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Evaluation of the Relationship between Sustainable and Healthy Eating Behaviours, Phytochemical Index, Anthropometric Measurements, and Depression in Young Adults

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Abstract

Aim: This study was planned and conducted to evaluate the relationships among sustainable and healthy eating behaviours, the phytochemical index, anthropometric measurements, and depression in adults.

Methods: A total of 400 participants aged 18–30 years were included in this cross-sectional study. Data were collected through a structured questionnaire comprising the Sustainable and Healthy

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Eating Behaviours Scale (SHEBS) and the Beck Depression Inventory (BDI). A 24-hour dietary recall was used to calculate the Phytochemical Index. Anthropometric measurements, including weight, height, and circumferences of the waist, hip, and neck, were obtained using standardised procedures.

Results: There was no significant correlation among SHEBS, the phytochemical index, and BDI scores ($p>0.05$). But the SHEBS scores of the 3rd and 4th quartiles of the phytochemical index were significantly different ($p<0.05$). A negative relationship was also detected between the SHEBS score and body mass index, waist circumference, neck circumference, waist-hip ratio, and waist-height ratio ($p<0.05$). The BDI score was found to be negatively correlated with waist circumference, neck circumference, and waist/height ratio ($p<0.05$).

Conclusions: In this study, sustainable healthy eating behaviour is associated with anthropometric measurements, but not with phytochemical index or depression. While healthy eating behaviours constitute an indispensable component of physical and mental health, their environmental effects and positive contributions to sustainability should not be ignored. Therefore, it is thought that more comprehensive studies investigating sustainable nutrition, phytochemical intake and depression are needed.

Keywords: Sustainable eating, Healthy eating, Phytochemical index, Depression

Introduction

Sustainability and sustainable development have become among the most pressing global concerns. The Brundtland Commission defined sustainable development as “meeting the needs of the present without compromising the ability of future generations to meet their own needs”[1].

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Within this framework, sustainable nutrition plays a central role. It refers to shifting dietary preferences toward nutritionally adequate diets with lower environmental impacts and reduced excessive consumption[2].

Sustainable diets promote health while minimising environmental damage by emphasising plant-based food choices and reducing food waste[3,4]. Sustainable and healthy diets respect biodiversity and ecosystems, are culturally acceptable, accessible, affordable, and nutritionally adequate, while optimising the use of natural and human resources[5]. Common features include reduced intake of red meat and dairy products, preference for certified fish, limited processed food consumption, and higher intake of seasonal, local fruits, vegetables, and other plant foods[6].

Among sustainable dietary patterns, the Mediterranean and vegetarian diets are the most recognised[7-10]. Sustainable dietary practices generally involve reducing animal products and increasing plant-based foods. With these characteristics, sustainable diets not only create positive environmental impacts but also have a more positive effect on human health. Both emphasise plant-based foods and have been associated with lower risks of obesity and chronic diseases such as cardiovascular disease and diabetes[11-16]. Plant-based foods, especially those with very high phytochemical content, are closely associated with positive health effects. These health benefits are largely attributed to phytochemicals, bioactive compounds synthesised by plants during growth and defence processes[17]. A diet rich in fruits, vegetables, whole grains, and nuts can provide up to 5,000 phytochemicals[18], which help reduce oxidative stress and inflammation, contributing to the prevention of metabolic and neurodegenerative diseases[19-21].

Recent evidence also suggests that phytochemicals influence mental health, particularly depression. Depression affects approximately 120–350 million people globally, with a lifetime

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risk of 10–15%[22,23]. Studies have shown that higher phytochemical intake is associated with a lower risk or severity of depression[24-29]. Proposed mechanisms include modulation of oxidative and inflammatory pathways: pro-inflammatory cytokines increase reactive oxygen species and nitric oxide, leading to decreased monoamine and brain-derived neurotrophic factor (BDNF) levels, which contribute to depressive symptoms[30-32]. Phytochemicals may counteract these effects by inhibiting Nuclear Factor Kappa B (NF-κB) activation and reducing cytokine and Inducible Nitric Oxide Synthase (iNOS) expression[33].

Despite the growing body of literature on sustainable diets, phytochemical intake, and mental health, these components are generally examined in isolation. However, a review of the literature clearly shows that sustainable nutrition encourages greater consumption of plant-based foods, and a greater consumption of plant-based foods naturally increases phytochemical intake. Increased intake of phytochemicals also has a beneficial effect on the development of many physical and mental illnesses, including depression and obesity. So, sustainable dietary patterns are inherently rich in phytochemicals, which may influence both physical and mental health outcomes, including depression. Therefore, understanding these relationships within a single framework is essential. While previous studies have investigated sustainable diets or phytochemical intake in relation to health outcomes, and others have explored dietary patterns and depression[19-21, 24-29], no study has simultaneously evaluated sustainable and healthy eating behaviours, phytochemical intake, anthropometric measures, and depression. Such an integrated approach may provide a more comprehensive understanding of how sustainable nutrition influences both physical and mental health, offering implications for public health strategies and dietary recommendations. Therefore, the present study aimed to investigate the relationship between sustainable and healthy eating behaviours, phytochemical index, anthropometric measurements, and depression in adults.

