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Evaluation of sustainable and healthy eating behaviors and ecological footprint awareness in college students

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ARTICLE INFO	ABSTRACT
	Introduction: Assessing university students' eating habits and environmental awareness is important for adopting a healthy and sustainable lifestyle in the future. This study aimed to investigate university students' ecological footprints and their awareness of sustainable and healthy eating (SHE) habits. **Methods:** Data from 307 students was collected via a web-based survey. The survey form included demographic information, anthropometric data, the "sustainable and healthy eating behaviors scale," and the "ecological footprint awareness scale." **Results:** There was a significant difference in healthy and balanced nutrition scores between the nutrition and dietetics department and other departments ($p < 0.05$). Healthy and balanced nutrition, reducing meat consumption, local foods, preventing food waste, and seasonal foods sub-dimensions showed a weak and positive correlation with education level ($p < 0.05$). The water consumption score, a sub-dimension of the "ecological footprint awareness scale," showed a significant difference between the nutrition and dietetics department and other departments. The "sustainable and healthy eating behaviors scale" showed weak to strong positive correlations with food, waste, housing, and mobility ($p < 0.05$). Energy and water consumption showed weak to moderate positive correlations with the "sustainable and healthy eating behaviors scale" (excluding local food) ($p < 0.05$). **Conclusion:** Ecological footprint awareness (EFA) and SHE behaviors are related among college students. Young adults with higher levels of education have higher EFA and are more prone to healthy and sustainable eating behaviors. **Keywords:** ecological footprint, sustainable eating, healthy eating, college students, nutrition education

INTRODUCTION

Food preferences and eating behaviors have important implications for individual health and planetary health [1]. Modern dietary habits, consisting of high amounts of refined sugar, fat, and meat, negatively impact environmental sustainability [2]. Researchers have reported that food processes cause about 30% of greenhouse gas emissions [3, 4]. Moreover, the literature indicates that agricultural greenhouse gas emissions could increase by 80% unless modern dietary trends are managed [5]. Therefore, environmental sustainability is associated with healthy nutrition[6]. Food and Agriculture Organization (FAO) and World Health Organization (WHO) have published guideline for the development of sustainable healthy eating policies [7, 8]. According to this guide, sustainable eating is a form of nutrition that supports individuals' health and quality of life in every way, does not harm the environment, is accessible to all members of society, is safe, and is in line with cultural values [8]. The common principles of these organizations include limiting the intake of

foods high in sugar, salt, and fat, as well as highly processed foods; increasing the amount of unprocessed or minimally processed foods; ensuring moderate intake of red meat; and reducing food waste [7, 9].

The ecological footprint assesses the impact of biological resource use on the environment and environmental sustainability [10]. A study has shown that the Mediterranean diet and similar healthy dietary patterns reduce greenhouse gas emissions, thus having positive effects on environmental sustainability [11]. Another study found that individuals with high adherence to the Mediterranean diet showed strong awareness of reducing their ecological footprint [12]. Improvements in individuals' dietary habits contribute to sustainability. Especially for young adults, encouraging healthy and environmentally friendly eating habits is critically important for sustainability [13]. Naja et al. reported an increase in the ecological footprint score of young adults across 12 years. This result has been attributed to the worsening dietary habits of young adults over the years [14]. It has been demonstrated that compliance with the Mediterranean diet model and sustainable eating behaviors

positively affect the ecological footprint score [15]. Therefore, investigating the factors that affect sustainable and healthy eating (SHE) behaviors among young adults is necessary. The purpose of the present study is to reveal the relationship between college students' ecological footprint awareness (EFA) and SHE behaviors.

MATERIALS AND METHODS

Design and Sample

This cross-sectional study included 307 students from the faculty of health sciences at Trakya University University. G*Power was used to calculate post-hoc power analysis. The effect size of the relationship between healthy and balanced nutrition and food subscale scores has been calculated. As a result of the analyses, the statistical power (1-β) of the study was calculated to be 82% at a two-tailed 5% significance level.

Ethical Approval

Before beginning the research, approval was obtained from the non-Interventional Scientific Research Ethics Committee of the Dean's Office at Trakya University University Faculty of Medicine on April 4, 2022 (decision no. 07/10). The study was carried out in accordance with the Helsinki Declaration.

Eligibility Criteria and Settings

The data for this study was collected using a web-based questionnaire. The inclusion criteria for the study were university students without a specific dietary plan. Individuals fulfilling the inclusion criteria and volunteering to participate in the study were included in the study sample. The survey form consists of sociodemographic characteristics, anthropometric measurement, "sustainable and healthy eating behaviors scale" and "ecological footprint awareness scale" sections.

