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Association between perceived stress, emotional eating, and adherence to healthy eating patterns among Saudi college students: a cross-sectional study

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Abstract

Background College students are vulnerable to high perceived stress (PS) and emotional eating (EE) levels, which are associated with their food consumption. In this study, we aimed to examine the links between perceived stress, emotional eating, and adherence to a healthy eating index. Furthermore, we aimed to test whether sociodemographic data and health measures, including body mass index and physical activity, are associated with perceived stress, emotional eating, or healthy eating index.

Methods This study included students from King Abdulaziz University. The participants completed validated perceived stress, emotional eating, and short healthy eating index surveys via an online questionnaire from September to December 2022. Univariate linear regression analysis was performed to examine the association between perceived stress, emotional eating, and adherence to healthy eating index using the short healthy eating index.

Results Of 434 students (49.8% male, mean age 21.7 ± 3.0 years), 11.3% had low, 72.0% moderate, and 16.7% high perceived stress. Students with moderate perceived stress had the highest short healthy eating index score ($P=0.001$), outperforming those with low and high perceived stress for fruit juice ($P=0.002$), fruits ($P<0.001$), vegetables ($P=0.03$), greens and beans ($P<0.001$), whole grains ($P=0.009$), and seafood/plant proteins ($P=0.001$) consumption. Also, emotional eating was significantly associated with short healthy eating index score ($P=0.04$), fruit juice ($P=0.01$) fruit consumption ($P<0.001$), added sugar ($P=0.02$) and saturated fatty acids ($P=0.03$). Academic major was associated with perceived stress ($P=0.006$) and emotional eating ($p=0.04$). Higher physical activity levels were associated with low perceived stress levels ($P<0.001$) and high short healthy eating index score ($P=0.001$), while high body mass index was associated with high emotional eating score ($P<0.001$).

Conclusions The findings confirmed that students are highly vulnerable to moderate and high perceived stress levels. Furthermore, high perceived stress is inversely associated with adherence to a healthy eating index, especially for fruits, vegetables, greens and beans, whole grains, and seafood and plant proteins consumption. Emotional eating,

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also, associated with students dietary pattern. Physical activity will be beneficial for reducing the level of perceived stress and improving overall dietary patterns.

Keywords Dietary patterns, Perceived stress, Students, Healthy eating index, Emotional eating

Background

Stress is considered as any physical, chemical, behavioral, and social factor that can disturb an individual's physiological homeostasis or psychological well-being [1]. Experiencing stress can impact health outcomes directly and indirectly [2]. The direct pathway involves autonomic and neuroendocrine responses. The human body adapts to internal and external environmental changes (some of which may be stressful) via the production of hormones (e.g., cortisol, adrenaline, and noradrenaline) and signaling of the autonomic nervous system and the central nervous system [2]. Stress also influences the activation of the hypothalamic-pituitary-adrenal glands, increasing the levels of circulating glucocorticoids and adrenocorticotropic hormones in the body [3]. Stress can indirectly contribute to obesity, cardiovascular disease, and cancer risk by inducing changes in health behaviors such as dietary patterns, resulting in increased consumption of unhealthy food [2], poor diet quality [4, 5], and overeating or undereating [6, 7]. Dietary patterns comprise the quantities and frequency of different foods and drinks consumed habitually, which are influenced by a combination of internal and external factors [8]. The internal factors include physiologic mechanisms that regulate appetite and satiety through several hormones, and external factors include environmental aspects such as economic situation, food availability, and social factors [9]. Perceived stress (PS) is one of the external factors influencing dietary patterns [1].

Previous studies have confirmed that college students, especially female students, experience high stress levels globally [10–12]. Life cycle changes and adjustment to college life have been associated with increased PS among students [13, 14]. Moreover, several factors contribute to the increased level of PS in students, including financial difficulties (lack of financial support or poor financial situation), personal relationships, academic-related pressure, health concerns, and lack of social engagement [13, 15–17].

High levels of PS have been linked to several health outcomes among students, including mental health, which may lead to poor mental well-being and affect academic performance [18], sleep deprivation, and low levels of physical activity [19]. Moreover, PS is a confirmed risk factor for unhealthy eating patterns and metabolic disorders, such as obesity [10, 20]. A cross-sectional study conducted among South Korean college students showed that those with high PS levels had a higher consumption of fast foods, ready-made meals, and snacks, skipped meals more frequently, and had a higher rate of overeating than did those with lower PS levels [12]. Another study conducted among medical students from King Saud University showed that female students with PS tended to eat more than male students and had increased consumption of salty foods, sweets, and takeout foods [10]. These studies highlight the effect of PS on eating patterns, especially increased unhealthy food consumption among students with high levels of PS.