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Methods

The cross-sectional study was conducted at Gazi University and Akdeniz University from June to October 2023. A simple random sampling method was used to keep the selection rate of all participants equal. Surveys were distributed to students enrolled in these schools, and the required number was reached using snowball sampling with the help of participating students. The G*Power software (version 3.1.9.6) was used to determine the sample size for the study[34]. In the absence of comparable studies, the targeted effect size for the association between sustainable and healthy eating behaviours and the phytochemical index was aimed at being a poor or medium correlation. Based on the effect size $|\rho|=0.20$, correlation: point biserial model, according to the with two tails, α err prob=0.05, Power (1-β err prob)=0.95, the sample size was calculated as 314. In consideration of data loss, the sample size was augmented by 20%, resulting in a total of 400 participants aged 18-30 years. Among the students interviewed, 7 people were not included in the study because they did not agree to participate. Pregnant women, breastfeeding women and individuals following a specific diet programme were excluded from the study. In addition, individuals with a diagnosed psychiatric illness, those taking antidepressant medication, those with any chronic illness, and women who had gone through menopause were excluded from the study.

Akdeniz University Faculty of Medicine Clinical Research Ethics Committee 10/01/2023 date and 768 ethical approval was obtained with the decision number for the present study. Informed consent was also obtained from each participant. The study was conducted in accordance with the Declaration of Helsinki. This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines[35]. Data was collected by a face-to-face survey instrument. Participants' socio-demographic characteristics,

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anthropometric measurements, and self-reported health information were recorded. Sustainable and healthy eating behaviours were assessed using the Sustainable and Healthy Eating Behaviours Scale. Psychological status was evaluated with the Beck Depression Scale. Dietary intake was determined using a 24-hour dietary recall administered by an interviewer.

Anthropometric measurements, including body weight, height, waist circumference, hip circumference, and neck circumference, were measured by trained researchers using standardized procedures. The waist, hip, and neck circumferences were measured using a non-stretchable tape ensuring a precision of 0.1 cm. Waist circumference measurement was made from the midpoint between the lower edge of the last palpable rib and the protrusion of the iliac bone, with the individual standing, arms at the sides, feet together, and in a state of minimal breathing. Hip circumference measurement was taken from the highest part of the hip while the individual stood side-on. Neck circumference was measured perpendicular to the neck axis, below the most protruding point of the thyroid cartilage, with the individual's head upright[36].

Body mass index (BMI) was calculated as body weight (kg) divided by height (m^2) and evaluated according to the World Health Organisation (WHO) classification. Participants were categorised as underweight (BMI <18.50 kg/m²), normal weight (BMI 18.50–24.99 kg/m²), overweight (BMI 25.0–29.99 kg/m²), or obese (BMI ≥30.0 kg/m²)[37].

Waist circumference measurements of less than 80 cm in women and less than 94 cm in men are classified as normal. Measurements ranging from 80 to 88 cm in women and 94 to 102 cm in men are deemed risky, while measurements exceeding 88 cm in women and 102 cm in men are categorised as high risk for metabolic disease[38]. The waist-height ratio evaluation was assessed

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according to the <0.5 (normal) and ≥0.5 (risky) cut off points. The thresholds for abdominal obesity were defined as a waist-hip ratio of ≥0.90 for men and ≥0.85 for women[38,39].

Sustainable and Healthy Eating Behaviors Scale (SHEBS) was developed in 2019 to evaluate sustainable and healthy eating behaviours, according to Food and Agriculture Organization of the United Nations (FAO)'s definition of the concept of sustainable diet, the LiveWell approach, and the principles of sustainable and healthy eating habits[40]. Turkish validity and reliability study was also conducted in 2023. The scale consists of 8 factors and 34 items in total (Cronbach alpha: 0.912). These 34 items were evaluated with a seven-point Likert-type scale (Never=1 and Always=7 point). The mean scores for the eight components of the scale are assessed separately. The lowest score on the scale is 34, and the highest is 238. There is no threshold on the scale; as the score rises, sustainable and healthy eating patterns are considered to increase[41]. The Cronbach alpha coefficient of the scale was 0.895 in present study.

The Beck Depression Inventory (BDI) is a self-report scale developed by Beck in 1961 to measure emotional, cognitive, somatic, and motivational components[42]. Turkish validity and reliability were established in 1987. The scoring of the 4-point Likert-type scale, which consists of a total of 21 questions, varies between 0-63. According to the scores obtained from the questions in the evaluation of the scale, 0-9 points are considered as “no depression”, 10-16 points as “mild depression”, 17-29 points as “moderate depression”, and 30-63 points as “severe depression”[43]. The Cronbach alpha coefficient of the scale was 0.922 in the present study.