Data Collection

The "sustainable and healthy eating behaviors scale" is a measurement tool consisting of 34 items and structured as a 7-point Likert scale. The scale was adapted into Turkish and its validity and reliability analysis was conducted by [16]. The scale has a total of 8 sub-dimensions: healthy and balanced nutrition, quality rating, reduction of meat consumption, local foods, low fat, prevention of food waste, animal health, and seasonal foods. A high score indicates better "sustainable and healthy eating behaviors scale" [16].

"ecological footprint awareness scale," developed by [17] and tested for validity and reliability, was used to assess EFA in individuals. The 5-grade Likert-type scale consists of 40 items. The sub-dimensions of the scale are food, shelter and mobility, energy consumption, waste management, and water consumption. The sub-dimensions and total scores range from 1 to 5. Higher scores indicate that individuals are more aware of their ecological footprint. Participants reported their height and weight based on self-measurements, following instructions included in the questionnaire on how to take anthropometric measurements. Body mass index (BMI) is calculated by dividing an individual's body weight (kg) by the square of their height (m). Based on the resulting BMI values, individuals are classified as "underweight" (below 18.50 kg/m²), "normal weight" (18.50-24.99 kg/m²), "overweight" (25.00-29.99 kg/m²), or "obese" (30.00 kg/m² and above) [18].

Table 1. Evaluation of demographic and anthropometric characteristics of individuals

Variables	n (%)
Gender	
Female	168 (54.7%)
Male	139 (45.3%)
Grade of education	
1st	92 (30.0%)
2nd	106 (34.5%)
3rd	76 (24.8%)
4th	33 (10.7%)
Underweight (< 18.50 kg/m²)	36 (11.7%)
Normal (18.50-24.99 kg/m²)	230 (74.9%)
Overweight (25.00-29.99 kg/m²)	32 (10.4%)
Obese (≥ 30.00 kg/m²)	9 (2.9%)
	M ± standard deviation (SD)
Age (years)	20.7 ± 2.46
Body weight (kg)	
Female	58.4 ± 9.38
Male	76.3 ± 14.56
BMI (kg/m²)	21.8 ± 3.29

Statistical Analysis

Statistical package for the social sciences (version 22.0) was used for statistical analyses. Histograms, coefficient of variation, skewness, kurtosis, and Kolmogorov-Smirnov tests were performed to evaluate the distribution of data. The comparisons of independent groups were analyzed using the Mann-Whitney U test. Spearman's correlation coefficient was used to assess the relationships between numerical variables. Correlation coefficients greater than 0.50 were interpreted as indicating a strong association, values between 0.35 and 0.50 as representing a moderate association, and those below 0.35 as reflecting a weak association [19]. The analyses were conducted with a 95% confidence interval, and a p-value < 0.05 was taken as statistically significant.

RESULTS

The study was completed with 307 college students. The mean (M) age of the individuals was 20.7 ± 2.46 years. 30.0% of the students are studying in the 1st grade, 34.5% in the 2nd grade, 24.8% in the 3rd grade, and 10.7% in the 4th grade. The M BMI of individuals is 21.8 ± 3.29 kg/m². The majority of individuals (74.9%) are within the normal range according to BMI classification (**Table 1**).

Evaluation of SHE behaviors of individuals is given in **Table 2**. Statistically significant difference was found between the genders in terms of the M scores obtained from the sub-dimension of reducing meat consumption ($p < 0.05$). Statistically significant difference was determined between the individuals studying in the department of nutrition and dietetics and the individuals studying in other departments in terms of the M score of healthy and balanced nutrition ($p < 0.05$).

Healthy and balanced nutrition, reduced meat consumption, local foods, prevention of food waste, seasonal foods, and education level showed positive and weak correlations, respectively (r_1: 0.197, r_2: 0.119, r_3: 0.132, r_4: 0.126, r_5: 0.208, $p < 0.05$). There was a positive and weak correlation between local food consumption and age (r: 0.148, $p < 0.05$) (**Table 3**).

