

# FOOD AND MENTAL HEALTH: RELATIONSHIP BETWEEN FOOD AND PERCEIVED STRESS AND DEPRESSIVE SYMPTOMS AMONG UNIVERSITY STUDENTS IN THE UNITED KINGDOM

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## SUMMARY

**Aims:** The current study assessed, by university and sex, the association between nutritional behaviour (twelve independent variables), and stress and depressive symptoms (dependent variables) in a sample from three UK countries.

**Methods:** A cross-sectional survey was undertaken among undergraduates enrolled across seven universities in England, Wales and Northern Ireland (N = 3,706). Self-administered questionnaires included a 12-item food frequency questionnaire, Cohen's Perceived Stress Scale and modified Beck Depression Inventory. Sex and university comparisons were undertaken. Univariable and multivariable regression analyses were computed for each of the two outcomes – perceived stress and depressive symptoms.

**Results:** The frequencies of consuming of the various food groups differed by university and sex, as did depressive symptoms and perceived stress. Multivariable regression analyses indicated that consuming 'unhealthy' foods (e.g. sweets, cookies, snacks, fast food) was significantly positively associated with perceived stress (females only) and depressive symptoms (both males and females). Conversely, consuming 'healthy' foods (e.g. fresh fruits, salads, cooked vegetables) was significantly negatively associated with perceived stress and depressive symptoms scores for both sexes. There was significant negative association between consuming fish/sea food and depressive symptoms among males only. For males and for females, consuming lemonade/soft drinks, meat/sausage products, dairy/dairy products, and cereal/cereal products were not associated with either perceived stress or depressive symptoms.

**Conclusions:** The associations between consuming 'unhealthy' foods and higher depressive symptoms and perceived stress among male and female students as well as the associations between consuming 'healthy' foods and lower depressive symptoms and perceived stress among male and female students in three UK countries suggest that interventions to reduce depressive symptoms and stress among students could also result in the consumption of healthier foods and/or vice versa.

**Key words:** self reported, food consumption, dietary habits, depression, stress, university students, college health

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## INTRODUCTION

There are concerns about the rates of depression, stress and other psychiatric symptoms among university students, regardless of their academic disciplines (1–3). Entry to college, whilst exciting, can be stressful and taxing for many young adults, and depressive symptoms and stress are health problems among college students across the globe (4–7).

The sources of stress for university/college student are numerous. These include: achieving academic success despite financial constraints (8); adapting to changes in academic workloads, support networks and new environments; psychosocial changes in one's social and support systems (9); and being away from family home, with increased responsibility, in a period that could begin experimentation with drugs and other risk-taking behaviours (9). In addition, some disciplines e.g. medical courses could be more 'stressful' (10). Likewise, features of university accommodation

such as residence hall status (e.g. conflict with a roommate) or aspects related to faculty/staff (e.g. differences with tutors/lecturers) can be important predictors of stress (11).

Many young adults experience psychiatric episodes and mental illnesses during university time (12). The burdens facing university students were positively associated with higher depression, not only by mediation via perceived stress but also directly (2). In turn, stress has direct and indirect adverse effects on health, and one way stress may affect health is by influencing the foods people select to eat (13). At the general population level, there seems to be a collective effect of diet on mood (14), and regardless of the underlying reason of the mood disorder, the way we eat affects the way we feel (15) and possibly vice versa. Many examples illustrate such food-mood relationships.

**Carbohydrates and Sugars:** carbohydrate consumption seems to alleviate depressive moods (16), and this has been viewed as part of the link for developing obesity (17). For sugars, when

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stressed, students with increased appetite selected significantly more types of sweet foods (e.g. desserts, chocolate/candy bars, candy, ice cream) (18). A diet high in refined carbohydrates and sugars is common in depressive illness (19).

*Healthy Eating Choices and Fat Content of Foods:* a study of stress and appetite and eating habits of students found that under normal conditions, 80% of students made healthy eating choices, however, only 33% ate healthy when stressed (18). Equally, stress not only increased food consumption in certain individuals but also shifted their food choices from lower fat to higher fat foods (13). Likewise, research over six years of the diet and lifestyle of volunteers free of depression found that participants with high consumption of trans-fats (pastries and fast food) had up to 48% increase in the risk of depression when compared to participants who did not consume these fats (20).

*Fish and Meat:* omega-3 fatty acids (dietary consumption of fish) might be linked to depression, with research reporting a beneficial association between fish consumption and depression (21). Conversely, others did not support such relations (22), and the vegetarian diet seemed not to adversely affect mood (despite low intake of omega-3 fatty acids) (23). In connection to meat, a study showed lower odds of depression with high meat consumption (22), while others found that depressive symptoms were associated with less frequent meat consumption (24).

*'Whole Foods', Fruits and Vegetables:* the role of nutrition in the management of depression reported that the production of neurotransmitters requires nutrients (amino acids, minerals and B vitamins) found in whole grains, eggs, yogurt, beans, green leaf vegetables, and corn (19). Individuals with the highest intake of 'whole food' were least likely to be depressed compared to those with the lowest adherence to such diet (25), and diets rich in processed food may increase the risk of depression (19). For fruits and vegetables, depressive symptoms were associated with less frequent consumption of fruits/vegetables (24). Dietary fibers are associated with higher alertness and less perceived stress (26), and nutrition for depressed patients should include fruit, vegetables and wholegrains (27).