Dietary intake was assessed using a 24-hour dietary recall administered to all participants in order to evaluate daily energy and nutrient intake. Food consumption data were collected through face-to-face interviews conducted by the researchers. The participants' daily energy, macro and

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micronutrient intake levels were determined using the Nutrition Information System (BeBis) program[44]. We evaluated energy and nutrients using the reference values from the Nutrition Guide Specific to Turkey (TUBER)[45].

Energy and nutrient intakes were calculated using BeBis, and then the phytochemical index (PI) was calculated using McCarty's method. Phytochemical index is the percentage of energy intake derived from phytochemical-rich foods. Fruits, vegetables (except potatoes), legumes, whole grains, oilseeds, extra virgin olive oil, tea, coffee, herbal teas, fruit juices, vegetable juices, wine, soy, tomato sauce, and spices are considered phytochemical-rich foods when calculating the phytochemical index. In the study, the phytochemical index was calculated with the formula given below[46]:

PI= [Foods rich in phytochemicals (kcal/day) / total food intake (kcal/ day)] x 100

Individuals' dietary phytochemical index scores were evaluated by dividing them into quarter groups. Since the phytochemical index does not have a crossover point, and to better reflect the results by grouping them, it was analyzed by separating the values into quartiles. The first quartile (Q1) represents the diet with a low phytochemical index, and the 4th quarter (Q4) represents the diet with a high phytochemical index.

The statistical analysis of the data obtained from the study was conducted using SPSS 28.0 (Statistical Package for the Social Sciences) software. While arithmetic mean ($\bar{x}$) and standard deviation (SD) values were used for quantitative variables, the number of individuals (N) and percentages (%) were used for qualitative variables. The Kolmogorov-Smirnov test checked the normal distribution of the data. An independent samples t test was used to compare the mean of two groups. Differences between more than two groups were analysed using one-way analysis of

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variance (ANOVA). The Bonferroni post hoc test was used for multiple comparisons following the ANOVA analyses. The Pearson correlation coefficient was used to determine the relationship between scales and anthropometric measurements. Phytochemical index data are presented in statistical software, divided into quartiles. Accordingly, the data is shown as Q1 for 0-25%, Q2 for 25.1-50%, Q3 for 50.1-75%, and Q4 for 75.1-100%. In addition, multiple regression analysis and binary logistic regression analysis were performed to investigate the relationship between BDI and SHEBS with different parameters. The results were evaluated using a 95% confidence interval and a statistical significance level of $p < 0.05$.

Results

A total of 400 adult volunteers (116 men and 284 women) participated in this study. The mean age of the participants was 26.2±8.8 years. Table 1 presents the socio-demographic characteristics of participants categorised by gender. The majority of the participants (68.5%) appear to hold a university degree. Sixty-seven percent of participants were unemployed, while 47.3% indicated that their income and expenses are balanced.

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TABLE 1. WAS HERE

Participants' BDI, SHEBS, and PI scores and the distribution according to the BDI and anthropometric measurement classifications were shown in Table 2. The mean total BDI and SHEBS scores for women were significantly higher than those of men, while the mean PI score for women was significantly lower ($p<0.011$). While 52.5% of the individuals had no depression, 24.0% were classified as mild, 18.8% as moderate and 4.8% as severe depression. When evaluated according to gender, it was observed that depression tendency was higher in women ($p<0.01$). All

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classifications of anthropometric measurements showed a significant difference between genders ($p<0.05$).

TABLE 2. WAS HERE

The daily nutrient intakes, anthropometric measurements, and scale scores of the participants according to the phytochemical index classification were shown in Table 3. There was a significant difference among all groups in the intake of potassium, phosphorus, iron, copper, and vitamins A, B1, B2, B5, B6, and C ($p<0.01$). It was determined that there was a difference in magnesium intakes between the 1st and all other quartiles ($p<0.01$) and also between the 2nd and 3rd quartiles ($p<0.01$). There was a difference between the participant's zinc intakes in the 1st quartile and the 3rd quartile in the phytochemical index ($p<0.01$). It was determined that individuals in the 1st quartile had a statistically significantly lower intake of omega-3 fatty acids than the 4th quartile ($p<0.01$). Furthermore, it was found that the omega-6 fatty acid intake of those in the 2nd quarter was higher than that of those in the 4th quarter ($p<0.01$).

When anthropometric measurements and PI classifications were examined, body weight, BMI, waist circumference, and neck circumference of the participants in the 3rd quartile were higher than the other quartiles ($p<0.05$). Accordingly, while 25.8% (n:103) of the participants were in the 1st Quartile, 23.8% (n:95) were in the 2nd, 26.2% (n:105) were in the 3rd, and 24.2% (n:97) were in the 4th Quartile.

It was determined that the hip circumference measurements of participants in the 2nd and 4th quartiles were lower than those in the 3rd quartile ($p<0.01$). Also, there was a difference in SHEBS scores, especially between the 3rd and 4th quartiles ($p<0.05$).

