Ghahfarokhi et al. BMC Nutrition (2024) 10:114
https://doi.org/10.1186/s40795-024-00917-y

BMC Nutrition

RESEARCH

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The association between the dietary behavior, diet quality, and lifestyle scores with anthropometric indices and happiness levels among university students

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Abstract

Background Limited information exists linking food habits, diet quality, and lifestyle scores with anthropometric indices and happiness levels. Our aim was to examine the association between food habits, diet quality, and lifestyle scores with anthropometric indices and happiness levels in the Iranian population.

Methods This cross-sectional study included 200 students randomly selected from a university in Iran. Dietary intakes, physical activity (PA), and happiness levels of study participants were assessed using validated questionnaires. The anthropometric indices examined in this study included the body shape index (ABSI), body roundness index (BRI), and abdominal volume index (AVI). Multiple logistic regression models were used to examine the association between food habits, diet quality, and lifestyle scores with anthropometric indices and happiness levels.

Results The mean age and body mass index (BMI) of study participants were 23.5 years ± 4.52 and 23.8 kg/m2 ± 3.17, respectively. In the study population, no significant association was seen between ABSI, BRI, AVI and happiness with food habits, diet quality, and lifestyle scores respectively. After adjusting for potential confounders (age, energy intake, marital status, education, smoking, physical activity, gender, and BMI), the association remained not significant for ABSI and food habits, diet quality, and lifestyle scores respectively (OR: 0.56, 95% CI (0.25–1.34), $P = 0.193$; OR: 0.59, 95% CI (0.22–1.57), $P = 0.413$; OR:1.19, 95%CI (0.54–2.63), $P = 0.652$), BRI and food habits, diet quality, and lifestyle scores respectively (OR:1.98, 95% CI (0.41–9.49), $P = 0.381$; OR: 0.57, 95%CI (0.12–2.74), $P = 0.512$; OR: 1.19, 95% CI (0.3–4.71), $P = 0.811$), AVI and food habits, diet quality, and lifestyle scores (OR:1.15, 95% CI (0.53–2.48), $P = 0.743$, OR:1.01, 95% CI (0.47–2.18), $P = 0.965$; OR: 1.3, 95% CI (0.64–2.65), $P = 0.465$) and happiness and food habits, diet quality, and lifestyle scores respectively (OR:0.3, 95%CI (0.07–1.25), $P = 0.972$; OR: 0.77, 95%CI (0.18–3.19), $P = 0.724$, OR: 0.3, 95% CI (0.07–1.25), $P = 0.083$).

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Conclusions No significant association was detected between food habits, diet quality, and lifestyle scores with anthropometric indices and happiness levels. However, longitudinal studies are required to confirm these findings.

Keywords Dietary Behavior, Diet Quality, Lifestyle Scores, Anthropometric Indices, Happiness Levels, Mental Health, University Students

Introduction

Nutritional approaches, as one of the main components related to lifestyle factors, play a crucial role in the prevention and treatment of chronic diseases. Among these, interventions related to nutritional behaviors are of paramount importance [1–3]. Recent years have seen a growing interest in the relationship between dietary behavior, diet quality, lifestyle scores, and anthropometric indices such as body mass index (BMI) and waist circumference (WC) [4–8].

Lifestyle factors such as physical activity, smoking habits, and alcohol consumption, which are often included in lifestyle scores, along with the quality of diet, have been associated with various health outcomes, including anthropometric indices [5, 9]. In addition to physical health, happiness levels, which are indicators of mental health and life satisfaction, have been associated with dietary behavior and diet quality [10] and have also been positively correlated with lifestyle scores [11].

In the pre-pandemic era, public health was already under siege from a wave of lifestyle-related diseases, including cardiovascular diseases, hypertension, dyslipidemia, obesity, diabetes, colon cancer, osteoporosis, depression, and anxiety, largely attributed to physical inactivity according to the World Health Organization (WHO). The advent of the pandemic has further underscored the importance of physical activity, not only for its well-established benefits in mitigating these conditions, but also for its potential role in enhancing mental health and equipping individuals with the resilience to navigate the challenges of confinement [12].

Adopting healthy eating habits can serve as a protective measure for overall health and aid in preventing weight gain. [13]. Conversely, neglecting to adhere to physical activity recommendations can lead to functional and structural deterioration of the body. This can manifest in various ways, including reduced physical fitness, deteriorated metabolic and cardiovascular parameters, altered body composition with a decrease in muscle mass and increase in fat mass, increased depressive symptoms, and a decrease in general well-being [14]. This global issue has the potential to impact public mental health and, consequently, quality of life.

In the context of home confinement, dietary behaviors may undergo changes; hence, maintaining proper nutrition becomes crucial to support the immune system and improve energy balance, thereby reducing the risk of chronic and infectious diseases [15]. This is particularly important for dormitory students. It's worth noting that staying at home can present challenges such as difficulties in procuring fresh food and shortages of certain food products. On a positive note, closer contact with family members and increased home cooking due to the coronavirus disease of 2019 (COVID-19) pandemic can provide adolescents with opportunities to learn skills that can enhance their nutritional knowledge and behaviors, as reported in several studies [16, 17]. However, some studies have reported that staying at home and working remotely can influence daily eating habits, leading to increased energy intake and a heightened desire for "comfort food" due to boredom and stress [18].

Research has shown that regular physical activity improves overall health and has the capacity to reduce the risk of chronic diseases such as cardiovascular diseases, cancer, and diabetes [19]. A systematic review found that healthy dietary patterns such as the Mediterranean diet are associated with better health-related quality of life in both physical and mental summaries, while unhealthy dietary patterns and Western dietary patterns are associated with lower scores of health-related quality of life [20]. Another study found that high levels of physical activity in combination with other positive lifestyle choices are associated with better health outcomes [21].

