±10.64	41.68±10.51	0.10
Weight (kg)	72.34±13.48	72.73±14.01	71.93±13.73	0.79
BMI (kg/m^2)	27.38±4.51	27.33±4.49	26.93±4.49	0.24
Female (%)	235 (83.2)	235 (83.2)	229 (81.1)	0.75
University educated (%)	98 (34.8)	106 (36.8)	95 (33.9)	0.90
Severe physical activity (%)	22 (8.10)	22 (7.2)	27 (9.5)	0.65
Unemployed (%)	17 (6.1)	18 (5.7)	11 (4.0)	0.39
Married (%)	228 (81.0)	229 (80.7)	224 (79.6)	0.22
Disease history (yes) (%)	110 (39.1)	116 (40.4)	116 (41.1)	0.88
Smokers (%)	9 (3.2)	15 (4.31)	10 (3.6)	0.42
Hypertension (%)	41 (14.7)	46 (15.4)	50 (17.9)	0.55
Dinner score	**T1 *n*=282**	**T2 *n*=281**	**T3 *n*=284**	***P****
Age (year)	42.64±10.67	42.87±10.87	42.08±10.32	0.53
Weight (kg)	71.75±12.23	72.76±13.23	72.56±15.52	0.48
BMI (kg/m^2)	27.29±4.33	27.15±4.33	27.22±4.83	0.87
Female (%)	243 (86.4)	224 (79.6)	231 (81.4)	0.095
University educated (%)	106 (37.5)	93 (33.1)	102 (35.6)	0.65
Severe physical activity (%)	24 (8.7)	28 (10.1)	26 (8.7)	0.93
Unemployed (%)	15 (5.4)	15 (5.4)	16 (5.3)	0.52
Married (%)	224 (79.4)	230 (81.7)	228 (80.2)	0.94
Disease history (yes) (%)	100 (35.5)	124 (43.9)	121 (42.1)	0.10
Smokers (%)	6 (2.2)	12 (4.3)	12 (3.6)	0.31
Hypertension (%)	37 (13.0)	46 (16.2)	56 (19.1)	0.15

Data are presented as mean (SD) or percent. BMI: body mass index, DAQ: dietary antioxidant quality. *Obtained from one-way analysis of variance (ANOVA) or Chi-square test, where appropriate

intake were independent predictors of overweight/obesity, while an increased risk of obesity and overweight was linked to higher selenium intake. Another study examined the association between plasma lipid-soluble antioxidant vitamins and carotenoid levels and adiposity in adolescents. The investigators reported that higher levels of lipid-soluble antioxidant vitamins are associated with lower adiposity and improved cardiometabolic profile.[27] Another study with similar findings identified deficiencies in zinc, magnesium, and vitamins C and E as risk factors for elevated body fat percentage and central obesity.[28] In a further study, tocopherol concentrations were inversely correlated with abdominal adiposity.[29] However, Wallström *et al*.[30] revealed that adults' central and overall obesity was positively correlated with greater serum-tocopherol concentrations. In a cross-sectional study, an inverse relationship was found between plasma levels of vitamin C and BMI and waist circumference in nonsmoking adults.[31] In another study on obese preschool children, plasma Zn concentrations were not correlated with weight, WHZ, or waist circumference.[32] Our findings were also in line with another study in which BMI was not relationship with plasma vitamin C.[33]

Discrepant findings on the relationship between dietary antioxidants and odds of obesity and overweight might be explained by different nutritional assessment methods across studies and variations in the intake of antioxidant nutrients. Another potential explanation for the discrepancy might be associated with different covariates in statistical analysis across studies. Moreover, in the current study, we considered the

Table 2: Dietary intakes of some nutrients across categories of dietary antioxidant quality score