TABLE 3. WAS HERE

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The correlations between the scales and anthropometric measurements were shown in Table 4. There was a negative correlation between the SHEBS and all anthropometric measurements ($p<0.05$). A similar relationship was seen between BECK depression scale scores and waist circumference, neck circumference, and waist-hip ratio ($p<0.05$). There was no correlation between the SHEBS, BDI and PI scores ($p>0.05$).

TABLE 4. WAS HERE

To evaluate whether sustainable and healthy eating behaviors and phytochemical intake were independently associated with depressive symptoms, a multiple linear regression analysis was performed with BDI score as the dependent variable (Table 5). Age, sex, BMI, education level, smoking status, alcohol consumption, SHEBS score, and phytochemical index were entered into the model. The overall regression model was statistically significant ($F(8.380)=9.290$, $p<0.001$), explaining 16.4% of the variance in BDI scores ($R^2=0.164$, adjusted $R^2=0.146$). Neither SHEBS score ($\beta=-0.080$, $p=0.098$) nor phytochemical index ($\beta=-0.073$, $p=0.135$) was independently associated with BDI scores after adjustment for potential confounders. In contrast, age ($\beta=-0.338$, $p<0.001$), BMI ($\beta=0.232$, $p<0.001$), sex ($\beta=0.231$, $p<0.001$), and alcohol consumption ($\beta=0.160$, $p=0.001$) were significant predictors of depressive symptoms.

A multiple linear regression analysis was conducted to identify factors independently associated with SHEBS scores (Table 5). Age, sex, BMI, education level, smoking status, alcohol consumption, phytochemical index, and Beck Depression Inventory (BDI) score were included as independent variables. The overall model was statistically significant ($F(8.380)=2.818$, $p=0.005$), explaining 5.6% of the variance in SHEBS scores ($R^2=0.056$, adjusted $R^2=0.036$). Among the variables included in the model, only sex was significantly associated with SHEBS

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scores (β=0.128, p=0.022). Neither phytochemical index (β=0.066, p=0.204) nor BDI score (β=-0.090, p=0.098) was independently associated with SHEBS scores after adjustment for potential confounders.

TABLE 5. WAS HERE

Binary logistic regression analysis was performed to identify factors independently associated with the presence of depression (Table 6). Age, sex, BMI, smoking status, alcohol consumption, education level, SHEBS score, and phytochemical index were included in the model. BMI (OR=1.174, p=0.030) and phytochemical index (OR=0.942, p=0.039) were significantly associated with depression status. Higher BMI was associated with increased odds of depression, whereas higher phytochemical index scores were associated with lower odds of depression. No significant associations were observed for SHEBS score, age, sex, smoking status, alcohol consumption, or education level.

TABLE 6. WAS HERE

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Discussion

The significance of sustainable nutrition models lies in their ability to establish appropriate dietary patterns, particularly in terms of health. Sustainable and healthy diets encompass the integration of both nutrition and the preservation of biodiversity and ecosystems. These diets are culturally relevant, readily accessible, socially just, economical, nutritionally adequate, secure, and health-promoting[5]. Bioactive components, such as phytochemicals, are one of the most important components that enable the positive effects of sustainable nutrition on health[17,19-21]. The current study was planned and conducted to evaluate the relationship between sustainable and healthy

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eating behaviours, anthropometric measurements, phytochemical index, and depression in adults. Despite the absence of a statistically significant association between sustainable nutrition, the phytochemical index, and depression at the end of the study, the study's findings showed a negative correlation between sustainable dietary habits and both body weight and anthropometric measurements associated with obesity.

A diet in which plant-based foods dominate is much more beneficial for both human health and the planet than a diet in which animal-based foods are consumed in excess. Plant-based foods are known to positively affect achieving sustainable goals, ensuring food security[47] and animal welfare[48]. These reasons identify a plant-based diet as the key to sustainable nutrition on a global scale[49]. Increasing the intake of plant-based foods with rich sources of phytochemicals is one of the most critical factors that can increase serum levels of phytochemicals[50]. Phytochemicals, which have significant metabolic effects, are associated with both mental and physical illnesses[51,52]. Studies have found that high phytochemical consumption is associated with a low incidence of depression[24,26]. Sangouni et al[53] showed that individuals whose dietary phytochemical intake levels were in the 4th quartile had an approximately 50% reduction in their risk of depression and a 38% higher quality of life compared to those in the 1st quartile. Phytochemicals, particularly phenols, carotenoids, and sulphur-containing compounds, are recognised for their antioxidant capabilities[20]. It is stated that these substances can suppress fatty acid synthesis and gluconeogenesis, increase mitochondrial oxidation, reduce the levels of free radicals as well as oxidant agents and the activity of inflammatory markers[54,55]. NF-κB suppression by antioxidants reduced pro-inflammatory cytokines and inducible nitric oxide synthase in the brain[56,57]. Oxidative stress has also been connected to the pathogenesis of mental illnesses because it can disrupt circadian rhythms, impede neuronal and neurotransmitter function,