The association of dietary behavior, diet quality, lifestyle scores, anthropometric indices, and happiness levels among university students, a population group that undergoes significant lifestyle and dietary changes, is less explored. Given the conflicting results in the current literature and the need for better planning for future epidemics, there is a clear need for further research on these behaviors. This study aims to fill this gap by investigating these associations among students at Tehran University of Medical Sciences during the COVID-19 pandemic. By focusing on this specific population and time, we aim to provide valuable insights that can inform future research and public health planning.

Methods

Study population and sampling method

This cross-sectional study included 200 students who met the inclusion criteria. Inclusion criteria included personal willingness, students taking theoretical courses, apparently healthy individuals, students with no chronic illness or other infectious diseases (such as diabetes mellitus (DM), coronary heart disease, hypertension (HTN), multiple sclerosis (MS) or other nervous system disorders, irritable bowel syndrome (IBS), irritable bowel disease (IBD), rheumatoid arthritis (RA), pulmonary thromboendarterectomy (PTE), Crohn's disease (CD), ischemic heart disease (IHD), chronic kidney disease (CKD) and other kidney diseases, liver diseases, anemia, thalassemia, cancer, thyroid problems, asthma, Crohn's, colitis, Addison syndrome or Cushing's disease), age ranging between 18 and 40 years, not being pregnant or breastfeeding (in the past year), not adhering to a special diet, not having problems such as stress, anxiety, depression or the occurrence of unfortunate events in the last six months (self-declaration), having Iranian citizenship, not having any active infectious or inflammatory diseases and not being on a special diet. Exclusion criteria included dissatisfaction, lack of cooperation, and under-reporting or over-reporting results. Students were sampled randomly in proportion to the number of students of each faculty of Tehran University of Medical Sciences (TUMS). We also evaluated demographic, socio-economic, and lifestyle variables through face-to-face questionnaires. General information included age, contact number, place of residence, marital status, history of chronic diseases (such as: diabetes, cardiovascular disease, cancer, liver disease, kidney disease, lung disease, thyroid disease, and central nervous system disorders), medication and dietary supplementation, and smoking.

Study plan

The sampling method used in this study is a two-phase cross-sectional design.

In the first phase, demographic information was collected from 200 students via email using a questionnaire. This method allowed for a broad collection of data from a large group of individuals. In the second phase, a separate questionnaire was administered which focused on the students' eating habits both currently and prior to the COVID-19 pandemic. This questionnaire, known as the Eating Habits Questionnaire (EHQ) [22] allowed for a more specific exploration of the students' dietary behaviors. Additionally, the students were asked to self-report their height, weight, waist circumference, and other anthropometric indicators. While this method may not be as accurate as in-person measurements, it was deemed necessary due to the COVID-19 quarantine. The high education level of the target community and the provision of training on how to properly measure these indices helped to ensure the accuracy of this data [23, 24].

Physical activity data was also collected using the International Physical Activity Questionnaire (IPAQ). The student's food intake was collected by self-reported food frequency questionnaire (FFQ).

The Oxford Happiness Index (OHI) [25, 26] was included in our study to assess the overall well-being and happiness levels of the students. The OHI is a widely recognized tool that measures subjective well-being, which is an important aspect of mental health. In the context of our study, understanding the students' happiness levels can provide valuable insights into their overall quality of life and mental health status. This is particularly relevant given the potential impact of dietary habits and physical activity levels on mental health. By including the OHI in our study, we aimed to explore the potential correlations between dietary habits, physical activity, and happiness levels. This could help us understand whether and how lifestyle factors might influence mental well-being among students. The OHI has been previously validated and found to be reliable in Iran [27], making it a suitable tool for our study population. The questionnaire consists of several items that ask about different aspects of happiness and well-being, and respondents rate their agreement with each item on a scale. The scores are then summed to create an overall happiness score.

Previously, the validity and reliability of the IPAQ [28], FFQ [29] and OHI [26, 27] in Iran have been confirmed. This method of sampling allowed for a comprehensive collection of data from a large group of individuals, providing a broad overview of the students' demographic information, physical activity levels, dietary habits, and happiness levels.

Sample size calculation

In our study, we calculated the sample size using a two-phase cross-sectional design. We considered a type 1 error of 95% and a power of 80%. The prevalence of obesity in people who consume more white bread (P1) was 0.18 and in those who consume more whole wheat bread (P2) was 0.08. The observed ratio between healthy and unhealthy subjects was 30/70. The sample size was calculated based on a previous study [30], which found a significant difference in the prevalence of obesity between consumers of white bread and whole wheat bread. However, due to constraints, we were only able to randomly select 200 students for our research project. A detailed explanation for the sample size calculation is provided in the supplementary file.

Sampling method

In our study, we used a stratified random sampling method to ensure that our sample was representative of the student population at Tehran University of Medical Sciences (TUMS). Stratified random sampling is a method of sampling that involves dividing a population into smaller groups known as strata. In this case, the strata were the different faculties at TUMS. This method was chosen because it ensures that students from all faculties are adequately represented in the study. The process involved listing all the students in each faculty and then using a random number generator to select students from each list. The number of students selected from each faculty was proportional to the size of the faculty, ensuring a balanced representation across all faculties. We also evaluated demographic, socio-economic, and lifestyle variables through face-to-face questionnaires. General information included age, contact number, place of residence, marital status, history of chronic diseases (such as diabetes, cardiovascular disease, cancer, liver disease, kidney disease, lung disease, thyroid disease and central nervous system disorders), medication and dietary supplementation, and smoking. This method of sampling allowed us to obtain a sample that was representative of the student population at TUMS, while also ensuring that each student had an equal chance of being selected for the study. This helps to reduce selection bias and increase the external validity of our findings.

Assessment of dietary behavior

To assess healthy dietary behavior, we used the Food Habits section of a previously constructed dietary questionnaire, whose reliability has been previously reported [31]. This questionnaire assesses food habits which consists of 14 questions asking about daily consumption of main meals and especially regarding breakfast content, fruits and vegetables, cakes and desserts, soft and alcoholic beverages, etc. The responses ranges from "never" to "always" which reflected a score from zero to three points respectively with a maximum score of 42 points [31].

