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Nutritional Status and its Associations with Eating Behavior and Diet Quality among Adult: A Cross-Sectional Study

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Abstract

BACKGROUND*:* Obesity among adults is a significant public health problem. Diet quality might be influenced by eating behavior and is associated with nutritional status, but research is lacking in obese adults in Indonesia.

AIM: The purpose of this study was to investigate the relationship between eating behavior, diet quality, and obesity.

METHODS*:* A cross-sectional study was carried out among 144 respondents (39.6% males and 60.4% females), aged 39.07 ± 5.48 years, who were selected using stratified random sampling from five subdistrict in Malang City, East Java, Indonesia. The eating behavior score was calculated using the Dutch Eating Behavior Questionnaire (DEBQ) and the diet quality using the Diet Quality Index International (DQI-I) from SQ-FFQ. Association of eating behavior, diet quality, and nutritional status was analyzed using logistic regression analysis.

RESULTS*:* The study showed that the prevalence of obesity among female adults was higher (31.9%) than males (18.8%). The female participant had a two-fold higher likelihood of being overweight or obese than the male participant (OR = 2.25, 95% CI: 1.077; 4.071, $p < 0.05$). The average diet quality score was 57.99 ± 7.26 or 80% from a total score of 100. There was no significant difference in total DQI-I and component scores, including variety, adequacy, moderation, and overall balance across nutritional status and sex, $p > 0.005$. The poor-diet quality was higher in the overweight and obesity group (43.75 %) than the normal group (16.67%). There was a statistically significant difference of restrained eating with overweight and obesity status ($p < 0.05$) with OR 2,652 (CI 95% 1.149; 6.119) and female (OR 2.496, CI 95% 1.195; 5.212, $p < 0.05$).

CONCLUSIONS*:* It can be concluded that obesity was prevalent in female adults, and there is a relationship between obesity and restraint eating among adults. Future studies should examine the causal effects of eating behaviors on quality diet and in the development of obesity.

Introduction

Obesity is a significant public health problem. Globally, its prevalence is rising [1]. According to the WHO, the worldwide prevalence of obesity nearly tripled between 1975 and 2016. Overall, about 39% of adults aged 18 years and over were overweight, and 13% were obese [2]. About 21.8% of adults aged 18 years and older were obese in Indonesia, and 35.4% were overweight [3]. According to the prevalence threshold, the prevalence of overweight was ≥15% very high problem in public health [4]. Obesity was a condition of abnormal or excess fat accumulation that presents a risk of health. Body mass index (BMI) is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2), commonly used to classify overweight and obesity in adults. The WHO has classified overweight as a BMI ≥25, and obesity is a BMI ≥30 [5]. Obesity is associated with higher mortality and increased rates of cardiovascular disease, diabetes, hypertension, metabolic syndrome, depression [6], and anxiety [7].

The etiology of obesity includes behavior and psychological factors. Obesity is a complex interplay between genetic susceptibility and behavior, including eating behavior, dietary habit, and physical activity [8]. Obesity is caused by a long-term imbalance between energy intake from food consumption and energy consumption from physical activity. Physical activity can be important in weight control [9]. A behavioral risk factor has been postulated, including diets with a high energy density, large portion sizes, eating patterns, increased consumption of sugar-sweetened beverages, sedentary behavior, and low level of physical activity [10].

Eating behavior was associated with appetite and modulated by environmental, social factors, and internal biological mechanisms [11]. Eating behavior is related the food choice, including the selection and decision of which foods to eat [12]. Eating behavior is a complex interplay of physiologic, psychological, social, and genetic factors and can influence meal timing, the quantity of food intake, food preference, and food selection [13]. Eating behavior has been studied in association with body weight in aspect cognitive restraint, disinhibition, and susceptibility

to hunger [14], [15]. Eating behaviors associated with obesity-related responsiveness to taste, smell, availability, and emotions as external food, under responsiveness to internal satiety, and emotional overeating [16], [17].