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and cause dysregulation of this process[58]. However, in the present study, there was no significant correlation between the BDI and Phytochemical Index scores. Also, no significant difference was found in the BDI score according to the phytochemical index quartiles. But individuals in the 4th quartile of dietary phytochemical intake had the lowest BDI score. Regression analysis also found an association between a higher phytochemical index score and a lower probability of depression. One of the most important reasons for the differing results in this study compared to others may be the differences in sample selection. Another important reason is the method used to estimate phytochemical intake. While many previous studies calculated the phytochemical index using food frequency questionnaires that reflect habitual dietary intake, the present study relied on a 24-hour dietary recall. This method may not adequately capture individuals' usual dietary patterns and, therefore, may have limited the ability of the phytochemical index to accurately represent long-term phytochemical consumption. Further research on depression, phytochemicals, and antioxidants will help to elucidate the underlying mechanism and better understand these differences in study design.

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A plant-based diet is known to facilitate weight control while also supporting sustainability. At this point, the Mediterranean diet, which emphasises plant-based foods, stands out for its positive effects on sustainability, weight control, and obesity. Obesity is a significant aspect of the unsustainable food production and consumption model. The Mediterranean diet has been the most effective in preventing obesity and obesity-related diseases[15]. This study determined that the sustainable and healthy eating behaviours were correlated negatively with BMI, waist circumference, neck circumference, waist/hip ratio, and waist/height ratio (Table 4). In this study, unlike the literature, significantly higher values for BMI, waist circumference, and neck circumference were observed in the 3rd quartile of the phytochemical yeast index groupings.

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Regression analysis revealed that while a high BMI was associated with an increased likelihood of depression, no significant association was found between SHEBS score, age, gender, smoking status, alcohol consumption, or education level (Table 5). In a recent meta-analysis comparing the highest and lowest levels of adherence to sustainable diets, the pooled estimate associated with adherence was 0.69 (95% CI = 0.62-0.76) for overweight and 0.61 (95% CI = 0.47-0.78) for obesity, suggesting that sustainable diets may reduce the risk of overweight/obesity and thus improve both public and planetary health[14]. In sustainable nutrition models, limiting the consumption of processed foods, especially foods with high added sugar and fat content and thus high energy density, and emphasising the consumption of plant-based foods with low energy density, such as vegetables and fruits, may provide a reduction in risk of obesity by controlling energy intake. Also, the biological mechanisms through which sustainable diets protect against the accumulation of adipose tissue include their high dietary fibre content, enhancing feelings of fullness[59]. This situation may be due to outliers included in the study or to the different age groups in the sample.

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It is known that obesity and weight control, in addition to their environmentally sustainable effects, can also trigger mental problems and physical diseases[60]. Among these, the coexistence of obesity and depression is one of the common conditions in society. Although this study found no direct relationship between BMI and the risk of depression, it did reveal a weak negative correlation between BDI score and waist circumference, neck circumference, and waist-to-height ratio ($p<0.05$). Another study found that stress and depression may increase obesity by affecting metabolic responses, especially to foods high in fat[61]. On the other hands, a study indicated that obesity is a risk factor for recurrent episodes of depression, but that a link may not be established between obesity and single episodes of depression. One of the most important reasons for this is

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the use of antidepressant medications in cases of recurrent depression[61]. Studies have also shown that depressive symptoms in people who have not been diagnosed with depression may not be particularly related to BMI[62]. Depression and obesity are two diseases that interact bilaterally due to a variety of mechanisms and interactions. Generally, behavioural factors like low self-esteem and immune and endocrine system issues, commonly observed in obese individuals, drive this relationship[63]. However, given the inconsistent findings reported across studies, further research is needed to clarify the relationship between depression and obesity.

In conclusion, both sustainable healthy eating behaviours and depression scores were associated with anthropometric measurements; however, no significant relationships were observed between sustainable eating and depression or the phytochemical index and depression. These findings suggest that while anthropometric status may be linked to both dietary behaviours and mental health, the pathways connecting sustainable diets and phytochemical intake to depression may be more complex and require further investigation.

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Limitations

This study has several limitations. The inclusion of participants from only two provinces, the relatively small sample size, reliance on a single 24-hour dietary recall, and the lack of assessment of dietary supplement use constitute important limitations. The 24-hour reminder method was chosen for this study with the assumption that people would remember it better. However, food consumption for a single day may not adequately reflect a person's overall dietary patterns. This also increases the risk of observing changes within a single day that do not reflect the general pattern. Therefore, using tools that reflect general dietary patterns may yield better results. The fact that participants' physical activity was not assessed is another limitation of this study.

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Physical activity is a crucial component, particularly in relation to obesity. Therefore, assessing physical activity in addition to these parameters in future studies would be a significant contribution. In addition, this study has limitations such as its cross-sectional design, participants' self-report bias and limited geographical representation of the sample. It is worth noting that further research into these aspects of the study would be beneficial. Nevertheless, this study is among the limited number of studies evaluating multiple related scales concurrently and exploring their interrelationships. Future multidisciplinary research with larger and more diverse samples is warranted to address existing gaps and to further elucidate the interdependent relationship between health improvement, environmental protection, and sustainability.