Assessment of dietary quality

Participants' food consumption information was obtained through a 168-item Food Frequency Questionnaire (FFQ). This questionnaire also has validity and reliability confirmed in Iran [29]. To assess healthy dietary intake, we used Healthy Eating Index 2015 (HEI-2015). HEI-2015 is a scoring system used to evaluate the quality of diet to which degree it aligns to key dietary recommendations from the Dietary Guidelines of Americans. This indicator measures the quality of the diet and health outcomes such as the risk of death from cardiovascular disease. The score ranges from zero to 100 where a higher score reflects better adherence to HEI-2015 index [32].

To clarify the calculation of food frequency, each item in the FFQ represented a specific food or drink. Participants were asked to indicate their average frequency of consumption of each item over the past year. The frequency options ranged from 'never or less than once per month' to '6+times per day'. Each frequency response was converted into a daily intake. For example, a response of '2–3 times per week' was converted to 0.36 servings per day (2.5 times per week divided by 7 days). Portion sizes were specified for each food item in the FFQ, and participants were asked to indicate whether their usual portion size was smaller, larger, or about the same as the specified portion size. This information was used to adjust the daily intake calculations.

The HEI-2015 scores were then calculated based on the daily intake data from the FFQ. Each of the 13 components of the HEI-2015 (total fruits, whole fruits, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, fatty acids, refined grains, sodium, added sugars, and saturated fats) was scored proportionally based on the intake levels, with higher scores indicating greater adherence to the recommended intake levels. The component scores were then summed to give the total HEI-2015 score.

Assessment of healthy lifestyle score (HLS)

Data on diet, physical activity (PA), smoking status and other healthy habits were used to establish a healthy lifestyle score. HEI-2015 was used to assess healthy dietary intake. HLS score was calculated to assess adherence to a healthy lifestyle. Each participant was given one point for every one of the following ten habits: non-smoking, moderate to high physical activity (>20 MET hours per week), following Mediterranean diet (more than or equal to 4 adherence points), body mass index (BMI) less than or equal to 22, moderate alcohol consumption, low TV exposure (less than 2 h/day), not being a heavy drinker (less than 5 alcoholic drinks/d for men and less than 4 alcoholic drinks/d for women), a short afternoon nap (10–20 min/d), meeting friends for more than 6 h/day or at least 40 h/week. On this HLS scale, the score obtained can be between 0 points (unhealthy lifestyle) to 10 points (healthiest lifestyle).

Assessment of physical activity

The International Physical Activity Questionnaire (IPAQ) was assessed and analyzed based on the metabolic equivalent of a task (MET).h/d. This questionnaire consists of physical activity related to work, transportation, housekeeping, recreation, sports, time spent sitting and leisure activities. Patients were asked to report all their intense and moderate activities last week along with the time taken to do them. Then the intensity of each activity (MET) was multiplied by the time taken to do it, and finally these values were added together to determine the amount of MET.h / d. The validity and reliability of this questionnaire has been confirmed in Iran [28, 33].

Assessment of smoking

Smoking was assessed using a self-administered questionnaire which asked: "Are you a smoker or not a smoker or an ex-smoker?"

Assessment of anthropometric indices

Information related to weight, height, and abdomen circumference was obtained with accurate training to the target community, using a tape measure and self-reported information. A pilot study including 171 individuals reported the validity of the self-reported anthropometric values [34]. This study compared self-reported values of weight, height, and WC to the values measured by a trained nutritionist. The correlation coefficients for the self-reported height, weight and WC compared to measured values were 0.83 ($P<0.001$), 0.95 ($P<0.001$), and 0.60 ($P<0.001$), respectively. Moreover, the correlation between BMI values calculated from self-reported measures and the nutritionist values was 0.70 ($P<0.001$). These results indicate that self-reported measures can be a reasonable choice for anthropometric indices.

ABSI and BRI were calculated by previously mentioned formulas [35, 36] using WC (m), BMI (kg/m2), and height (m) as below:

$$ABSI = WC/BMI2/3 \times height1/2.$$

$$BRI = 364.2 - 365.5 \times 1 - WC/2\pi 2 0.5$$

ABSI and BRI were not previously validated against gold-standard measurements since these assessment methods are expensive and hard to use in large populations.

Abdominal volume index is a new indices to estimate abdominal volume which we calculated according to previous studies [37] according to the formula:

$$(AVI) = [2\ cm\ (waist)\ 2 + 0.7\ cm\ (waist - hip)\ 2]\ /1,000$$

$$Cutoff\ values\ for\ ABSI,\ BRI,\ and\ AVI$$

In accordance with the existing literature, the following cutoff values have been established:

ABSI [38]: The optimal cutoff value is 0.083 m^11/6 kg^-2/3.

BRI [39]: The optimal cutoff values are 3.49 (for males < 60 years), 3.46 (for males ≥ 60 years), 3.47 (for females < 60 years), and 3.60 (for females ≥ 60 years).

AVI [40]: The optimal cutoff values is > 15.56 for men and > 18.49 for women.

However, it is important to note that these cutoff values are population-specific and may not be directly comparable across different populations.

Assessment of happiness levels

Students' happiness levels were measured using the Oxford Happiness Questionnaire. This questionnaire consists of 29 questions with each question having a scale from zero to six ranging from strongly disagree to strongly agree respectively. Eventually the happiness score will be estimated in the range of 29 to 174, with a higher score indicating more happiness. The validity and reliability of this questionnaire in Iran have been mentioned previously [27].