Overeating is an eating behavior disorder that is one of the causes of obesity. Stress can increase risk factors for obesity and binge eating disorder (BED) [18], [19], [20], [21]. Several instruments have been developed to assess eating behavior, such as the three-factor eating questionnaire (TFEQ) and Dutch Eating Behavior Questionnaire (DEBQ), and measure domain dietary restraint, disinhibition with emotional or external overeating, and hunger [14], [22]. Three types of overeating were emotional eating, external eating, and restrained eating. (1) Emotional eating: eating in response to emotional arousal states such as fear, anger, or anxiety; (2) External eating: eating in response to external food cues such as sight and smell of food; (3) Restraint eating: overeating after a period of slimming when the cognitive resolve to diet is abandoned [22]. Restrained eating behavior is overeating after a period of slimming when the cognitive resolve to diet is abandoned or defined as a tendency to consciously restrict food intake, prevent weight gain, or promote weight loss by controlling both energy intake and food types eaten.

External eating behavior is eating in response to external food cues such as sight and smell of food and the tendency to overeat about external stimuli, such as palatable foods. Emotional eating behavior is eating in response to emotional arousal states such as fear, anger, or anxiety and the tendency to overeat in the presence of negative mood states, such as anxiety, depression, or loneliness [22]. A study indicated that the DEBQ had higher internal consistency and more stable factor structure across sexes and weight categories than the TFEQ [23]. The previous study showed that females have OR 3.7 ($p < 0.05$) for negative emotional eating [24] and a significant difference between the restrained and external eating scores in obese and overweight groups [25]. Food insecurity has higher odds of high eating behavior (OR 1.96; 95% CI 1.28: 3.02) [26].

Diet quality can influence cultural and food environment, socio-economic status, preference as confounding factors [27]. Diet quality is defined as a dietary pattern. Diet Quality Indices (DQIs) are instrument tools that can be used to quantify the overall quality of an individual's dietary intake by scoring food and nutrient intakes and comparing them with dietary guidelines [28]. Diet quality is defined as a healthy diet, balanced diet, nutritious foods, functional foods, and nutrient-rich diet [29]. It shows the effects of healthy eating and a reduction in risk for chronic diseases [28], [30], [31] and mortality [28], [32], [33]. The other studies reported that the diet quality of people who eat alone was lower than that of people who eat together both (β: - 0.110, $p = 0.002$) and female participants (β: - 0.069, $p = 0.005$), [34]. Obese T2D patients had significantly lower AHEI-2010 ($p < 0.001$), DQI-I ($p < 0.001$), and DASH total scores ($p = 0.044$) than their nonobese counterparts, independent of age and sex [35].

Adequacy, diet quality, and overeating were associated with the risk of obesity. Diet quality might be influenced by eating behavior related to nutritional status, but research is lacking in obese adults in Indonesia. The objective of the study was to investigate association between eating behavior, diet quality, and obesity.

Methods

Study design and participants

A cross-sectional survey was carried out to assess the relationship of diet quality, eating behavior and nutritional status among 144 respondents (39.6% of males and 60.4% of females), aged 39.07 ± 5.48 years, who were selected using stratified random sampling from five subdistrict in Malang City, East Java, Indonesia, between March and June 2018 from five subdistrict in Malang City, East Java, Indonesia.

Sample size calculations were conducted based on assuming a 95% confidence interval and 8% margin of error and taking overweight and obesity prevalence among adults aged 18 years and older was 35.4% [3]. The sample size required was 138 participants. The inclusion criteria were adults aged between 30 and 49 years and not pregnant and BMI ≥18. The exclusion criteria were acute infection disease (e.g., tuberculosis) and suffering diabetes mellitus. The Ethical Committee approved the Faculty of Medicine study, Universitas Brawijaya (Certificate No. 419/EC/KEPK/12/2017). Written consent from the adult was obtained before any data collection.

Measurements of data collection

The socioeconomic and demographic were collected using a structured questionnaire. Well-trained examiners measured the anthropometrics, both weight and height. Weight was measured to the nearest 10^{th} of a kilogram, and height was measured to the 10^{th} of a centimeter with a stadiometer. All measurements were performed twice using a standard protocol and techniques [36], [37]. Body mass index (BMI) was calculated as weight in kilograms divided by height in squared meters, and classified into normal, ≥18.5 to <23 kg/m^2; overweight, ≥23 to <24.9 kg/m^2; obese, ≥25 kg/m^2 [37].

Diet quality index assessed using the Diet Quality Index International (DQI-I) from food frequency questionnaire and 24-h recall. The DQI-I was calculated

using the method by Kim *et al*. [38]. The DQI-I focuses on four major aspects of diet quality, i.e., variety, adequacy, moderation, and overall diet balance. Scores for all four components are 100 points, including variety (0–20), adequacy (0–40), moderation (0–30), and overall balance (0–10). Scores of < 60% reflect the poor-diet quality and 60 and more as a high-diet quality [22].