Persistent stress promotes emotional eating (EE), a desire to eat as a strategy to block, numb, or control intense negative emotions, such as sadness, anger, loneliness, stress, or anxiety [21]; EE can also result from positive emotion [22]. EE is a behavior characterized by the failure to distinguish between physiological feelings of hunger and negative emotions as stress is considered negative; thus, eating becomes a strategy to cope with aversive affective states [21]. A previous study conducted among college students reported a positive association between PS and EE, as well as increased intake of sweets and soft drinks due to EE [23]. Another study showed that students with EE had high PS and body mass index (BMI), a low rate of physical activity, and an unhealthy diet [24].

College students are vulnerable to high PS levels and EE, and this has been associated with their food consumption. However, most studies on the association between PS or EE and diet among college students have focused on food preferences or choices [10, 12, 23, 25]. Assessing adherence to the Healthy Eating Index (HEI) is more comprehensive and can support better health status of college students. Therefore, this study aimed to investigate the association between PS and adherence to healthy eating patterns measured by short HEI (sHEI) and evaluate the association between EE and adherence to HEI measured by sHEI. Determining confounding factors such as sociodemographic characteristics and health measures, including BMI and physical activity, is important for building better strategies to manage PS or EE. Thus, the second aim was to test whether sociodemographic data and health measures, including BMI and physical activity, are associated with PS, EE, or HEI. The findings may be useful for effectively targeting sources of PS and EE among college students and increasing adherence to healthy eating patterns.

Methods

This cross-sectional study was conducted among conveniently sampled undergraduate students aged 17–29 years at King Abdulaziz University, Jeddah, Saudi Arabia, from September to December 2022. The study required a sample size of 383 to estimate a mean with 95% power and a significance level of 0.05. The calculation of sample size was performed using Raosoft® (Sample Size Calculator; Raosoft inc.) [26]. Postgraduate students and those who were not from King Abdulaziz University were excluded. Four sections, including questions on sociodemographic characteristics, Cohen Perceived Stress Scale (PSS-10) [27, 28], Emotional Eater Questionnaire (EEQ) [29], and sHEI survey [30], were compiled into a single questionnaire. A self-administered online questionnaire survey was developed and administered via Google Forms. This online questionnaire survey was disseminated through university communication tools and social networks such as email, Twitter, and Telegram in order to collect data from participants. The self-reported questionnaire was used because it assists in collecting data from large number of people and it is lower in cost, but it had some biases that could affect results, including social-desirability bias and measurement error bias. Participation in the study was voluntary, and no incentive was provided. The study was approved by the Biomedical Ethics Research Committee of King Abdulaziz University (reference number 247 – 22). Before completing the questionnaire, the students were required to review the objectives of the study and provide written informed consent for participation.

The first part of the questionnaire included questions regarding age, sex, academic year (first, second, third, or fourth), household income (less than 5000 SAR, 5000–10000 SAR, 10001–20000, or more than 20000 SAR), academic major, residence (with family, alone, with relatives, or in student accommodations), smoking status (non-smoker, current smoker, past smoker), following a specific diet (yes or no), marital status (single or married), physical activity (no practice; light, less than half-hour two days or less per week; moderate, one hour 3–4 days per week; or vigorous, more than one hour 5 days or more per week), part-time job (yes or no), and self-reported weight in kg and height in cm to calculate BMI (as weight in kg divided by height in m^2. Self-reporting is an acceptable method for determining BMI [31]. The BMI was categorized as underweight (< 18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (30 kg/m^2 and above) [32].

Stress was measured using the validated 10-item PSS-10 [27], which also has a validated Arabic version; the reliability of the Arabic PSS-10 was 0.74 [28], used in this cross-sectional study. The PSS-10 is a self-reported questionnaire that measures the degree to which situations in a person's life are appraised as stressful. It includes six negatively worded questions (e.g., How often did you feel you were on top of things?) and four positively worded questions (e.g., Felt confident about your ability to handle your personal problems?). Students expressed their feelings and thoughts regarding each item during the past month on a 5-point scale. Questions reflecting negative feelings were scored as follows: 0 = never, 1 = almost never, 2 = sometimes, 3 = often, and 4 = very often. Questions covering positive feelings were scored in reverse order. The total scale ranged from 0 to 40. Participant stress scores were categorized as follows: low PS (0–13), moderate PS (14–26), and high PS (27–40).

The EEQ is a validated 10-item questionnaire that measures eating behaviors in response to emotions [29]. The questionnaire was translated into the Arabic language and the translated version was assessed by some experts in the department to in order to check it suitability in Arabic. Cronbach's alpha for assessing the internal consistency reliability of the Arabic EEQ was 0.78. The EEQ assesses three major factors: (1) disinhibition, (2) type of food, and (3) guilt. The first factor, disinhibition, is covered by six questions (e.g., "Do you feel less control over your diet when you are tired after work at night?"). The second factor is covered by two questions (e.g., "Do you have cravings for specific foods?"). The third factor, feeling guilt, is covered by two questions (e.g., questions related to participant emotions, their relationship to body weight scales, and the sense of guilt that eating "forbidden" foods produces). All the questions had four possible answers: 1 = never, 2 = sometimes, 3 = generally, and 4 = always. Each reply received a score from 1 to 4, with a lower score representing healthier behavior. The total score ranged from 0 to 30. Participants with scores 0–5 were classified as non-emotional eaters, 6–10 as low-emotional eaters, 11–20 as emotional eaters, and 21–30 as very emotional eaters.