Statistical analysis

General characteristics and dietary intakes of study participants across categories of food habits, diet quality and HLS scores were examined using one-way analysis of variance (ANOVA) for continuous variables and chi-square for categorical variables. The objective of this analysis was to identify any significant differences in these characteristics and intakes across the different categories. The associations of food habits, diet quality and HLS with anthropometric indices (ABSI, BRI, AVI) and happiness levels were assessed by using multiple logistic regression in different models. The aim of this analysis was to understand the relationship between these factors and to identify any potential predictors of anthropometric indices and happiness levels.

In our statistical analysis, we explored the relationships between food habits, diet quality, the Healthy Lifestyle Score (HLS), and various anthropometric indices (ABSI, BRI, AVI) as well as happiness levels. Our dependent variables included these anthropometric indices and happiness levels, while food habits, diet quality, and the HLS served as our primary independent variables. For logistic regression models, we categorized the dependent variables (e.g., high vs. low ABSI) and adjusted for several confounders. Age (continuous) and energy intake (continuous) were adjusted in the first model. Marital status (non/married/not married), education (educated/not educated), smoking (smoker/not smoker/ex-smoker), physical activity (continuous) and gender (male/female) were adjusted in the second model. BMI (continuous) was additionally adjusted in the third model. All confounders were selected based on previous publications. The statistical analyses were carried out by using IBM SPSS statistics 25. Significance level was considered at $P<0.05$. The purpose of adjusting for these variables was to control for potential confounding factors that could influence the relationships we were investigating.

Results

General characteristics of study participants

The general characteristics of study participants among diet quality, food behavior and lifestyle score tertiles are presented in Table 1. Participants in the highest tertile of diet quality score were more likely to be employed (12% versus 2.5%, $P<0.001$) and physically active (275.92 min/week ± 77.92 versus 233.28 min/week ± 79.02, $P=0.003$) compared to participants in the lowest tertile. The participants did not differ significantly in terms of other general characteristics among the tertiles of the diet quality

Table 1 General characteristics of study participants among diet quality, food habits and healthy lifestyle score tertiles

Diet quality score tertiles				
General characteristics	**T1 = 80**	**T2 = 50**	**T3 = 70**	***P-value***
Age (years)	23.07 (4.19)	24.56(4.83)	24.12(4.57)	0.146
Weight (kg)	68.62 (11.57)	70.96(8.78)	70.07(14.22)	0.533
Height (cm)	171.45 (12.29)	172.38(9.78)	173.32(12.06)	0.615
BMI (kg/m^2)	23.34 (2.99)	23.95(2.94)	23.25(3.51)	0.444
WC (cm)	84.08 (7.12)	85.58(6.37)	84.46(8.99)	0.546
Height (cm)	93.51 (27.58)	100.36(29.20)	101.17(29.55)	0.210
Males (%)	54 (45.8%)*	27(22.9%)	37(31.4%)	0.135
Married (%)	14 (7%)	8(4%)	13(6.5%)	0.935
Having bachelor (%)	52 (26%)	27(13.5%)	48(24%)	0.368
Employed (%)	5 (2.5%)	15(7.5%)	24(12%)	0.000
Smoker (%)	18 (9%)	5(2.5%)	13(6.5%)	0.202
Physical activity (min/week)	233.28 (79.02)	263.27(75.86)	275.92(77.92)	0.003
Food habits score tertiles				
General characteristics	**T1 = 65**	**T2 = 75**	**T3 = 60**	***P-value***
Age (years)	24.03(4.72)	23.41(3.95)	24.08(4.96)	0.623
Weight (kg)	67.49(9.53)	68.66(11.88)	73.43(13.65)	0.013
Height (cm)	170.92(10.93)	171.18(11.10)	175.31(12.52)	0.058
BMI (kg/m^2)	23.14(2.93)	23.45(3.41)	23.82(3.11)	0.490
WC (cm)	83.66(6.44)	83.97(8.00)	86.35(8.22)	0.099
Height (cm)	102.01(28.99)	95.96(26.52)	95.87(31.15)	0.376
Males (%)	26(19.5%)	47(23.5%)	32(16%)	0.538
Married (%)	11(5.5%)	11(5.5%)	13(6.5%)	0.562
Having bachelor (%)	42(21%)	44(22%)	41(20.5%)	0.495
Employed (%)	13(6.5%)	18(9%)	13(6.5%)	0.848
Smoker (%)	12(6%)	15(7.5%)	9(4.5%)	0.808
Physical activity (min/week)	246.70(79.81)	253.57(80.71)	268.12(78.25)	0.312
Healthy lifestyle score tertiles				
General characteristics	**T1 = 60**	**T2 = 76**	**T3 = 64**	***P-value***
Age (years)	23.51(4.71)	24.09(4.24)	23.76(4.68)	0.276
Weight (kg)	69.70(9.44)	69.86(13.34)	69.54(12.52)	0.012
Height (cm)	172.43(10.74)	172.65(11.67)	171.87(12.43	0.081
BMI (kg/m^2)	23.50(3.02)	23.36(3.23)	23.53(3.26)	0.059
WC (cm)	84.78(6.58)	84.32(8.26)	84.72(7.94)	0.076
Height (cm)	95.33(27.16)	98.85(25.98)	99.18(33.33)	0.342
Males (%)	37(18.5%)	40(20%)	41(20.5%)	0.345
Married (%)	7(3.5%)	14(7%)	14(7%)	0.315
Having bachelor (%)	37(18.5)	49(24.5%)	41(20.5)	0.971
Employed (%)	10(5%)	17(8.5)	17(8.5)	0.411
Smoker (%)	11(5.5%)	15(7.5%)	10(5%)	0.980
Physical activity (min/week)	257.23(87.05)	253.91(80.51)	256.39(72.62)	0.032

*Values are mean (standard deviation) for ANOVA test and count (percentage) for chi square test

Values are obtained using one-way analysis of variance (ANOVA) for continuous variables and chi-square for categorical variables

score. Also, participants in the highest tertile of food habits score had significantly higher weight (73.43 kg ± 13.65 versus 67.49 kg ± 9.53, $P = 0.013$) compared to participants in the lowest tertile. Other general characteristics of the participants among the tertiles of food habits score were not significantly different. Participants in the lowest tertile of the healthy lifestyle score were more likely to be higher in weight (69.54 kg ± 12.52 versus 69.70 kg ± 9.44, $P = 0.012$) and physically active (256.39 min/week ± 72.62 versus 257.23 min/week ± 87.05) compared to participants in the highest tertile and this result was statistically significant ($P < 0.05$). Other general characteristics of study participants in the healthy lifestyle score tertiles were not significantly different.