Table 2. Evaluation of SHE behaviors of individuals

Sub-dimensions	M±SD			p	M±SD		p
	Total (n = 307)	Male (n = 139)	Female (n = 168)		Department of nutrition and dietetics (n = 148)	Other departments (n = 159)	
Healthy and balanced nutrition	4.6 ± 1.01	4.4 ± 1.28	4.6 ± 0.96	0.175	4.7 ± 0.85	4.2 ± 1.44	**0.012***
Quality marks (local and organic)	4.2 ± 1.19	4.2 ± 1.41	4.1 ± 1.15	0.654	4.1 ± 1.08	4.3 ± 1.56	0.112
Reducing meat consumption	3.4 ± 1.24	2.9 ± 1.25	3.4 ± 1.22	**0.019***	3.4 ± 1.20	3.2 ± 1.38	0.452
Local food	3.2 ± 1.40	3.7 ± 1.72	3.1 ± 1.33	0.059	3.1 ± 1.30	3.6 ± 1.71	0.064
Low fat	4.4 ± 1.33	4.3 ± 1.57	4.3 ± 1.29	0.869	4.3 ± 1.25	4.3 ± 1.62	0.842
Avoiding food waste	4.7 ± 1.28	4.7 ± 1.70	4.7 ± 1.21	0.817	4.8 ± 1.16	4.4 ± 1.64	0.077
Animal health	3.8 ± 1.49	3.9 ± 1.75	3.8 ± 1.46	0.645	3.8 ± 1.46	3.8 ± 1.66	0.984
Seasonal foods	4.4 ± 1.33	4.3 ± 1.72	4.4 ± 1.27	0.887	4.5 ± 1.21	4.1 ± 1.73	0.187

Note. [1]Mann Whitney U test & *Significant at p < 0.05

Table 3. The relationship between SHE behaviors and some variables

Sub-dimensions	Age (years)	Grade of education	Body weight (kg)	BMI (kg/m^2)
Healthy and balanced nutrition	r = 0.056 & p = 0.332	r = 0.197 & **p = 0.001***	r = 0.013 & p = 0.815	r = 0.017 & p = 0.771
Quality marks (local and organic)	r = -0.007 & p = 0.897	r = 0.062 & p = 0.276	r = 0.024 & p = 0.671	r = 0.006 & p = 0.910
Reducing meat consumption	r = 0.026 & p = 0.650	r = 0.119 & **p = 0.037***	r = -0.102 & p = 0.073	r = -0.016 & p = 0.784
Local food	r = 0.148 & **p = 0.009***	r = 0.132 & **p = 0.021**	r = 0.075 & p = 0.192	r = 0.074 & p = 0.193
Low fat	r = 0.038 & p = 0.512	r = 0.061 & p = 0.283	r = -0.025 & p = 0.660	r = -0.056 & p = 0.330
Avoiding food waste	r = -0.003 & p = 0.964	r = 0.126 & **p = 0.028***	r = 0.105 & p = 0.066	r = 0.072 & p = 0.210
Animal health	r = -0.095 & p = 0.098	r = -0.003 & p = 0.960	r = 0.025 & p = 0.662	r = 0.019 & p = 0.747
Seasonal foods	r = 0.066 & p = 0.252	r = 0.208 & **p < 0.001***	r = 0.099 & p = 0.083	r = 0.087 & p = 0.126

Note. [1]Spearman correlation & *Significant at p < 0.05

Table 4. Evaluation of individuals' EFA

Sub-dimensions	M±SD			p	M±SD		p
	Total (n = 307)	Male (n = 139)	Female (n = 168)		Department of nutrition and dietetics (n = 148)	Other departments (n = 159)	
Food	3.1 ± 0.64	2.9 ± 0.96	3.1 ± 0.57	0.207	3.1 ± 0.51	3.1 ± 1.03	0.928
Shelter and mobility	3.3 ± 0.82	3.1 ± 1.11	3.2 ± 0.77	0.380	3.2 ± 0.74	3.1 ± 1.09	0.179
Energy consumption	3.9 ± 0.89	3.6 ± 1.17	4.0 ± 0.83	0.138	4.1 ± 0.77	3.6 ± 1.22	0.108
Waste management	3.8 ± 0.85	3.5 ± 1.20	3.8 ± 0.78	0.082	3.9 ± 0.73	3.5 ± 1.20	0.091
Water consumption	3.9 ± 0.86	3.5 ± 1.29	3.9 ± 0.77	0.152	4.0 ± 0.70	3.5 ± 1.28	**0.044***

Note. [1]Mann Whitney U test & *Significant at p < 0.05

There was no statistically significant difference between the genders in terms of the M scores of the "ecological footprint awareness scale" sub-dimensions (p > 0.05). A statistically significant difference was found in the average water consumption score between individuals studying in the department of nutrition and dietetics and those studying in other departments (p < 0.05) (**Table 4**).