Dietary information was obtained from participants using the validated sHEI [30], which contains 22 questions related to the consumption of food groups or nutrients. The food groups or nutrients included in the survey are fruits (question 1 [Q1]), fruit juices (Q2), vegetables (Q3), green vegetables (Q4), starchy (Q5), grains (Q6 and Q7), whole grains (Q8 and Q9), milk (Q10 and Q11), low-fat milk (Q12 and Q13), beans (Q14), nut seeds (Q15), seafood (Q16 and Q17), sugar-sweetened beverages (Q18 and Q19), added sugar (Q20), saturated fat (Q21), and water (Q22). The participants were asked how often they consumed these food items on average daily. Participant responses to questions 1, 2, 3, 4, 5, 6, 8, 10, 12, 14, 15, 16, and 18 were recorded over eight frequency options (less than once per day, 1, 2, 3, 4, and 5 times per day, 6 or more times per day, or choose not to answer). If they answered questions 6, 8, 10, 12, 16, and 18 less

than once per day, they answered questions 7, 9, 11, 13, 17, and 19 on a scale of six options (a couple of times per week, month, or year, almost never, never, or choose not to answer). Participants' responses to questions 20–22 were recorded over four frequency options (none, almost none, some, a lot, or choose not to answer). sHEI scores were calculated as previously described [30], indicating overall adherence to healthy eating patterns and individual food group scores. In brief, sHEI scores ranged from 0 (non-adherence) to 100 (perfect adherence) based on how often participants consumed foods or nutrients in questions 1, 2, 4, 5, 6, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, and 22, as well as sex, in which the scores of some question differed between males and females. The total score of sHEI is the sum of the scores for total fruits (score ranges 0–5), whole fruits (score ranges 0–5), total vegetables (score ranges 0–5), greens and beans (score ranges 0–5), whole grains (score ranges 0–10), dairy (score ranges 0–10), total protein (score ranges 0–5), seafood and plant (score ranges 0–5), fatty acids (score ranges 0–10), refined grains (score ranges 0–10), sodium (score ranges 0–10), added sugar (score ranges 0–10), and saturated fat (score ranges 0–10) consumption. The data of any participants who chose not to answer any question, which may have affected the calculation of the sHEI, were not included in the analysis.

The data obtained were analyzed using the Statistical Package SPSS version 25 and presented using descriptive statistics such as frequencies and percentages for categorical variables and means and standard deviations for quantitative variables. The normality of each score variable was checked using the Kolmogorov–Smirnov test. All variables were normally distributed. Sex differences were determined in quantitative variables using the independent sample t-test and in categorical variables using the chi-squared test. Univariate linear regression analysis was performed to examine the association between sHEI, PSS-10, and EE. The confounders in the model were sex, age,, academic major, residence, smoking, marital status, sports, and BMI. The PS and EE scores were independent variables in the analysis, whereas sHEI was dependent. Significance was set at an alpha level of 0.05. This study followed the reporting guidelines of the STROBE checklist for cross-sectional study to ensure comprehensive reporting.

Results

In total, 501 participants consented to participate in the study, and 67 were excluded based on the exclusion criteria or because of incomplete responses. The remaining 434 participants included in the study completed all four sections. The mean age of the students was 21.7±3.0 years, with female students 22.1±3.2 years being significantly older than male students 21.3±2.7 years (P=0.009) (Table 1). Medical school was the faculty of study of the highest percentage major of male students (24.5%), while literature was the major for the highest percentage of female students (30.6%; P<0.001). Most students of both sexes lived with their families (82.3%), but 13.9% of male students lived independently, compared with 5% of female students (P=0.006). Almost 5.0% of students of both sexes lived in student accommodations, and 5.0% of female students lived with their relatives, compared with 2.0% of male students. Female students were more inactive (33.9%) and engaged in light physical activities (47.7%) than male students (26.4% and 36.1%, respectively) (P<0.001). In contrast, male students had higher levels of moderate- and vigorous-intensity activities than did female students (25.9% and 11.6% vs. 13.8% and 4.6%, respectively) (P<0.001). Although 91.0% of the students were single, more females (11.9%) than males (6.0%; P=0.04) were married. A higher average BMI was noted in male (24.8±6.1 kg/m^2) than in female students (22.5±5.8 kg/m^2). PS scores were higher in female than in male students (21.6±6.3 vs. 19.6±6.0; P<0.001). Female students had significantly higher sHEI scores (45.8±9.2) than did male students (39.9±9.2, P<0.001).