Variety in the diet is evaluated from overall food group variety from five food groups (meat/poultry/fish/egg, dairy/beans, grains, fruits, and vegetables) in total scores 15, and variety within protein sources (consume at least three differences sources from meat, poultry, fish, dairy, beans, eggs) in total score 5. Adequacy is evaluated from vegetable, fruit, grain groups (>100 % recommendation from RDA/d) and fiber, protein, iron, calcium, Vitamin C (>100% recommendation from RDA), and a total of eight components was 40 points. Moderation is evaluated from the percentage of energy from total fat (≤20% of total energy/d), saturated fat (≤7% of total energy)/d, cholesterol (≤300 mg/d), sodium (≤2400 mg/d), empty-calorie food (≤3% of total energy/d) with total scores was 30 points. Total scores of the overall balance were 10 points, including ratio carbohydrate: protein: fat (44−65: 10−15: 15−25) with 6 points and ratio PUFA: MUFA (1−1.5) and MUFA: SFA (1−1.5) with 4 points [39].

The eating behavior score was assessed using Dutch Eating Behavior Questionnaire (DEBQ) developed by Van Strien *et a*l. [22]. It consists of 33 items for evaluating three scales of eating behaviors in adults: (1) emotional eating (13 items), (2) external eating (10 items), and (3) restrained eating (10 items. Responses are given through a 5-point Likert scale with details of 1 (never), 2 (rarely), 3 (sometimes), 4 (often), and 5 (very often). The questionnaire was translated into the Indonesian language. Before the study, the validity of the questionnaire from 33 items had a significant Pearson Correlation (p = 0.000). The reliability was measured using Cronbach's alpha for restrained eating (α = 0.835), emotional eating (α = 0.974), external eating (α = 0.705), and all of them α > 0.60.

The score for each component of eating behavior is obtained from the total number of responses from each question item. Categorized as emotional eating or external eating or restrained eating if ≥2.5, and not emotional eating or not external eating or restrained eating if <2.5 [22].

Statistical analysis

Participants' characteristics were presented in descriptive statistics (means and standard deviations or frequencies). The independent t-test and χ^2 analyses were performed to assess differences between nutritional status, sex, eating behavior, and diet quality. Association of eating behavior, diet quality, and nutritional status was analyzed logistical regression and independent t-test. Analyses were conducted using IBM SPSS 22.0. Statistical significance was defined as a two-tailed p < 0.05.

Results

Characteristics of participant

A total of 144 adults were enrolled in the study. Table 1 shows the characteristics of participants by nutritional status. The mean age was 39.22 ± 5.50 years. The participants were grouped by nutritional status, and there were 28.5 % with BMI 18.5-24.9 kg/m^2 (normal group) and 71.5%% with BMI ≥25 kg/m^2 (overweight and obesity). Most of the participants were female (60.4%), <40 years old (56.3%), completed education length around 12 years (13.9%), and smokers (59.7%). In the overweight and obesity group, the proportion of females; less than 40 years old, who do not have an occupation, married status, and smoker status was higher than participants in the BMI normal group. As presented in Table 1, all characteristic respondents did not differ significantly among the two groups (p > 0.05).

Table 1: The characteristics of participants by nutritional status

Characteristics	All (n = 144)	Normal (n = 41)	Overweight and Obesity (n = 103)	p-value	χ^2
Sex, % (n)				0.054	0.522
Female	60.4 (87)	28.5 (41)	31.9 (46)		
Male	39.6 (57)	31.9 (46)	18.8 (27)		
Age group, % (n)				0.274	0.091
Less 40 years	56.3 (81)	18.1 (26)	38.2 (55)		
More than 40 years	43.8 (63)	10.4 (15)	33.3 (48)		
Education level, % (n)				0.787	0.032
Primary school	13.9 (20)	4.2 (6)	9.7 (14)		
Secondary school	20.8 (30)	5.6 (8)	15.3 (22)		
High school	48.6 (70)	33.3 (48)	33.3 (48)		
Graduate degree	16.7 (24)	13.2 (19)	13.2 (19)		
Employment's status, % (n)				0.580	-0.046
No occupation	50 (72)	13.2 (19)	36.3 (53)		
Employee	50 (72)	15.3 (22)	34.7 (50)		
Marital status, % (n)				0.441	0.064
Married	92.4 (133)	27.1 (39)	65.3 (94)		
Separated	2.8 (4)	0	2.8 (4)		
Single	4.9 (7)	1.4 (2)	3.5 (5)		
Cigarettes % (n)				0.950	0.017
Smoker	59.7 (86)	17.4 (25)	42.4 (61)		
Ex-Smoker	4.9 (7)	1.4 (2)	3.5 (5)		
No-Smoker	35.4 (51)	9.7 (14)	25.7 (37)		