Dietary intake of study participants

The dietary intake of study participants in the study among the tertiles of food habits score, diet quality score and healthy lifestyle score are show in Table 2. No significant difference was observed between the dietary intake of participants among the tertiles of food habits score, diet quality score and healthy lifestyle score ($P>0.05$).

Multivariable adjusted odds ratio for ABSI, BRI, AVI indices and happiness levels among tertiles of food habits, diet quality and healthy lifestyle score tertiles are shown in Table 3. No significant difference was shown in either of the models before or after adjustment for confounders between ABSI and food habits, diet quality, and lifestyle scores respectively (OR: 0.56, 95% CI (0.25–1.34), $P=0.193$; OR: 0.59, 95% CI (0.22–1.57), $P=0.413$; OR:1.19, 95%CI (0.54–2.63), $P=0.652$), BRI and food habits, diet quality, and lifestyle scores respectively (OR:1.98, 95% CI (0.41–9.49), $P=0.381$; OR: 0.57, 95%CI (0.12–2.74), $P=0.512$; OR: 1.19, 95% CI (0.3–4.71), $P=0.811$), AVI and food habits, diet quality, and lifestyle scores (OR:1.15, 95% CI (0.53–2.48), $P=0.743$, OR:1.01, 95% CI (0.47–2.18), $P=0.965$; OR: 1.3, 95% CI (0.64–2.65), $P=0.465$) and happiness and food habits, diet quality, and lifestyle scores respectively (OR:0.3, 95%CI (0.07–1.25), $P=0.972$; OR: 0.77, 95%CI (0.18–3.19), $P=0.724$, OR: 0.3, 95% CI (0.07–1.25),$P=0.083$).

Discussion

This study aimed to assess the relationship between dietary behaviors, diet quality and lifestyle scores with novel anthropometric indices and happiness levels in Iranian university students. No significant association was found between any of the anthropometric indices and happiness levels with dietary behavior, diet quality and healthy lifestyle scores.

ABSI was not significantly associated with either food habits score, diet quality score or lifestyle score. ABSI is a metric which includes human body weight, height, and waist circumference. Waist circumference in ABSI made it a better indicator of mortality risk coming from weight excess than did the BMI [41]. A main drawback of BMI is that it doesn't discriminate between fat and muscle mass unlike a high ABSI which reveals central obesity than the BMI [42]. Few studies to date have studied the association between ABSI and diet. In a recent study, Krakauer et al. found that an increased consumption of animal fat, protein and high energy intake was associated with higher ABSI, while higher intake of plant fat, protein and carbohydrates was associated with lower ABSI [43]. Several reasons could explain the differences between our findings and the previous study. The larger sample size (15000 adults) used in Krakauer et al. study increased the power to detect significant association. Also, the different study design used (cohort study) also plays an important role. An important contributor also might be the adjustment for more confounders in their study. Furthermore, psychological disorders could contribute to a low lifestyle score. In contrast to our study finding, Lotfi et al. found a direct association between ABSI and anxiety, depression, and psychological distress [44] while Hadi et al. found no significant association between ABSI and anxiety and depression [45]. Several factors could explain the differences between our findings and previous studies. Similar to our study low sample size (200 students), Hadi et al. study constituted 307 adults while Lotfi et al. study large sample size (3213 adults) has more power to reach a significant association. As stated, there is a lack of evidence regarding the association between dietary behavior/quality and lifestyle score and ABSI, so further prospective cohort studies are needed to investigate this relationship.

No significant association was found between BRI and either food habits score, diet quality score or lifestyle score. Limited studies have investigated the association between BRI and the mentioned scores. In contrary to our findings, Sanchez et al. in a large sample of middle-aged adults found that moderate to vigorous physical activity practice was associated with lower obesity indices, while Mediterranean diet revealed a minor impact on anthropometric indices [46]. Several factors have contributed to the differences between Sanchez et al. study and our results. First, they used a larger sample which increased the power of the study to detect these associations. Second, information about socio-demographic and lifestyle characteristics was not available in their study, while it was present in the current study. Third, our study included healthy young students below 50 years of age while the mentioned study included participants above 50 years of age with at least one cardiovascular risk factor. Fourth, we used different dietary tools to assess the diet of participants. Similarly, in a controlled trial, nutritional advice and yoga which contributes to healthy lifestyle, was associated with decreased BRI [47]. A major difference between our study and the study conducted by Telles et al. is the difference in study design (interventional versus observational). A significant direct association was detected in Kohansal et al. study where plant proteins consumption was associated with higher BRI [48]. However, our study has failed to detect this association. On the other hand and similar to our study, Lotfi et al. found no significant association between BRI and psychological factors after adjusting for potential confounders [44].