Variables	T1 *n*=281	T2 *n*=281	T3 *n*=281	*P**
Breakfast score				
Energy (kcal)	405.16±144.04	417.92±147.80	441.44±156.88	<0.006
Carbohydrate (g/d)	66.64±24.72	70.43±25.57	73.59±24.46	0.01
Protein (g/d)	11.83±5.62	15.34±26.24	13.48±7.64	0.24
Fat (g/d)	12.45±8.61	14.26±22.83	14.12±9.13	0.206
Vitamin C	6.98±6.24	15.64±12.22	27.49±22.33	<0.001
Zinc	1.13±0.65	1.49±0.81	1.98±0.62	<0.008
Vitamin A	92.02±45.00	127.54±93.13	224.35±310.84	<0.001
Vitamin E	0.62±0.51	1.21±1.43	1.91±6.54	<0.001
Selenium	0.67±0.90	1.92±1.38	3.12±1.69	0.18
Calcium	161.87±73.82	196.10±81.86	225.16±122.88	<0.001
Fiber	7.06±32.79	10.78±36.79	10.78±36.12	0.22
Sugar	21.51±66.19	20.96±10.95	20.97±14.32	0.39
Lunch score	**T1 *n*=280**	**T2 *n*=284**	**T3 *n*=278**	***P****
Energy (kcal)	551.82±196.12	525.44±168.14	528.74±172.42	0.70
Carbohydrate (g/d)	60.41±24.03	69.93±42.76	70.98±29.28	<0.001
Protein (g/d)	19.44±7.69	22.69±8.50	24.41±8.69	<0.001
Fat (g/d)	16.84±7.72	20.45±8.96	23.88±9.50	<0.001
Vitamin C	15.80±10.19	25.12±15.17	42.29±32.82	<0.001
Zinc	2.11±0.71	2.75±0.84	3.23±1.11	<0.001
Vitamin A	112.96±104.42	168.72±128.44	391.92±345.66	<0.001
Vitamin E	1.15±1.10	2.23±2.22	5.31±3.99	<0.001
Selenium	2.11±1.59	3.04±1.70	3.48±2.09	0.15
Calcium	145.21±104.74	189.24±106.08	226.16±126.24	<0.001
Fiber	5.50±5.99	5.93±3.33	6.70±2.77	<0.001
Sugar	7.35±15.10	6.88±5.84	11.17±11.46	0.04
Dinner score	**T1 *n*=282**	**T2 *n*=281**	**T3 *n*=284**	***P****
Energy (kcal)	425.39±172.51	500.07±160.80	596.71±189.69	<0.001
Carbohydrate (g/d)	59.61±22.72	72.72±31.51	82.86±30.97	<0.001
Protein (g/d)	15.15±6.93	19.12±6.53	22.24±9.08	<0.001
Fat (g/d)	14.32±6.89	16.51±6.73	21.78±10.23	<0.001
Vitamin C	19.47±13.68	28.32±15.40	43.67±36.54	<0.001
Zinc	1.65±0.62	2.28±0.76	3.00±1.25	<0.001
Vitamin A	121.14±87.99	181.97±128.57	351.14±327.42	<0.001
Vitamin E	1.58±1.81	2.42±2.34	4.44±4.21	<0.001
Selenium	1.46±1.29	2.89±1.74	3.51±1.78	0.19
Calcium	161.44±101.04	206.76±111.64	263.82±162.63	<0.001
Fiber	6.51±8.74	6.20±3.89	7.50±3.35	<0.001
Sugar	12.65±14.30	15.99±22.73	17.47±9.22	0/001

Data are presented as mean (SD). DAQ: dietary antioxidant quality. *Obtained from one-way analysis of variance (ANOVA)

overall association of antioxidants with obesity, while other studies investigated the association of individual nutrients. Finally, The use of foods high in energy and antioxidants, such as fruits, chocolate, and potatoes, may raise the risk of obesity in people who have a high daily energy intake.

Lunch is considered the main meal for most people in Iran and a large part of micronutrients are consumed in this meal. Therefore, the inverse association between lunch DAQs and overweight might be explained by a higher intake of antioxidant nutrients in this meal.

Inflammation and oxidation Stress is a significant factor in the emergence of obesity. and its metabolic complications.[34] Findings from observational studies provide evidence supporting a positive association between adiposity and markers of systemic inflammation.[35-37] Inflammation could affect the number and size of adipocytes. It also promotes lipogenesis, stimulates preadipocyte differentiation, and regulates the energy balance in hypothalamic neurons.[34,38]

On the other side, some studies documented that nutrient levels such as vitamins C and E, zinc and selenium, and magnesium are low in obese individuals. Garcia-Diaz *et al*.[39] reported that vitamin C dose-dependently reduces leptin secretion and inhibits glucose uptake in primary rat adipocytes. Oral vitamin C supplementation can also reduce apelin gene expression, which is associated with insulin resistance,

Table 3: Odds ratios and 95% CIs of overweight or obesity across categories of breakfast' DAQ score

	Categories of breakfast' DAQ score		
	T1	T2	T3
Overweight			
Crude	1	(1.10-0.53) 0.77	(1.36-0.65) 0.94
Model 1	1	(1.14-0.53) 0.78	(1.42-0.65) 0.96
Model 2	1	(1.08-0.48) 0.72	(31.38-0.63) 0.93
Obesity			
Crude	1	(1.17-0.53) 78/0	(1.58-0.73) 1.08
Model 1	1	(1.23-0.54) 0.81	(1.65-0.74) 1.10
Model 2	1	(1.56-0.68) 1.03	(1.10-0.44) 0.70