Values are expressed as % (n). * Significant at P ≤ 0.05. χ^2 Chi-square test.

Association diet quality and nutritional status

The mean of body massa image (BMI) was 26.14 ± 4.99 (95% CI: 25.34; 27.0), and the mean BMI among female participants was higher than males (26.61 ± 4.88: 95% CI: 25.56; 27.67 vs. 25.42 ± 5.13: 95% CI: 24.12; 26.62, p > 0.05). Most of the participants had a BMI of 25 and more. The prevalence of overweight with BMI 25−29.9 was 20.8%, and obesity with BMI ≥30 was

50.7%. The female participant had a two-fold higher likelihood of being overweight or obese than the male participant (OR=2.25, 95% CI: 1.077; 4.071, p < 0.05).

The diet quality index was assessed using the Diet Quality Index-International (DQI-I). The total DQI-I and component of diet quality for study participants in Table 2 and by nutritional status and sex are shown in Table 3. The DQI-I total score reached 58% from the 100% possible score. Table 2 shows that the best achieved DQI-I score was variety (80.6%; 57.99 ± 7.26), followed by moderation (68.8%; 20.63 ± 4.18) and adequacy (48.8%; 19.50 ± 4.58). DQI-I total score overall balance was the lowest score (17.5%; 1.75 ± 2.14). The balance of energy sources from macronutrients was 23.8%; the however ratio of PUFA to SFA and MUFA to SFA was 8%. Scoring criteria and points are referred to Tur *et al*. [39].

Table 2: Diet quality index-international scores and components

Component	Score range (points)	Mean ± SD	95% CI
DQI-I total score	0−100	57.99 ± 7.26	56.79–59.18
Variety	0−20	16.11 ± 2.85	15.64–16.58
Overall food group variety	0−15	12.21 ± 2.34	11.82–12.59
Within-group variety for protein sources	0−5	3.90 ± 1.00	3.74–4.07
Adequacy	0−40	19.50 ± 4.58	18.75–20.25
Vegetable group	0−5	1.52 ± 1.55	1.27–1.78
Fruit group	0−5	0.98 ± 1.55	0.72–1.24
Grain group	0−5	3.33 ± 1.51	3.05–3.55
Fiber	0−5	1.04 ± 0.37	0.98–1.1
Protein	0−5	4.81 ± 0.59	4.71–4.90
Iron	0−5	2.55 ± 1.52	2.30–2.80
Calcium	0−5	1.83 ± 1.26	1.63–2.04
Vitamin C	0−5	3.47 ± 1.53	3.22–3.72
Moderation	0−30	20.63 ± 4.18	19.94–21.31
Total fat	0−6	2.15 ± 2.18	1.79–2.50
Saturated fat	0−6	1.31 ± 2.03	0.98–1.65
Cholesterol	0−6	5.17 ± 1.89	4.85–5.
Sodium	0−6	6.0 ± 0	6
Empty calorie foods	0−6	6.0 ± 0	6
Overall balance	0−10	1.75 ± 2.14	1.40–2.10
Macronutrient ratio	0−6	1.43 ± 1.97	1.11–1.76
Fatty acid ratio	0−4	0.32 ± 1.08	0.14–0.50

In Table 3, the comparison DQI-I total scores between normal BMI groups and the overweight and obesity group was 58.03 ± 6.95 versus 57.95 ± 7.60, p > 0.005. However, the female and male groups were 57.40 ± 7.08 versus 58.88 ± 7.51, p > 0.005. There was no significant difference in total DQI-I and component scores, including variety, adequacy, moderation, and overall balance across nutritional status and sex, p > 0.005 the lowest score of DQI was balanced ration energy from carbohydrate, protein, and fat, and also ratio MUFA to SFA ad Ratio PUFA to SFA .