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Table 1. Socio-demographic characteristics of participants according to gender

	Men (n:116)		Women (n:284)		Total (n:400)	
	n	**%**	**n**	**%**	**n**	**%**
Education status						
Primary school	12	10.3	11	3.9	23	5.8
Middle school	8	6.9	8	2.8	16	4.0
High school	37	31.9	50	17.6	87	21.8
University	59	50.9	211	74.3	274	68.5
Working status						
Employed	62	53.4	70	24.6	132	33.0
Unemployed	54	46.6	214	75.4	268	67.0
Economic status						
Income is less than expenses	23	19.8	104	36.6	127	31.8
Income equals expenses	58	50.0	131	46.1	189	47.3
Income exceeds expenses	35	30.2	49	17.3	84	21.0
Marital status						
Married	71	61.2	123	43.3	194	48.5
Single	45	38.8	161	56.7	206	51.5
Smoking status						
Yes	52	44.8	59	20.8	111	27.8
No	59	50.9	220	77.5	279	69.8
Former smoker	5	4.3	5	1.8	10	2.6
Alcohol use status						
Yes	19	16.4	38	13.4	57	14.2
No	97	83.6	246	86.6	343	85.8

n: number

Table 2. Participants' scale scores and the distribution according to the Beck Depression Inventory and anthropometric measurement classifications

	Men (n:116)	**Women (n:284)**	**Total (n:400)**	
BDI total score (x̄±SD)	7.4±10.79	11.9±9.54	10.6±10.11	p<0.001*
BDI classification	**n (%)**	**n (%)**	**n (%)**	
No depression	84 (72.4)	126 (44.4)	210 (52.5)	X^2: 28.226; p<0.001**
Mild depression	15 (12.9)	81 (28.5)	96 (24.0)	
Moderate depression	11 (9.5)	64 (22.5)	75 (18.7)	
Severe depression	6 (5.2)	13 (4.6)	19 (4.8)	

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Phytochemical index	17.5±11.18	17.3±12.15	17.4±11.87	p=0.11*
SHEBS total score	3.2±0.60	3.5±0.67	3.4±0.66	p=0.11*
BMI (kg/m²) (x̄±SD)	22.2 ±3.52	24.9±3.33		p<0.001*
BMI classification	**n (%)**	**n (%)**	**n (%)**	
Underweight	1 (0.9)	27 (9.5)	28(7.0)	X^2: 35.682;
Normal	62 (53.4)	204 (71.8)	266 (66.5)	p<0.001**
Overweight/Obese	53 (45.7)	53 (18.7)	106 (26.5)	
Waist circumference (cm) (x̄±SD)	88.9±8.5	75.5±9.5		p<0.001*
Waist circumference classification	**n (%)**	**n (%)**		
No risk	85 (73.3)	213 (75.0)		
Risky	27 (23.3)	41 (14.4)		X^2: 8.723;
High risk	4 (3.4)	30 (10.6)		p=0.013**
Waist/Hip ratio (x̄±SD)	0.7±0.07	0.8±0.04		p<0.001*
Waist/Hip classification	**n (%)**	**n (%)**		
Normal	70 (60.3)	238 (83.8)		X^2: 25591;
Risky	46 (39.7)	46 (16.2)		p<0.001**
Waist/Height ratio (x̄±SD)	0.4±0.06	0.5±0.46		p<0.001*
Waist/Height classification	**n (%)**	**n (%)**		
Normal	46 (39.7)	211(74.3)		X^2: 43.027;
Risky	70 (60.3)	73 (25.7)		p<0.001**

BDI: Beck Depression Inventory; BMI: Body Mass Index; SHEBS: Sustainable and Healthy Eating Behaviors Scale

* t test **Chi-square test, p < 0.05

Table 3. Distribution of nutrient intakes, anthropometric measurements, and scale scores according to phytochemical index classification