No significant association was found between AVI and either food habits score, diet quality score or lifestyle score. Similarly, Kohansal et al. found no significant association between plant proteins consumption and AVI [48]. In the study of Hadi et al., participants with depression and anxiety have higher AVI [45]. In the current study, lifestyle score was not significantly associated with AVI. A major discrepancy between both studies is the use of different questionnaires to assess the psychological

Table 2 Dietary intake of participants among diet quality, food habits and healthy lifestyle score tertiles

Diet quality score tertiles				
Energy (Kcal/day)	2021.94(508.75)	2093.31(512.27)	2148.76(616.88)	0.369
Food groups (g/d)	**T1 = 80**	**T2 = 50**	**T3 = 70**	***P-value*****
Fruits	207.39(93.03)*	202.99(110.39)	195.04(79.22)	0.719
Vegetables	305.02(121.05)	335.66(120.23)	314.94(114.22)	0.358
Red meat	25.74(12.71)	22.35(12.95)	23.53(14.27)	0.337
Processed meat	6.42(6.97)	6.56(6.72)	5.57(4.59)	0.615
Fish & sea food	14.20(10.44)	15.82(11.36)	16.67(21.13)	0.602
Dairy	477.42(228.34)	596.63(332.01)	526.46(270.43)	0.054
Nuts	19.68(14.37)	19.64(13.99)	17.51(12.78)	0.573
Refined grains	292.32(149.01)	260.18(153.45)	332.93(183.83)	0.052
Nutrients				
Protein (g/day)	75.36(21.45)	78.95(20.12)	80.13(22.31)	0.369
Fat (g/day)	69.98(20.53)	73.90(22.99)	71.86(23.17)	0.613
CHO (g/day)	283.48(78.13)	289.62(74.54)	305.52(94.47)	0.262
Fats (g/day)	24.12(8.13)	26.10(8.40)	24.42(8.43)	0.391
MUFA (g/day)	22.80(7.12)	23.96(7.36)	23.43(7.98)	0.683
PUFA (g/day)	15.63(6.51)	16.19(7.37)	15.93(6.63)	0.897
EPA (mg/day)	0.021(0.019)	0.023(0.017)	0.026(0.051)	0.694
DHA (mg/day)	0.058(0.053)	0.061(0.044)	0.070(0.134)	0.725
Mg (mg/day)	276.57(77.20)	298.74(87.26)	300.60(79.86)	0.138
Food habits score tertiles				
Energy (Kcal/day)	2066.3(564.7)	2012.92(448.76)	2192.54(634.46)	0.161
Food groups (g/d)	**T1 = 65**	**T2 = 75**	**T3 = 60**	***P-value***
Fruits	194.64(91.39)	196.54(92.81)	216.69(94.69)	0.341
Vegetables	303.66(122.82)	303.93(113.70)	304.97(116.58)	0.079
Red meat	25.62(14.02)	23.92(13.65)	22.73(12.21)	0.476
Processed meat	5.11(4.52)	7.25(7.08)	5.92(6.32)	0.114
Fish & sea food	17.36(22.2)	15.35(10.78)	13.57(9.53)	0.381
Dairy	505.94(274.44)	509.62(245.64)	563.08(307.82)	0.429
Nuts	18.17(14.14)	17.10(12.04)	21.98(14.84)	0.105
Refined grains	300.59(165.40)	296.42(148.31)	298.84(185.04)	0.989
Nutrients				
Protein (g/day)	77.48(23.59)	75.75(18.64)	81.14(22.21)	0.161
Fat (g/day)	69.09(23.23)	69.82(18.59)	76.59(24.17)	0.111
CHO (g/day)	293.79(82.41)	281.02(70.97)	306.22(97.45)	0.218
Fats (g/day)	23.94(8.68)	24.05(7.26)	26.41(8.95)	0.170
MUFA (g/day)	22.13(7.61)	23.19(6.85)	24.74(7.92)	0.146
PUFA (g/day)	15.31(6.84)	15.26(6.02)	17.26(7.37)	0.165
EPA (mg/day)	0.029(0.054)	0.022(0.017)	0.020(0.014)	0.282
DHA (mg/day)	0.077(0.143)	0.059(0.047)	0.053(0.038)	0.282
Mg (mg/day)	280.08(87.85)	285.28(69.90)	308.40(84.99)	0.116
Healthy lifestyle score tertiles				
Energy (Kcal/day)	2063.29(605.55)	2091.01(542.44)	2095.62(510.65)	0.940
Food Groups (g/d)	**T1 = 60**	**T2 = 76**	**T3 = 64**	***P-value***
Fruits	203.74(91.92)	207.43(106.17)	193.82(76.54)	0.385
Vegetables	324.15(117.63)	311.30(117.93)	314.42(121.49)	0.205
Red meat	23.15(12.49)	26.52(14.68)	22.17(12.16)	2.099
Processed meat	5.33(5.93)	6.27(6.33)	6.80(6.17)	0.899
Fish & sea food	15.10(9.97)	15.21(20.58)	16.11(11.49)	0.086
Dairy	496.30(233.32)	542.00(307.51)	530.04(271.01)	0.481
Nuts	22.03(14.89)	18.22(13.84)	16.80(11.93)	2.444
Refined grains	304.62(172.25)	303.70(176.22)	286.59(143.99)	0.245
Nutrients				

Table 2 (continued)

Protein (g/day)	76.92(22.19)	77.42(22.10)	79.48(20.13)	0.777
Fat (g/day)	70.04(22.98)	73.76(23.16)	70.54(19.81)	0.556
CHO (g/day)	292.48(90.44)	290.04(80.59)	296.16(81.45)	0.911
Fats (g/day)	23.39(8.15)	25.77(8.58)	24.73(8.03)	0.253
MUFA(g/day))	22.73(7.81)	24.06(7.94)	22.97(6.55)	0.539
PUFA(g/day))	15.85(6.62)	16.41(7.55)	15.27(5.84)	0.610
EPA (mg/day) (	0.020(0.015)	0.023(0.048)	0.027(0.033)	0.547
DHA (mg/day))	0.054(0.040)	0.062(0.125)	0.073(0.068)	0.488
Mg (mg/day)	295.53(90.62)	290.14(85.11)	286.28(66.61)	0.818

*Values are mean (standard deviation)

**Values are obtained using one-way analysis of variance (ANOVA)

health of participants. In Telles et al. study, participants having yoga which contributes to a healthy lifestyle have a decreased AVI [47]. In contrast, the current study failed to find this association. An important reason for this difference is that in Telles et al. study, participants were female vegetarians while our study included students of both genders having a general diet. Similarly, Cameron et al. found that moderate-to-vigorous physical activity was inversely associated with visceral adipose tissue and percent body fatness in adults [49].