Analysis of covariance (ANCOVA) was performed to compare DQI-I total score with adjusted age and sex as covariates. There was no significant association between DQI-I total score and nutritional status (F = 0.715, p > 0.05). The score of DQI-I less than 60% reflects a poor-diet quality. More than half of the study participants had a poor-diet quality (60.4%). The poor-diet quality was higher in the overweight and obesity group (43.75%) than the normal group (16.67%), (Figure 1). The proportion of poor-diet quality in the female group (40.3%) was higher than the male group (20.15). The study participants' overweight and obesity had a 1.12-fold likelihood of poor-diet quality (OR 1.116, 95% CI 0.534; 2.331, p > 0.05). The female adult had a. 1.931-fold likelihood of poor-diet quality OR 1.931 (95% CI 0.974; 3.825, p > 0.05).

Association eating behavior and nutritional status

In Table 4, it was shown that there was no statistically significant difference in the emotional eating score, external eating score, and restrained eating score among BMI normal and overweight-obesity. Comparison based on sex in Table 4 showed that restrained eating score in males was higher than female adults and a significant difference (p<0.05).

The emotional and external eating scores negatively correlated with overweight and obesity status and sex (p > 0.05). There was a significant positive correlation between restrained and sex (p < 0.01) but not significantly with nutritional status (p > 0.005), as shown in Table 5.

Most adults experience emotional eating 13.6% and external eating 45.1%, and neither significant difference with overweight and obesity status nor sex (p > 0.05). The proportion of adults with overweight and obesity was higher with experience restrained eating than adults with BMI normal and female. There was a significant difference of restrained eating with overweight and obesity status (p < 0.05) with OR 2.652 (CI 95% 1.149; 6.119) and female (OR 2.496, CI 95% 1.195; 5.212, p < 0.05).

Discussion

The study investigated the association of overweight and obesity with diet quality and eating behavior. Overweight and obesity are associated with excess food intake and are related to quantity, quality, and eating behavior. Eating behavior can influence food intake and diet quality and impact of imbalance energy intake. Food choice, food intake, and eating behavior can influence confounding variables such as socio-demographic factors. In the study, the characteristics of the participants with BMI normal and overweight and obesity groups are similar, which minimized the potential for bias from confounding factors.

In the study, overweight and obesity, central obesity, are more prevalent among women than male participants. In Tanzania, the risk of overweight/obesity was higher among older women (PR 1.59; 95% CI: 1.30–1.95), [40]. A high prevalence of maternal obesity is reported in a systematic review and meta-analysis across Africa, 6.5−50.7% [41].

Table 3: Diet quality index-international across nutritional status and sex

Dietary component	Overweight and obesity (n = 103)	Normal (n = 41)	p-value	Female (n = 87)	Male (n = 57)	p-value
DQI-I score (0−100)	57.95 ± 7.60	58.03 ± 6.95	0.946	57.40 ± 7.08	58.88 ± 7.51	0.235
Component scores						
Variety (0−20)	16.38 ± 3.16	15.83 ± 2.48	0.142	16.13 ± 2.85	16.09 ± 2.88	0.937
Adequacy (0−40)	19.71 ± 4.50	19.28 ± 4.69	0.572	19.62 ± 4.50	19.32 ± 4.73	0.698
Moderation (0−30)	20.34 ± 4.0.1	20.92 ± 4.36	0.413	20.21 ± 4.20	21.26 ± 4.10	0.139
Overall balance (0−10)	1.51 ± 2.08	2.0 ± 2.19	0.490	0.25 ± 0.96	0.42 ± 1.24	0.360

Table 4: Eating behavior components by nutritional status and sex

Eating Behavior Component #	All (n = 144)	Nutritional Status			Sex		
		Overweight and Obesity (n = 103)	Normal (n = 41)	p-value	Female (n = 87)	Male (n = 57)	p-value
Emotional eating	1.46 ± 0 0.89	1.43 ± 0.81	1.53 ± 1.06	0.565	1.42 ± 0.86	1.53 ± 1.93	0.467
External eating	2.35 ± 0.88	2.43 ± 1.06	2.50 ± 0.73	0.067	2.32 ± 0.74	2.32 ± 0.73	0.997
Restrained eating	2.32 ± 0.74	2.40 ± 0.81	2.22 ± 1.02	0.281	2.04 ± 0.79	2.55 ± 0.88	0.001*

DEBQ, Dutch Eating Behavior Questionnaire. * Significant at P ≤ 0.05.