The association between PS and sHEI is presented in Table 2. The proportions of participants with low, moderate, and high PS scores were 11.3%, 72.0%, and 16.7%, respectively. sHEI was significantly different across the three levels of PS (P=0.001); students with moderate PS had the highest sHEI score (43.7±9.3), followed by those with low PS (41.5±9.5; P=0.10) and high PS (40.3±10.5; P<0.001). In addition, the scores for consumption of fruit juice (P=0.002), total fruit (P<0.001), total vegetable (P=0.03), greens and beans (P<0.001), whole grains (P=0.009), and seafood and plant protein (P=0.001) were significantly higher in students with moderate PS than in those with low or high PS.

Table 3 shows the association between EE and sHEI. EE was significantly associated with sHEI (P=0.04), where high emotional eaters had the lowest sHEI scores (41.7±10.7) and non-emotional eaters had the highest sHEI scores (44.3±10.8). Fruit juice and total fruit consumption scores differed significantly among the four types of emotional eaters (P=0.01 and <0.001, respectively). Low emotional eaters had higher fruit juice and total fruit consumption scores (2.0±1.9 and 3.2±1.9, respectively) than did moderate emotional eaters (1.9±1.9; P=0.95 and 3.0±2.0; P=0.67, respectively), non-emotional eaters (1.2±1.6; P=0.03 and 2.2±1.9; P=0.009, respectively), and high emotional eaters (1.2±1.7; P=0.03 and 2.3±2.1; P=0.004, respectively). In addition, the scores for consumption of added sugar (P=0.02), and saturated fatty acids (P=0.03) were significantly higher in non-emotional eater students than in those with low, moderate, or high emotional eating.

Table 1 Study participant characteristics

Variables	Total (*n* = 434)	Male (*n* = 216)	Female (*n* = 218)	*P* value
Age (years)	21.7 ± 3.0	21.3 ± 2.7	22.1 ± 3.2	0.009
Smoking				
Non-smoker	344 (79.3)	149 (69.0)	195 (89.4)	< 0.001
Smoker	63 (14.5)	47 (21.8)	16 (7.3)	
Past smoker	27 (6.2)	20 (9.3)	7 (3.2)	
Diet				
No	331 (76.3)	165 (76.4)	166 (76.1)	1.00
Yes	103 (23.7)	51 (23.6)	52 (23.9)	
Academic year				
First year	106 (24.4)	58 (26.9)	48 (22.0)	0.13
Second year	107 (24.7)	60 (27.8)	47 (21.6)	
Third year	79 (18.2)	37 (17.1)	42 (19.3)	
Last year	142 (32.7)	61 (28.2)	81 (37.2)	
Academic major				
Preparation year	59 (13.5)	34 (15.7)	25 (11.6)	< 0.001
Literature	115 (26.4)	49 (23.1)	66 (30.6)	
Economic and business	48 (11.0)	16 (7.5)	32 (14.8)	
Human sciences and design	34 (7.8)	2 (0.9)	32 (14.6)	
Medical schools	70 (16.1)	52 (24.5)	18 (8.3)	
Engineering	39 (8.9)	33 (15.6)	6 (2.8)	
Sciences	69 (15.8)	30 (14.2)	39 (18.1)	
Household income				
Less than 5000 SAR	49 (11.3)	26 (12.0)	23 (10.6)	0.05
From 5000 to less than 10,000 SAR	131 (30.2)	56 (25.9)	75 (34.4)	
From 10,000 to less than 20,000 SAR	153 (35.3)	73 (33.8)	80 (36.7)	
More than 20,000 SAR	101 (23.3)	61 (28.2)	40 (18.3)	
Residence				
Independent	41 (9.4)	30 (13.9)	11 (5.0)	0.006
With family	357 (82.3)	172 (79.6)	185 (84.9)	
With relatives	15 (3.5)	4 (1.9)	11 (5.0)	
Student accommodation	21 (4.8)	10 (4.6)	11 (5.0)	
Physical activity				
inactive	131 (30.2)	57 (26.4)	74 (33.9)	< 0.001
Low physical activity	182 (41.9)	78 (36.1)	104 (47.7)	
Moderate physical activity	86 (19.8)	56 (25.9)	30 (13.8)	
High physical activity	35 (8.1)	25 (11.6)	10 (4.6)	
Marital status				
Single	395 (91.0)	203 (94.0)	192 (88.1)	0.04
Married	39 (9.0)	13 (6.0)	26 (11.9)	
Parttime work				
No	361 (83.2)	173 (80.1)	188 (86.2)	0.09
Yes	73 (16.8)	43 (19.9)	30 (13.8)	
Body mass index (kg/m^2)	23.7 ± 6.1	24.8 ± 6.1	22.5 ± 5.8	< 0.001
Perceived stress score	20.6 ± 6.2	19.6 ± 6.0	21.6 ± 6.3	< 0.001
Emotional eating score	13.3 ± 6.0	13.3 ± 5.9	13.3 ± 6.1	0.97
Healthy Eating Index score	42.8 ± 9.6	39.9 ± 9.2	45.8 ± 9.2	< 0.001