Data are presented as OR (95% CI). DAQ: dietary antioxidant quality, OR: odds ratio, CI: confidence interval. ORs were obtained from binary logistic regression. Model 1: adjusted for age, gender, education, smoking, occupation, physical activity, marital status, disease history, and hypertension. Model 2: further adjustment for energy intake, fiber, calcium, and sugar in breakfast meal

Table 4: Odds ratios and 95% CIs of overweight or obesity across categories of lunch' DAQ score

	Categories of lunch' DAQ score		
	T1	T2	T3
Overweight			
Crude	1	(1.26-0.48) 1.23	(1.75-0.78) 1.10
Model 1	1	(1.80-0.86) 1.25	(1.69-0.81) 1.17
Model 2	1	(2.11-0.94) 1.41	(1.87-0.88) 1.28
Obesity			
Crude	1	(1.59-0.73) 1.08	(1.64-0.76) 1.12
Model 1	1	(1.67-0.75) 1.12	(1.75-0.79) 1.17
Model 2	1	(1.75-0.72) 1.12	(1.82-0.82) 1.21

Data are presented as OR (95% CI). DAQ: dietary antioxidant quality, OR: odds ratio, CI: confidence interval. ORs were obtained from binary logistic regression. Model 1: adjusted for age, gender, education, smoking, occupation, physical activity, marital status, disease history, and hypertension. Model 2: further adjustment for energy intake, fiber, calcium, and sugar in lunch meal

Table 5: Odds ratios and 95% CIs of overweight or obesity across categories of dinner' DAQ score

	Categories of dinner' DAQ score		
	T1	T2	T3
Overweight			
Crude	1	(1.65-0.82) 1.16	(1.57-0.78) 1.11
Model 1	1	(1.73-0.83) 1.20	(1.61-0.77) 1.12
Model 2	1	(2.18-0.95) 1.44	(1.81-0.85) 1.24
Obesity			
Crude	1	(1.33-0.63) 0.91	(1.17-0.54) 0.80
Model 1	1	(1.39-0.63) 0.94	(1.14-0.51) 0.76
Model 2	1	(1.47-.0.61) 0.95	(1.16-0.50) 0.76

Data are presented as OR (95% CI). DAQ: dietary antioxidant quality, OR: odds ratio, CI: confidence interval. ORs were obtained from binary logistic regression. Model 1: adjusted for age, gender, education, smoking, occupation, physical activity, marital status, disease history, and hypertension. Model 2: further adjustment for energy intake, fiber, calcium, and sugar in dinner meal

obesity, and inflammation.[40] In the study of Shen *et al*.,[41] administration of vitamin E in obese rats significantly reduced leptin and adiponectin expression. Moreover, Vitamin E contributes to the metabolism of lipids, mostly by reducing oxidative damage and protecting lipids from oxidation.[42] It has been shown that zinc supplementation elevated circulating levels of leptin.[43] In particular, zinc is essential for the synthesis, storage, and production of insulin in the body.[44] investigation showed that increased DAQS was linked to reduced diastolic blood pressure.[45]

Strengths and limitations

This study has a number of advantages. First, we used a sizable sample size for our investigation. In order to get an independent connection, we were able to adjust for a wide variety of potential confounders thanks to the accessibility of detailed information on dietary and non-dietary factors. Additionally, validated questionnaires were used to collect the data, which can further enhance the validity of the results. But some restrictions must be taken into account. First off, this study cannot prove that the relationships are causally related. Second, even though we took into account the majority of lifestyle determinants, residual or unmeasured confounding cannot be completely ruled out. Third, it is certain that research participants will be incorrectly classified as a result of the use of the FFQ, as is typical in nutritional epidemiology. Fourth, DAQS does not take antioxidant bioavailability or metabolism into account and is based solely on dietary intake of antioxidants. BMI is the most common anthropometric measure used in epidemiological studies and is simple to calculate, but because it does not distinguish between lean body mass and fat mass, it may not be a reliable prediction of obesity. Finally, we lacked information on how to cook foods in a way that wouldn't change their antioxidant content.

Conclusion

We found that a higher lunch's DAQ score was significantly linked to a lower risk of overweight, but not with obesity. Moreover, no association was found between breakfast and dinner DAQ score and risk of obesity and overweight. Future prospective research in various populations are required to confirm our findings.

Ethics approval and consent to participate

All techniques used in studies involving human subjects were carried out in accordance with the institutional and/or national research committee's ethical guidelines, the 1964 Helsinki declaration and its later amendments, or equivalent ethical standards. The Tehran Municipality's Health Bureau's coordination and the assistance of the city's medical facilities made it easier to gather the samples. The study protocol and informed consent form were approved by the Islamic Azad University's ethical council (Ethic Number IR.IAU.SRB.REC.1400.220). Prior to participating in the study, After receiving written information regarding the background and procedures of the investigation, all patients gave their informed consent.

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Conflicts of interest

There are no conflicts of interest.

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