There were weak to strong positive correlations between all subscales of the "sustainable and healthy eating behaviors scale" and the food subscale of the "ecological footprint awareness scale" (p < 0.01). There were weak to moderate positive correlations between all subscales of the "sustainable and healthy eating behaviors scale" and the shelter and mobility subscale of the "ecological footprint awareness scale" (p < 0.01).

In addition, there were weak to moderate positive correlations between all subscales of the "sustainable and healthy eating behaviors scale" and the waste management subscale of the "ecological footprint awareness scale" (p < 0.05). Weak to moderate positive correlations were found between the sub-dimensions of the "ecological footprint awareness scale," energy and water consumption, and all sub-dimensions of the "sustainable and healthy eating behaviors scale" (except local food) (p < 0.05). Weak positive correlations were revealed between educational status and energy consumption, waste management, and water consumption, respectively (r_1: 0.158, r_2: 0.145, r_3: 0.153, p < 0.05) (**Table 5**).

DISCUSSION

This present study aimed to investigate young adult university students' awareness of their ecological footprint and their SHE behaviors. The findings of the study revealed that as the level of education increased, SHE behaviors and EFA were exhibited in a positive aspect. In addition, high SHE behaviors have been associated with high EFA.

SHE and EFA are essential to optimize the health and well-being of all individuals in present and future generations, prevent malnutrition and infectious diseases, and protect the health of the planet and its ecosystems [8]. Indeed, sustainable eating habits are commonly associated with better health outcomes in the literature [20]. This finding is based on the low environmental impact of natural and plant-based foods such as fruits, vegetables, and grains, and their greater health benefits compared to processed and animal-based foods [21]. However, young adults are reported to have low intakes of fruits, vegetables and whole grains and high intakes of sodium, sugar and fats [22]. Nutrition education affects the eating behaviors and lifestyle of young adults at university [23]. For example, a study conducted with university students reported that nutrition education positively affects healthy eating behaviors and lifestyle [24]. Similarly, our current study revealed that nutrition education positively influenced SHE behaviors. Our findings indicate that nutrition and dietetics students demonstrated higher health and balanced nutrition

Table 5. The relationship of EFA with some variables

Variables	Ecological footprint awareness scale sub-dimensions				
	Food	Shelter and mobility	Energy consumption	Waste management	Water consumption
Sustainable and healthy eating behaviors scale sub-dimensions					
Healthy and balanced nutrition	r = 0.386 & **p < 0.001***	r = 0.293 & **p < 0.001***	r = 0.365 & **p < 0.001***	r = 0.373 & **p < 0.001***	r = 0.331 & **p < 0.001***
Quality marks (local and organic)	r = 0.462 & **p < 0.001***	r = 0.302 & **p < 0.001***	r = 0.253 & **p < 0.001***	r = 0.294 & **p < 0.001***	r = 0.198 & **p < 0.001***
Reducing meat consumption	r = 0.307 & **p < 0.001***	r = 0.192 & **p = 0.001***	r = 0.115 & **p = 0.045***	r = 0.151 & **p = 0.008***	r = 0.122 & **p = 0.032***
Local food	r = 0.426 & **p < 0.001***	r = 0.299 & **p < 0.001***	r = 0.094 & p = 0.101	r = 0.144 & **p = 0.011***	r = 0.106 & p = 0.063
Low fat	r = 0.376 & **p < 0.001***	r = 0.291 & **p < 0.001***	r = 0.299 & **p < 0.001***	r = 0.297 & **p < 0.001***	r = 0.293 & **p < 0.001***
Avoiding food waste	r = 0.335 & **p < 0.001***	r = 0.286 & **p < 0.001***	r = 0.432 & **p < 0.001***	r = 0.441 & **p < 0.001***	r = 0.404 & **p < 0.001***
Animal health	r = 0.501 & **p < 0.001***	r = 0.372 & **p < 0.001***	r = 0.287 & **p < 0.001***	r = 0.309 & **p < 0.001***	r = 0.325 & **p < 0.001***
Seasonal foods	r = 0.417 & **p < 0.001***	r = 0.275 & **p < 0.001***	r = 0.354 & **p < 0.001***	r = 0.379 & **p < 0.001***	r = 0.353 & **p < 0.001***
Age (years)	r = -0.085 & p = 0.135	r = -0.025 & p = 0.661	r = 0.064 & p = 0.260	r = 0.024 & p = 0.672	r = 0.034 & p = 0.549
Grade of education	r = 0.001 & p = 0.985	r = -0.045 & p = 0.435	r = 0.158 & **p = 0.005***	r = 0.145 & **p = 0.011***	r = 0.153 & **p = 0.007***
Body weight (kg)	r = -0.040 & p = 0.488	r = -0.053 & p = 0.355	r = 0.009 & p = 0.878	r = -0.019 & p = 0.740	r = -0.061 & p = 0.290
BMI (kg/m^2)	r = -0.015 & p = 0.793	r = -0.040 & p = 0.490	r = -0.014 & p = 0.814	r = -0.033 & p = 0.567	r = -0.104 & p = 0.068