[a]Data are presented as frequency and percentage for categorical variables and mean and standard deviation for continuous variables

[b]Differences between sexes are calculated using the chi-squared test for categorical variables and independent t-test for continuous variables

SAR: Saudi Riyals

Table 2 Association between perceived stress and healthy eating index among study participants

Diet	Low perceived stress (*n* = 49)	Moderate perceived stress (*n* = 312)	High Perceived Stress (*n* = 73)	*P* value
sHEI score	41.5 ± 9.5	43.7 ± 9.3	40.3 ± 10.5	0.001
Fruit juice score	1.5 ± 1.7	2.0 ± 1.9	1.1 ± 1.6	0.002
Total fruit score	3.1 ± 1.7	3.2 ± 2.0	1.8 ± 1.9	< 0.001
Total vegetables score	2.5 ± 0.7	2.5 ± 0.7	2.3 ± 0.8	0.03
Green and bean score	3.3 ± 2.3	3.9 ± 2.0	2.8 ± 2.4	< 0.001
Whole green score	3.3 ± 1.9	3.6 ± 2.1	3.3 ± 2.4	0.009
Dairy score	4.5 ± 1.4	4.5 ± 1.4	4.3 ± 1.2	0.17
Total protein score	4.6 ± 0.4	4.7 ± 0.3	4.7 ± 0.3	0.15
Seafood plant protein score	2.1 ± 1.5	2.4 ± 1.6	1.7 ± 1.2	0.001
Fatty acid score	3.6 ± 1.2	3.6 ± 1.2	3.8 ± 1.2	0.69
Refined grain score	3.7 ± 2.4	4.1 ± 2.9	4 ± 2.7	0.54
Sodium score	3.8 ± 2.0	4.2 ± 1.9	4 ± 2.2	0.18
Add sugar score	2.1 ± 3.1	1.9 ± 2.8	2.6 ± 3.6	0.39
SFA score (Saturated fatty acid)	2.8 ± 1.4	2.8 ± 1.5	3.3 ± 1.4	0.24

[a]Data presented as mean and standard deviation

[b]*P* values are calculated using linear regression. The values are adjusted for sex, age, faculty of study, residence, smoking, marital status, sport, and body mass index

The associations between demographic characteristics and health measures, including BMI and physical activity, PS, EE, and sHEI, are presented in Table 4. Academic major was associated with PS ($P=0.006$) and EE ($p=0.04$) students studying economic and business had higher PS and EE scores than students in other majors. In addition, PS was associated with physical activity ($P<0.001$). Inactive students had the highest PS score (22.5±6.7), followed by those who were engaged in low activity (20.2±6.1; $P<0.001$), moderate-intensity physical activity (19.2±4.5; $P<0.001$), and high-intensity physical activity (18.7±6.9; $P=0.01$). Also, association was observed between physical activity and sHEI ($P=0.001$), where inactive (41.1±10.4) had lower sHEI scores and high-intensity physical activity (45.9±8.4) had higher sHEI scores. Age is another factor was associated with sHEI, younger students (43.6±9.4; $P=0.01$) had higher sHEI scores than their older counterparts (41.3±10.0). There was a trend for increasing EE score with increasing BMI ($P<0.001$); students who were underweight had the lowest EE score (10.4±5.0), followed by those with normal weight (12.7±5.6; $P=0.003$), those who were overweight (15.1±6.1; $P<0.001$), and those with obesity (16.5±6.1; $P<0.001$).

Discussion

This cross-sectional study was conducted to investigate the association of PS and EE with adherence to HEI using sHEI in a representative sample of college students from

Table 3 Association between emotional eating and healthy eating index among study participants