	1.Quartile (n:103)	**2.Quartile (n:95)**	**3.Quartile (n:105)**	**4.Quartile (n:97)**	**p**
Daily energy and nutrient intakes	**x̄±SD**	**x̄±SD**	**x̄±SD**	**x̄±SD**	
Energy (kcal)	1773.9±593.07^{a,b}	1937.5±608.4^{a}	1946.2±691.12^{a}	1690.1±554.14^{b}	<0.01
Protein (g)	63.2±25.32^{a}	69.9±25.94^{a,b}	75.3±30.88^{b}	66.0±22.12^{a,b}	<0.01
Vegetable protein (g)	20,5±8,48^{a}	26,1±9,25^{a,b}	29,1±10,15^{b}	28,9±12,34^{b}	<0.01
Lipid (g)	81,8±35,92	88,4±34,46	82,8±36,15	75,9±31,42	0.09
Carbohydrate (g)	192,7±73,25^{a,b}	210,3±77,45^{a}	219,9±85,30^{b}	180,2±72,00^{a,b}	<0.01
Fibre (g)	13,4±5,55^{a}	19,8±7,36^{b}	24,0±11,18^{c}	25,8±12,97^{c,d}	<0.01
Antioxidant (mmol)	2.4±1.82	2.9±9.39	4.5±17.22	6,9±32.89	0.35
ORAC	1310.8±1359.09^{a}	2785.8±2231.64^{b}	4058.1±3075.72^{c}	5254.8±3205.14^{d}	<0.01
Potassium (mg)	1908.5±777.71^{a}	2665.3±1024.39^{b}	2727.5±1086.21^{b}	2818.1±1083.99^{b}	<0.01
Calcium (mg)	503.8±233.12	556.1±265.46	590.1±252.93	596.8±325.25	0.06
Magnesium (mg)	195.2±73.87^{a}	260.6±95.36^{b}	284.7±113.62^{b,c}	300.7±131.16^{c}	<0.01
Phosphorus (mg)	911.2±340.77^{a}	1046.0±349.54^{b}	1123.3±415.76^{b}	1099.2±348.13^{b}	<0.01
Iron (mg)	8,5±3,52^{a}	11,0±4,56^{b}	11,8±5,36^{b}	11,6±4,67^{b}	<0.01

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Zinc (mg)	8,5±3,92 [a]	9,8±3,89 [a,b]	10,6±4,73 [b,c]	9,9±4,01 [a,c]	<0.01
Copper (mg)	1.1±0.49 [a]	1.4±0.51 [b]	1.6±0.64 [b]	1.6±0.67 [b]	<0.01
Vitamin A (µg)	604.8±406.44 [a]	1106.8±830.5 [b]	1079.6±815.19 [b]	1289.8±1005.6 [b]	<0.01
Retinol (µg)	311.2±161.5	342.7±215.53	324.2±196.84	324.6±211.11	0.73
Carotene (µg)	1.7±2.19 [a]	4.5±4.80 [b]	4.5±4.65 [b]	5.8±6.09 [b]	<0.01
Vitamin E (mg)	24.7±16.19	26.9±16.60	23.3±14.67	22.8±13.47	0.24
B_1 (mg)	0.6±0.28 [a]	0.9±0.29 [b]	1.0±0.38 [b,c]	1.0±0.37 [c]	<0.01
B_2 (mg)	1.1±0.49 [a]	1.2±0.52 [b]	1.2±0.50 [b]	1.2±0.48 [b]	0.03
Niacin (mg)	14.1±9.87	15.4±10.23	16.0±9.40	14.7±7.86	0.48
B_5 (mg)	4.2±1.76 [a]	5.3±2.12 [b]	5.4±2.10 [b]	5.2±1.98 [b]	<0.01
B_6 (mg)	1.0±0.50 [a]	1.4±0.58 [b]	1.5±0.70 [b]	1.5±0.58 [b]	<0.01
Folate (µg)	195.9±79.03	308.2±137.9	347.6±167.59	360.9±165.61	0.62
B_{12} (µg)	4.2±3.28	4.8±3.61	4.6±3.36	4.7±3.69	0.62
Vitamin C (mg)	75.2±59.91 [a]	116.9±81.45 [b]	127.0±80.88 [b]	126.5±70.18 [b]	<0.01
Omega-3 (g)	1.2±1.64 [a]	1.6±1.59 [a,b]	1.5±1.65 [a,b]	2.0±1.62 [b]	0.01
Omega-6 (g)	21.6±13.87 [a,b]	22.8±14.27 [a]	19.3±12.44 [a,b]	18.1±10.31[b]	0.04
MUFA (g)	24.3±10.01	27.1±10.59	27.3±12.65	26.3±13.97	0.24
PUFA (g)	23.3±14.68	24.8±14.93	21.3±13.26	20.6±10.72	0.12
SFA (g)	25.8±11.34 [a,b,c]	27.6±11.30 [b]	26.1±12.64 [a]	22.3±10.32 [a,c]	0.01
Cholesterol (mg)	306.4±192.63	337.3±175.55	333.5±224.36	302.2±183.8	0.47
Anthropometric measurements					
Body weight (kg)	63.6±12.43 [a]	63.6±12.27 [a]	68.3±13.87 [b]	62.7±12.46 [a]	<0.01
BMI (kg/m^2)	22.6±3.70 [a]	22.6±3.25 [a]	23.9±3.67 [b]	22.7±3.91 [a]	0.02
Waist circumference (cm)	78.6±10.76 [a]	78.7±11.09 [a]	82.4±11.53 [b]	77.6±10.04 [a]	<0.01
Hip circumference (cm)	97.4±9.00 [a,b]	96.8±7.32 [b]	99.5±8.10 [a]	95.9±7.69 [b]	0.01
Waist/Hip ratio	0.8±0.08	0.8±0.08	0.8±0.08	0.8±0.08	0.273
Waist/Height ratio	0.4±0.04	0.5±0.05	0.5±0.06	0.5±0.05	0.08
Neck circumference (cm)	33.9±4.17 [a]	33.8±4.45 [a]	35.1±4.40 [b]	33.7±3.56 [a]	0.04
Scale scores					
SHEBS total score	3.5±0.77 [a,b]	3.6±0.86 [a,b]	3.3±0.61 [a]	3.6±0.65 [b]	0.01
BDI total score	11.4±9.70	11.0±9.85	10.1±11.87	9.7±8.70	0.62