Note. [1]Spearman correlation & *Significant at $p < 0.05$

scores compared to students from other departments ($p < 0.05$).

This study found a positive correlation between educational level and SHE behaviors (excluding animal health) ($p < 0.05$). The existing literature includes studies showing that as individuals' educational levels increase, they tend to adopt SHE behaviors [22, 24, 25]. According to one study, increased healthy eating literacy positively affected the subdimensions of SHE, namely seasonal foods, prevention of food waste, healthy and balanced eating, and local food scores [26]. Furthermore, researchers attributed the high healthy eating literacy scores to the fact that the majority of participants had a university degree or higher. In another study, the group that received online sustainable nutrition education scored higher than the control group in seasonal foods, preventing food waste, animal health, reducing meat consumption, healthy and balanced nutrition, and low-fat nutrition [27]. In light of these data, nutrition education and a high level of education can encourage SHE behaviors.

Another finding of this study demonstrated significant differences between genders in the score for reducing meat consumption. In this study, women scored higher than men in reducing meat consumption. This finding is consistent with previous results indicating that men consume more meat than women and are less inclined toward vegetarianism [28].

Ecological footprint is a term developed within the scope of sustainable development that measures the use of natural resources and evaluates the impact of human needs on natural resources [29, 30]. EFA can be affected by sociodemographic variables such as age, gender, educational status, and occupation [31, 32]. The present study demonstrate positive relationship between scores on the subdimensions of the "ecological footprint awareness scale"—energy consumption, waste management, and water consumption—with educational status ($p < 0.05$). Similarly, previous studies suggest that education level is related to EFA [33-36]. However, it has been pointed out that the increase in educational attainment also increases the ecological footprint; this may be related to environmental issues not being sufficiently addressed in the curriculum [36]. On the other hand, two studies reported that there was no significant difference in the total EFA score according to educational status, with differences only in waste management and energy consumption [33, 34]. Another finding was that there was no

significant difference between the nutrition and dietetics department and other departments, except for water consumption. This may be because all participants are students who have received similar education in the field of health sciences.

Finally, current study revealed a positive relationship between SHE eating behavior and EFA. The findings are further supported by previous studies [12, 29]. This result may be explained by the increasing environmental awareness affecting food choice motivations [29]. In addition, it was reported that adherence to the Mediterranean diet, SHE behaviors, and awareness of reducing the ecological footprint are interrelated [12]. The researchers stated that this result is due to the Mediterranean diet being a sustainable eating model that concerns both ecological and individual health [12]. Indeed, the double pyramid model developed by the Barilla Center for Food and Nutrition shows that foods required for healthy nutrition have a lower environmental impact, whereas foods that should be limited have a higher environmental impact. Therefore, it is important to enhance consumers' awareness from an early age that their food choices have an impact beyond their own health.

Limitations and Implications

Some limitations of the present study should be considered. First, this research was conducted only with students at Trakya University. Therefore, the results of our study cannot be generalized to the whole population. Another limitation is that only the academic year is considered for the level of education. Future studies may include participants with a wider range of educational levels (elementary school, high school, associate's degree, bachelor's degree, postgraduate degree). Finally, anthropometric variables were obtained using self-reported outcome measures. Hence, correlations between BMI and other variables may not have been observed.

Young adults should be encouraged to adopt SHE behaviors to maintain personal and environmental health. Therefore, raising awareness among young adults about SHE eating and reducing their ecological footprint is essential. In this regard, providing educational programs for young people throughout their university life (on themes such as sustainability, healthy eating, and ecological footprint) is a key strategy for improving personal and ecological health.

CONCLUSION

In conclusion, our findings show that having SHE behaviors increases EFA. Furthermore, it has been demonstrated that both SHE and EFA are influenced by educational level. However, no significant relationship was found between these two variables and age or BMI. Scores for healthy and balanced nutrition and water consumption were higher in the nutrition and dietetics department compared to other departments.

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