Diet	Non-emotional eater (*n* = 36)	Low emotional eater (*n* = 123)	Moderate emotional eater (*n* = 220)	High emotional eater (*n* = 55)	*P* value
sHEI score	44.3 ± 10.8	44.1 ± 9.2	42.3 ± 9.3	41.7 ± 10.7	0.04
Fruit juice score	1.2 ± 1.6	2 ± 1.9	1.9 ± 1.9	1.2 ± 1.7	0.01
Total fruit score	2.2 ± 1.9	3.2 ± 1.9	3.0 ± 2.0	2.3 ± 2.1	< 0.001
Total vegetables score	2.4 ± 0.7	2.6 ± 0.7	2.5 ± 0.7	2.4 ± 0.7	0.19
Green bean score	3.4 ± 2.3	3.8 ± 2.1	3.6 ± 2.1	3.5 ± 2.2	0.42
Whole green score	3.7 ± 2.2	3.6 ± 2	3.4 ± 2.1	3.6 ± 2.2	0.66
Dairy score	4.4 ± 1.3	4.6 ± 1.4	4.5 ± 1.4	4.4 ± 1.3	0.46
Total protein score	4.6 ± 0.4	4.7 ± 0.3	4.7 ± 0.3	4.7 ± 0.3	0.53
Seafood plant protein score	1.9 ± 1.4	2.3 ± 1.6	2.3 ± 1.6	2.4 ± 1.5	0.44
Fatty acid score	3.7 ± 1.3	3.6 ± 1.1	3.7 ± 1.1	3.8 ± 1.2	0.77
Refined grain score	4.6 ± 3.3	4.3 ± 2.9	3.9 ± 2.7	3.7 ± 2.6	0.11
Sodium score	4.4 ± 1.9	4.2 ± 1.9	4.1 ± 2.0	3.8 ± 2.1	0.79
Add sugar score	3.3 ± 3.1	2.1 ± 3.0	1.7 ± 2.9	2.2 ± 3.1	0.02
SFA score (Saturated fatty acid)	3.6 ± 1.5	2.9 ± 1.4	2.8 ± 1.4	3.2 ± 1.7	0.03

[a]Data presented as mean and standard deviation

[b]*P* values are calculated using linear regression. The values are adjusted for sex, age, academic major, residence, smoking, marital status, sport, and body mass index

King Abdulaziz University. Additionally, we investigated the association of demographic data and health measures such as BMI and physical activity with PS, EE, and sHEI. Our findings showed that moderate PS was associated with better sHEI scores, as well as increased fruit, vegetable, greens and bean, whole grain, and seafood and plant protein consumption scores. EE was associated with sHEI, with non-emotional eaters having higher sHEI scores than other emotional groups. Low EE levels were associated with increased fruit intake. However, non-emotional eaters had higher score in the added sugar and saturated fatty acids than other emotional eating groups. Academic major was associated with PS and EE scores. High physical activity was inversely associated with PS levels and positively with sHEI. Younger college students had higher sHEI scores. A linear trend was observed between BMI and EE.

The association between PS and HEI has been examined in various populations and different age groups. Our findings are in line with those of a previous study, where high PS was associated with low alternate HE1 2010 scores, which comprises 11 food groups with scores ranging from 0 to 10 that were summed to generate the total score in Puerto Rican adults [33]. A meta-analysis of 3,471 women of reproductive age revealed an inverse association between stress and diet quality [34], which were assessed using diverse indices, including alternate healthy and healthy eating indexes [34]. Various studies have reported that PS influences the intake of some specific foods. In line with our findings, a study conducted in Riyadh showed that PS was associated with low fruit and vegetable intake among medical college students [10] and college students in the UK [35] and among adults [34, 36, 37]. However, PS was associated with an increased intake of salad/raw vegetables and cooked meals among female college students in the United Arab Emirates (UAE) [25]. The difference between our study and the UAE study is that the frequency of consumption in our study ranged between less than once a day to 6 times a day, while the UAE study had a broader range from never, monthly, and weekly to several times per day. Another point is that adjustments for covariates were performed in this study but not in the UAE study. Inter-individual variation in response to PS and different methods of collecting dietary intake data could explain the differences in findings.

Our study showed that students with high PS levels had low consumption of greens and beans, whole grains, seafood, and plant proteins. These results are consistent with those of a previous study that found that consumption of Mediterranean diet components such as whole grains, dark green leafy vegetables, fish, and beans negatively correlated with total PS score among adults aged > 18 years [38]. A Puerto Rican adult study showed that high PS is associated with low dietary fiber and vegetable protein intake [33]. A meta-analysis of women of reproductive age also demonstrated that stress was associated with low fish intake [34]. In the UK, male college students' consumption of fish/seafood was negatively associated with depressive symptoms but not PS [35]. However, among UAE female college students, neither PS nor depressive symptoms were associated with fish/seafood and cereal/cereal product intakes [25]. This shows that outcomes may differ by region.