In the current study, no association was seen between food habits score and any of the anthropometric indices or happiness. However, dietary behavior might have an important impact on anthropometric indices. In Cameron et al. study [49], the inverse association detected between physical activity and percentage of body fat was greater for non-Latinos compared to Latinos which introduces the possibility that differences in eating habits might have an important impact of physical activity on anthropometric indices. However, some discrepancies such as the study design (randomized controlled trial) and including overweight participants compared to normal weight participants in our study, might explain the difference in the study findings.

No significant association was found between happiness and either food habits score, diet quality score or lifestyle score. Cascales et al. found that adherence to Mediterranean diet was associated with greater subjective happiness among adolescents [50]. Several factors might have contributed to the differences in the study findings. Cascales et al. study used larger sample size and both studies used different scales to assess happiness for participants. Similarly, Mujcic et el found that increased fruits and vegetable consumption was associated with greater happiness [51]. A major discrepancy between both studies is that they used a much larger sample size and used food diaries to assess food intake while our study used FFQ.

The underlying mechanisms driving the positive impact of a healthy lifestyle on anthropometric indices should be carefully addressed. Physical activity is considered an important component of a healthy lifestyle. Skeletal muscles during intense exercise secrete interleukin (IL)-6 into the circulatory system which acts as a pro-inflammatory cytokine, an anti-inflammatory myokine and lipolytic agent [52, 53]. Also, a healthy diet could have an important effect in increasing happiness levels in individuals. This is related to self-perception of healthy food where consumption of certain healthy foods might be related to an increase in self-awareness of developing a healthy lifestyle which in turn increase happiness levels and overall wellbeing [54]. Another mechanism is that healthy food which is rich in antioxidants such as vitamins C and E were found to have a beneficial effect in decreasing depressive symptoms [55] which in turn results in a better lifestyle.

This study has several strengths. First, few studies to date have been conducted investigating the association between healthy dietary scores, healthy dietary behavior, and lifestyle scores with the mentioned novel anthropometric indices and happiness. Second, we used a relatively representative sample size and utilized new anthropometric indices. It's also worth noting that this is the first study to analyze the association between food habits score, dietary quality score and lifestyle score with novel body composition indices. Third, we adjusted energy intake in our study which is an important confounder. However, there are some limitations. The cross-sectional design of study, and the probability to miss some important confounders which prevent us to draw causal relationships of the associations between variables, resulting to insignificant findings. Also, one of the limitations of our study is related to the sample size. We were only able to randomly select 200 students for our research project due to constraints. While this number was determined based on the resources available and the feasibility of reaching the students, it's important to note that this smaller sample size may affect the power of our study and the reliability of our results. Future studies may benefit from ensuring a larger sample size to increase the statistical power and the precision of the estimates. This would allow for a more robust analysis and potentially

Table 3 Results of the multiple logistic regression for ABSI, BRI, AVI and happiness among tertiles of food habits, diet quality, and lifestyle scores

ABSI				
	T1 = 65	**T2 = 75 OR, 95%CI**	**T3 = 60 OR, 95%CI**	***P-trend***
Tertiles of food habits score				
Raw model	1	1.1 (0.48–2.49) *	0.59 (0.26–1.32)	0.215
model I[a]	1	1.16 (0.51–2.66)	0.6 (0.26–1.35)	0.212
model II[b]	1	1.23 (0.53–2.87)	0.6 (0.26–1.38)	0.224
model III[c]	1	1.23 (0.53–2.9)	0.56 (0.25–1.34)	0.193
Tertiles of diet quality score				
Raw model	1	0.3 (0.12–0.71)	0.55 (0.21–1.42)	0.291
model I[a]	1	0.30 (0.12–0.74)	0.56 (0.21–1.45)	0.315
model II[b]	1	0.27 (0.11–0.68)	0.58 (0.22–1.55)	0.391
model III[c]	1	0.27 (0.11–0.69)	0.59 (0.22–1.57)	0.413
Tertiles of healthy lifestyle score				
Raw model	1	1.13 (0.5–2.5)	1.30 (0.61–2.78)	0.495
model I[a]	1	1.15 (0.51–2.63)	1.31 (0.61–2.81)	0.494
model II[b]	1	1.22 (0.52–2.84)	1.16 (0.53–2.55)	0.689
model III[c]	1	1.23 (0.52–2.88)	1.19 (0.54–2.63)	0.652
BRI				
	T1 = 65	**T2 = 75 OR, 95%CI**	**T3 = 60 OR, 95%CI**	***P-trend***
Tertiles of food habits score				
Raw model	1	1.02 (0.51–2.02)	1.49 (0.73–3.05)	0.271
model I[a]	1	0.98 (0.49–1.97)	1.42 (0.69–2.92)	0.344
model II[b]	1	1.01 (0.49–2.06)	1.45 (0.68–3.06)	0.319
model III[c]	1	1.66 (0.44–6.32)	1.98 (0.41–9.49)	0.381
Tertiles of Diet Quality Score				
Raw model	1	0.63 (0.31–1.26)	0.73 (0.36–1.5)	0.394
model I[a]	1	0.59 (0.29–1.2)	0.7 (0.34–1.44)	0.355
model II[b]	1	0.61 (0.29–1.28)	0.69 (0.33–1.45)	0.344
model III[c]	1	0.44 (0.09–2.06)	0.57 (0.12–2.74)	0.512
Tertiles of Healthy Lifestyle Score				
Raw model	1	0.9 (0.44–1.85)	0.79 (0.41–1.54)	0.501
model I[a]	1	0.86 (0.42–1.78)	0.77 (0.39–1.49)	0.443
model II[b]	1	0.76 (0.36–1.62)	0.83 (0.42–1.66)	0.584
model III[c]	1	0.49 (0.11–2.17)	1.19 (0.3–4.71)	0.811
AVI				
	T1 = 65	**T2 = 75 OR, 95%CI**	**T3 = 60 OR, 95%CI**	***P-trend***
Tertiles of food habits score				
Raw model	1	1.06 (0.52–2.17)	1.21 (0.57–2.55)	0.613
model I[a]	1	1.02 (0.49–2.12)	1.17 (0.55–2.48)	0.689
model II[b]	1	0.94 (0.45–1.98)	1.17 (0.54–2.52)	0.701
model III[c]	1	0.95 (0.45–1.98)	1.15 (0.53–2.48)	0.743
Tertiles of Diet Quality Score				
Raw model	1	0.89 (0.42–1.79)	1.05 (0.5–2.2)	0.895
model I[a]	1	0.83 (0.4–1.73)	1.02 (0.48–2.16)	0.943
model II[b]	1	0.77 (0.36–1.66)	0.99 (0.46–2.15)	0.983
model III[c]	1	0.78 (0.36–1.67)	1.01 (0.47–2.18)	0.965
Tertiles of Healthy Lifestyle Score				
Raw model	1	1.2 (0.51–2.35)	1.3 (0.65–2.57)	0.448
model I[a]	1	1.07 (0.49–2.3)	1.28 (0.64–2.54)	0.491
model II[b]	1	1.08 (0.49–2.38)	1.29 (0.64–2.62)	0.483
model III[c]	1	1.09 (0.49–2.4)	1.3 (0.64–2.65)	0.465
Happiness				
	T1 = 65	**T2 = 75 OR, 95%CI**	**T3 = 60 OR, 95%CI**	***P-trend***