BDI: Beck Depression Inventory; BMI: Body Mass Index; SHEBS: Sustainable and Healthy Eating Behaviors Scale; One-way ANOVA test; Bonferroni post hoc test was used to determine differences between groups; there is a significant difference between a, b, c, d groups, $p<0.05$

Table 4. Correlation of the relationship between scales and anthropometric measurements

BDI: Beck Depression Inventory; BMI: Body Mass Index; SHEBS: Sustainable and Healthy Eating Behaviors Scale Pearson Correlation, *$p<0.05$ **$p<0.01$

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		1	2	3	4	5	6	7
1. SHEBS score	r	1						
	p							
2. Phytochemical index	r	0.060	1					
	p	0.231						
3. BDI score	r	-0.039	-0.076	1				
	p	0.438	0.131					
4. BMI	r	-0.102*	0.020	0.037	1			
	p	0.041	0.684	0.463				
5. Waist circumference	r	-0.140**	-0.007	-0.113*	0.769**	1		
	p	0.005	0.894	0.024	0.000			
6. Neck circumference	r	-0.167**	0.019	-0.227**	0.522**	0.708**	1.	
	p	0.001	0.710	0.000	0.000	0.000		
7. Waist-hip ratio	r	-0.143**	0.023	-0.149**	0.486**	0.782**	0.621**	1
	p	0.004	0.644	0.003	0.000	0.000	0.000	
8. Waist-height ratio	r	-0.108**	0.003	-0.053	0.806**	0.925**	0.522**	0.722**
	p	0.032	0.949	0.291	0.000	0.000	0.000	0.000

Table 5. Multiple linear regression analysis of factors associated with BDI and SHEBS scores

Variable	B	SE	β	t	p-value	95% CI for B
Beck Depression Inventory (BDI) scores						
R^2 = 0.164; Adjusted R^2 = 0.146; F(8.380) = 9.290; p < 0.001						
SHEBS score	-1.093	0.658	-0.080	-1.660	0.098	-2.388, 0.202
Age	-0.392	0.076	-0.338	-5.139	<0.001	-0.542, -0.242
BMI	0.637	0.151	0.232	4.217	<0.001	0.340, 0.934
Phytochemical Index	-0.062	0.041	-0.073	-1.497	0.135	-0.143, 0.019
Sex	5.210	1.154	0.231	4.516	<0.001	2.943, 7.479
Smoking status	-1.019	1.171	-0.045	-0.870	0.385	-3.321, 1.284
Alcohol consumption	4.643	1.424	0.160	3.260	0.001	1.843, 7.443
Education level	-1.210	0.745	-0.106	-1.625	0.105	-2.674, 0.254
Sustainable and Healthy Eating Behaviors Scale (SHEBS) scores						
R^2 = 0.056; Adjusted R^2 = 0.036; F(8.380) = 2.818; p = 0.005						
Age	-0.004	0.006	-0.051	-0.713	0.477	-0.016, 0.008
BMI	0.005	0.012	0.024	0.403	0.687	-0.019, 0.028
Phytochemical Index	0.004	0.003	0.066	1.272	0.204	-0.002, 0.010
Sex	0.210	0.091	0.128	2.298	0.022	0.030, 0.389
Smoking status	-0.092	0.091	-0.056	-1.010	0.313	-0.270, 0.087
Alcohol consumption	0.057	0.112	0.027	0.508	0.612	-0.163, 0.277
Education level	0.093	0.058	0.112	1.603	0.110	-0.021, 0.206
BDI score	-0.007	0.004	-0.090	-1.660	0.098	-0.014, 0.001

BMI: Body Mass Index, $p < 0.05$

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Table 6. Binary logistic regression analysis of factors associated with depression status

Variable	B	SE	Wald	p-value	OR (Exp (B))	95% CI for OR
Age	-0.176	0.148	1.403	0.236	0.839	0.627–1.122
BMI	0.161	0.074	4.719	0.030	1.174	1.016–1.358
SHEBS score	-0.111	0.375	0.087	0.768	0.895	0.429–1.868
Sex	1.201	0.706	2.891	0.089	3.322	0.832–13.257
Smoking status	0.180	0.666	0.073	0.787	1.197	0.325–4.416
Alcohol consumption	0.371	0.644	0.331	0.565	1.449	0.410–5.121
Education level	1.455	1.493	0.950	0.330	4.286	0.230–79.967
Phytochemical Index	-0.059	0.029	4.245	0.039	0.942	0.891–0.997

BMI: Body Mass Index; SHEBS: Sustainable and Healthy Eating Behaviors Scale; OR: Odds Ratio; CI: Confidence Interval

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