Evidence from previous studies suggests that consumption of a high-quality diet is associated with better psychiatric health in terms of stress, depression,

Table 4 Association between sociodemographic variables and perceived stress, emotional eating, and healthy eating index among study participants

Sociodemographic variables	Perceived stress	*P* value	Emotional eating	*P* value	Short healthy eating index	*P* value
Age (years)						
18–22	20.7 ± 6.5	0.34	13.2 ± 6.1	0.50	43.6 ± 9.4	0.01
23–29	20.2 ± 5.5		13.5 ± 5.9		41.3 ± 10.0	
Smoking						
Non-smoker	20.7 ± 6.3	0.21	13.2 ± 6.1	0.65	42.8 ± 9.8	0.14
Smoker	19.9 ± 5.3		13.9 ± 5.7		43.9 ± 8.8	
Past smoker	21.1 ± 6.7		12.9 ± 5.5		41.2 ± 9.2	
Academic year						
First year	21.1 ± 6.8	0.41	12.9 ± 6.5	0.38	42.4 ± 9.8	0.43
Second year	20.1 ± 6.3		14.1 ± 5.6		43.2 ± 9.2	
Third year	20.5 ± 6.2		13.0 ± 5.9		43.1 ± 8.8	
Last year	20.7 ± 5.6		13.3 ± 5.9		42.9 ± 10.2	
Academic major						
Preparation year	22.7 ± 7.1	0.006	13.8 ± 5.9	0.04	40.8 ± 9.3	0.11
Literature	19.7 ± 5.4		13.1 ± 5.9		44.5 ± 9.0	
Economic and business	23.0 ± 6.4		15.2 ± 5.9		42.4 ± 9.6	
Human sciences and design	19.5 ± 5.3		10.7 ± 4.9		49.0 ± 9.3	
Medical schools	19.3 ± 6.3		14.1 ± 5.7		42.1 ± 8.9	
Engineering	20.7 ± 4.8		12.7 ± 5.5		40.7 ± 9.2	
Sciences	20.9 ± 6.8		13.2 ± 6.8		42.6 ± 10.2	
Household income						
Less than 5000 SAR	21.3 ± 6.8	0.06	13.0 ± 6.4	0.37	42.5 ± 8.9	0.28
From 5000 to less than 10,000 SAR	21.0 ± 5.4		13.2 ± 5.5		44.4 ± 9.5	
From 10,000 to less than 20,000 SAR	19.6 ± 6.3		13.3 ± 6.1		42.5 ± 9.5	
More than 20,000 SAR	21.1 ± 6.6		13.6 ± 6.3		41.6 ± 10.0	
Residence						
Independent	19.0 ± 5.5	0.31	12.8 ± 5.5	0.75	40.9 ± 9.4	0.68
With family	20.9 ± 6.4		13.3 ± 6.1		42.7 ± 9.7	
With relatives	17.8 ± 3.2		13.8 ± 5.2		46.4 ± 7.5	
Student accommodation	19.9 ± 4.6		14.1 ± 5.3		46.9 ± 8.7	
Physical activity						
inactive	22.5 ± 6.7	< 0.001	13.3 ± 6.6	0.59	41.1 ± 10.4	0.001
Low physical activity	20.2 ± 6.1		13.1 ± 5.4		43.3 ± 8.6	
Moderate physical activity	19.2 ± 4.5		13.8 ± 6.1		43.8 ± 10.2	
High physical activity	18.7 ± 6.9		13.8 ± 6.4		45.9 ± 8.4	
Parttime work						
No	20.8 ± 6.5	0.63	13.3 ± 6.1	0.94	42.7 ± 9.7	0.68
Yes	19.6 ± 4.4		13.2 ± 5.6		43.9 ± 8.9	
Body mass index						
Underweight	21.0 ± 6.1	0.11	10.4 ± 5.0	< 0.001	43.8 ± 9.2	0.34
Normal weight	20.1 ± 5.9		12.7 ± 5.6		43.0 ± 9.8	
Overweight	20.4 ± 6.1		15.1 ± 6.1		43.6 ± 10.0	
Obese	22.0 ± 7.4		16.5 ± 6.1		40.0 ± 8.4	

[a]Data presented as mean and standard deviation

[b]*P* values are calculated using linear regression. The values are adjusted for sex, age, academic year, household income, smoking, academic major, residence, marital status, sport, part-time job, and body mass index depending on the test fixed factor

SAR: Saudi Riyals

and anxiety. Certain nutrients and foods play a role in the biological processes underlying stress [39]. For example, omega-3 (docosahexaenoic acid) regulates cortisol levels in response to an acute stress test [40]. Moreover, supplementation with omega-3 can impede hypothalamic-pituitary-adrenal glands axis hyperactivity, which results in the prevention of chronic stress-induced increase in plasma corticosterone levels [41, 42] and chronic social defeat stress-induced emotional and neuronal impairments [42]. Omega-3 and dietary fiber play

anti-inflammatory roles in the human body, including the brain, and studies have shown that individuals with stress or depression have elevated inflammation markers in their brains and bodies [43]. In addition, some vitamins and minerals, such as magnesium, zinc, vitamin C, folic acid, and vitamin B12, play a role in neurotransmitter production, suggesting an improvement in stress and depression symptoms [44]. Adopting a nutritious, well-balanced diet is a beneficial approach to stress management to improve brain functioning [45].