The proportion of participants' poor-diet quality was high in the study, both nutritional status and sex. The lowest percentage of the score on the overall balance component, including ratio PUFA to SFA and MUFA to SFA, was 8% and ratio macronutrient. The diet quality measurement based on the DASH score reported no significant association between dietary quality and obesity indicators [40].

Table 5: Interclass correlation eating behavior components, obesity status, and sex

Eating behavior component[#]	Nutritional status		Sex	
	Pearson coefficient	p-value	Pearson coefficient	p-value
Emotional eating	−0.003	0.974	−0.071	0.397
External eating	−0.142	0.090	−0.003	0.972
Restrained eating	0.160	0.56	0.305	0.000**

[#]DEBQ, Dutch Eating Behavior Questionnaire. *Significant at P ≤ 0.05 **Significant at P ≤ 0.01.

Similar results had been reported that after adjusting for age, sex, energy intake, physical activity, and smoking status, multivariate analysis of covariance did not show any significant results regarding diet quality indices' in Tehran [42]. HEI-2005 and DQI-I could not predict overweight and obesity. In another cross-sectional survey study, informed diet quality score was associated with nutrition knowledge score and no significant correlation with BMI and diet quality index [43].

The prevalence of overweight and obesity was higher among females. The study participants overweight and obesity had a 2.6-fold likelihood of experiencing restrained eating, and the female participant had a 2.5-fold likelihood of experiencing eating. The overweight and obese adult attempts to manage their body weight [44]. Restrained eating was overeating after a period of slimming when the cognitive resolve to diet is abandoned. Restrained eating is an individual's attempt to manage body weight by cognitively controlling food intake [45]. The previous study showed that have prospectively linked restrained eating to a higher risk of developing obesity in preadolescent and adolescent girls [46], [47] and greater weight gain in adults [48], [49]. Study in the USA informed that restraint scale scores were positively associated with both BMI (adjusted β = 0.39 kg/m^2; 95% confidence interval (CI) = 0.34–0.44; p < 0.001) and weight gain (adjusted β = 0.33 pounds; 95% CI = 0.17–0.49; p < 0.001) [50].

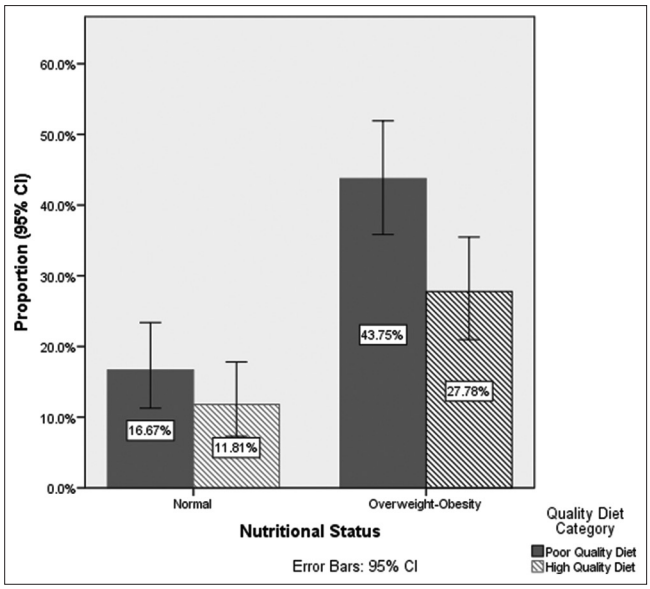

Figure 1: Proportion poor-diet quality across by nutritional status

This study had several limitations; first, there are limitations inherent in a cross-sectional study design. The cause-and-effect relationship between obesity status, diet quality, and eating behavior could not be determined [51]. The study might not include all the possible cofounder factors, such as sex, age, BMI, sociodemographic, and stress exposure.

Conclusion

Overweight and obesity, as well as central obesity, is prevalent among women than male participants. Restrained eating was higher in the overweight and obesity group and female participants. A diet quality index could not predict associated with overweight and obesity. Future studies should examine the causal effects of eating behaviors on quality diet and in the development of obesity.

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