Table 3 (continued)

Tertiles of food habits score				
Raw model	1	0.83 (0.39–1.75)	0.52 (0.25–1.07)	0.078
model I[a]	1	0.77 (0.36–1.66)	0.49 (0.24–1.03)	0.065
model II[b]	1	0.69 (0.31–1.51)	0.5 (0.24–1.07)	0.074
model III[c]	1	0.27 (0.05–1.43)	0.3 (0.07–1.25)	0.972
Tertiles of Diet Quality Score				
Raw model	1	0.70 (0.34–1.45)	0.62 (0.29–1.34)	0.223
model I[a]	1	0.65 (0.31–1.36)	0.59 (0.27–1.28)	0.182
model II[b]	1	0.66 (0.3–1.42)	0.57 (0.26–1.27)	0.173
model III[c]	1	1.13 (0.27–4.72)	0.77 (0.18–3.19)	0.724
Tertiles of Healthy Lifestyle Score				
Raw model	1	1.91 (0.93–3.94)	1.58 (0.70–3.58)	0.084
model I[a]	1	2.02 (0.97–4.2)	1.57 (0.68–3.57)	0.069
model II[b]	1	0.69 (0.31–1.51)	0.50 (0.24–1.07)	0.073
model III[c]	1	0.27 (0.05–1.43)	0.3 (0.07–1.25)	0.083

These values are odds ratios (95% confidence interval)

[a] Adjusted for age and energy intake

[b] In addition to previous items, adjusted for marital status, education, smoking, physical activity, gender

[c] In addition to the previous ones, adjusted for body mass index

more generalizable results. Another limitation of the study is that diets have been self-reported which might have led to misinterpretation of questions resulting in incorrect responses. Moreover, happiness is subjective by nature, which might be related to self-reporting of the responder resulting in biased findings.

Conclusion

In conclusion, our study found no significant association between food habits score, diet quality score, and lifestyle score with anthropometric indices and happiness in healthy Iranian students. This suggests that these factors may not play a significant role in determining anthropometric indices and happiness levels in this population. However, it's important to note that these findings are specific to the context of our study and may not be generalizable to other populations or settings. Despite these findings, the role of food habits, diet quality, and lifestyle in health and well-being should not be discounted. These factors have been shown to be important in other studies and contexts, and further research is needed to fully understand their impact. Our study also highlights the need for further prospective cohort studies to clarify these associations. Such studies could provide more robust evidence and help to identify potential causal relationships. They could also explore other potential confounding factors that were not considered in our study.

Finally, our findings have implications for public health and education. Even though we did not find a significant association in our study, promoting healthy food habits, a quality diet, and a healthy lifestyle remains important for overall health and well-being. Educational programs could focus on these areas to improve the health outcomes of students and other populations.

Abbreviations

ABSI	A Body Shape Index
BRI	Body roundness index
AVI	Abdominal volume index
BMI	Body Mass Index
PA	Physical Activity
COVID-19	Coronavirus Disease of 2019
HEI-2015	Healthy Eating Index 2015
FFQ	Food Frequency Questionnaire
IPAQ	International Physical Activity Questionnaire
MET	Metabolic Equivalent of a Task
WC	Waist Circumference
ANOVA	One-Way Analysis of Variance
HLS	Healthy Lifestyle Score

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40795-024-00917-y.

Supplementary Material 1

Acknowledgements

We thank all those involved and participants for taking part in the present study.

Author contributions

AHSG contributed to data collection, data analysis, data interpretation and manuscript drafting. BG contributed to data analysis, data interpretation, manuscript drafting and manuscript revision. PS contributed to study design and revised the final manuscript. LA contributed to idea conception, design, data collection, supervised the whole study and revised the final manuscript. AS contributed to study design, supervised the psychiatric section in the study and supervised the whole study. All authors approved the final manuscript.

Funding

Not applicable.

Data availability
The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

Ethics declarations

Ethics approval and consent to participate
This study was performed in accordance with the Declaration of Helsinki. This study received ethical approval from the Research Ethics Committee of Tehran University of Medical Sciences. Informed consent was obtained from all participants included in this study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Conflict of interest
All authors declare that they have no competing interests.

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Received: 24 August 2023 / Accepted: 29 July 2024
Published online: 26 August 2024

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