Findings from the current study revealed that EE was associated with sHEI score. Low EE levels were associated with increased fruit intake. In line with our findings previous studies have shown that EE is negatively associated with HEI [46] and positively associated with unhealthy eating habits [47, 48] among adolescents. Additionally, adults with abdominal obesity, identified as emotional or very emotional eaters, had a low intake of healthy diets (including fruits, vegetables, olive oil, oilseeds, legumes, fish, and seafood) [49]. However, a study among first-year college students did not show an association between emotion and fruit intake [50]. These results confirmed that EE was associated with unhealthy eating patterns among different age groups. One possible explanation of this association is affect regulation models, where individuals feeling negative emotion, i.e. PS, tend to lose control of unhealthy eating to avoid, or escape, these negative emotions [51]. However, non-emotional eaters had high intake of added sugar and saturated fatty acids in our study, which differs from a previous study that found positive association between EE and desserts, sweets, sugar, and fast food [49]. The differences can explained by using different methods of dietary intake assessment and dietary habits may vary between different population.

Academic major is one of sociodemographic factors that showed association with PS as well as EE in our study. A previous study showed that percentage of PS was higher among medical college students than non-medical college, but the difference was not significant [52]. Similar to our physical activity results, US college students who achieved the recommendations for vigorous physical activity reported a lower PS level than did students who did not achieve these recommendations [53]. Another study of 4,189 German college students showed that the lowest PS score was observed among students with high physical activity levels and low sedentary time, compared with those in other groups [54]. Even during the coronavirus disease (COVID-19) pandemic, meeting physical activity recommendations was protective against PS among the older population [55]. This may be because physical activity affects brain regulation on the hypothalamic-pituitary-adrenal axis, stimulation of neurogenic processes, and alteration of the inflammatory system [56, 57], and reduces cortisol levels during psychosocial stress, thus reducing the effect of stress on health [58]. Furthermore, physical activity positively associated with sHEI score in our study. This finding is comparable to those of studies conducted in Dutch older adults [59] and Polish girls [60], where being active associated with high intake of fruit and vegetables [59, 60], and more healthy dietary habits [61]. The explanation is that following healthy dietary pattern may encouraged adopting more healthier lifestyle such as physical activity and vice versa.

Age was found to influence adherence to a healthy dietary pattern in the present study. In contrast with our findings, adherence to the Mediterranean diet, which is characterized by a high intake of vegetables, fruits, legumes, fish and seafood, nuts and cereals, and unsaturated fatty acids (found in olive oil) [62], was higher among older Gulf participants than among younger participants [63]. Another study also showed that younger Saudi college students from Jeddah consumed snacks and fast food more conveniently than older college students [64]. The explanation of our findings is that the early academic years are associated with low stress levels [65].

Another significant finding confirmed was the positive association between EE and BMI, which is in line with studies conducted on female college students in Ghana [66] and adults during the COVID-19 pandemic [67, 68]. As we mentioned previously in our discussion, negative emotion is associated with loss of control and eating disorders which are associated with increased body weight [22, 51]. However, a study conducted among Turkish obese participants did not observe association between obesity classification and EE scale [69]. The differences colud be explained by a small sample size in the Turkish study ($n=145$) and the fact that it only included obese participants, whereas our study included all BMI classification.

This study has some limitations. Given the cross-sectional design of the study, we could not infer causality because a temporal sequence could not be established. Self-reported questionnaires may introduce reporting errors, including social-desirability bias (participants may misreport by faking good or bad responses), recall bias, and may not reflect the long-term period. This bias could influence the associations observed in the study. The self-reported measures used to assess physical activity and BMI are another limitation. However, this study also has some strengths. We used validated questionnaires in addition to calculating the HEI, which was validated using a short survey. Possible confounders were controlled for in the analysis. The study size was appropriate based on the sample size calculations.

Conclusions

This study revealed an association between PS and sHEI among college students. Students with high PS had low HEI scores and low intakes of fruits, vegetables, green beans, whole grains, and seafood plant protein. Moreover, non-emotional eater students had high HEI scors, and low EE students had high fruit intake. Academic major was one of sociodemographic factors that affect PS and EE levels. Physical activity was a protective factor against PS and associated with better adherence to HEI. Obesity and overweight were associated with EE. Therefore, eating highly palatable food and engaging in physical activities may have a favorable effect on reducing stress among college students; moreover, weight reduction may have a positive impact on EE. A replication of current findings is warranted in studies with large sample sizes.

Author contributions

I.M.S. contributed to conceptualization, M.A.A. and I.M.S. contributed to methodology, and collected data, M.A.A. run statistical analysis, I.M.S. validated analysis, M.A.A. wrote—original draft preparation, I.M.S. wrote—review and edited manuscript. All authors have read and agreed to the published version of the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The study was approved by the Biomedical Ethics Research Committee of King Abdulaziz University (247 – 22). Before completing the questionnaire, the students were required to review the objectives of the study and provide written informed consent for participation.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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