The literature also suggested that there are sex differences. Research found that only in females, perceived stress was associated with more frequent consumption of sweets/fast foods and less frequent consumption of fruits/vegetables (24). Indeed, the effect of stress level on food choice seems different for men and women (28).

We explored the links between nutritional habits and mental health indicators at seven universities in the United Kingdom. Apart from a few exceptions, while most studies focused on data from one university across several countries or within one country (29, 30), less studies examined the same question (associations between mental health indicators and nutrition) across large samples of diverse students at different universities of one nation. This is despite calls that research on nutrition and on the correlation between depression and food consumption should be conducted across diverse student populations (31). In addition, others (24) reported that single-country studies are rarely directly comparable to one another due to the differences in food consumption measures or mental health indicators. The current study bridged these knowledge gaps and surveyed students at seven universities in the United Kingdom, employing the same food consumption measures and the same mental health indicators

across the universities to assess the associations between mental health indicators and nutrition. If evidence suggests that particular nutritional habits are associated with stress and/or depressive symptoms, then programmes and interventions addressing mental health may also be associated with the consumption of healthier foods and/or vice versa.

The current survey assessed the associations between mental health indicators and nutritional habits of a representative sample of undergraduate students (N = 3,706) across 7 universities in the UK (2007–2008). We explored the links between self-reported perceived stress and depressive symptoms on the one hand, and the food habits in terms of the usual consumption of 12 selected food groups on the other. The three objectives were to:

- describe the food consumption behaviour and two mental health indicators (perceived stress and depressive symptoms) of students by university and by sex;
- assess the associations between food consumption behaviour (individual food groups separately) and two mental health indicators by sex (univariable analysis);
- assess the associations between food consumption behaviour (all food groups together) and two mental health indicators by sex (multivariable analysis).

## MATERIALS AND METHODS

### Sample and Data Collection

In agreement with other student health and well-being studies across various countries (8, 29–35), no monetary or course credit incentives were provided for participation. Ethical approval was obtained at each participating university, and data were collected simultaneously at 7 universities in Northern Ireland, Wales and England. Each questionnaire included participant information outlining the research objectives. Data were confidential and protected, participation was voluntary and anonymous, and students were informed that by completing the questionnaire, they consent to participate in the study. For quality assurance, data were computer entered at one site to minimise potential data entry errors. Based on the number of returned questionnaires, the response rate was ≈80%.

### Health and Well-being Questionnaire

*Assessment of Dietary Intake:* Students self-reported their nutritional habits in a food frequency questionnaire (12 indicator variables) that measured their consumption of sweets, cakes/cookies, snacks and fast/canned food, fresh fruits, raw and cooked vegetables and salads, meat and fish, milk products, and cereals (Table 1). In line with others, this instrument was developed to include food groups that are critical for studies of dietary habits, and the face and content validity of the tool were established by grounding the questionnaire on wide literature review. The introductory question, "How often do you eat the following foods?" queried students about the frequency of their usual consumption of each food group separately (5-point scale: 'several times a day', 'daily', 'several times a week', '1–4 times a month', and 'never'). No formal test of validity was undertaken, but the questionnaire was very similar to other food frequency questionnaires that had

been validated (36, 37). In addition, the authors agreed on the high face validity of the food frequency questionnaire that the study employed.

*Stress and Depressive Symptoms measures:* Perceived stress was assessed with Cohen's Perceived Stress Scale (PSS-4 items) that measured the extent to which participants felt life situations to be stressful (38). The four items assessed how unpredictable, uncontrollable and overloaded respondents find their lives (5-point Likert scale, 1 = 'Never', 5 = 'Very Often'). We then recoded the responses across the four items, in such a way that for all answers, the lowest code 1 'Never' = positive mental state; whereas the highest code 5 = negative mental state. Each student's total Perceived Stress Score was obtained by summing their responses to all 4 items. Depressive symptoms were assessed by a Modification of the Beck Depression Inventory (MBDI) (39, 40), which is a single statement per symptom (six-point Likert scale, 0 = 'Never', 5 = 'Almost Always') measuring its frequency in the last four weeks. For each participant, MBDI score was the sum of the participant's responses to all 20 items. The scale had excellent internal consistency, as in our sample of students in Northern Ireland, Wales and England, Cronbach's alpha of MBDI was 0.88, 0.87, and 0.89, respectively (0.88 for the whole sample).

## Data Analysis

For descriptions, we computed the means of the consumption frequency of the various food groups as well as mental health indicators by country and sex. Perceived Stress Score variable (PSS) was generated by dividing by 4 the sum of the responses to all 4 items of Cohen's Perceived Stress Scale (5-point Likert scale response format, 1 = 'Never', 5 = 'Very Often'). In addition, we computed a Modification of the Beck Depression Inventory (MBDI) score by summing up the responses to all 20 items that measure this mental health indicator (Table 1). For the univariable analysis, we assessed associations between consumption of each food group individually and both mental health indicators using linear regression stratified by sex and adjusted for university. For the multivariable analysis, we used multiple linear regressions to assess associations between consumption of all food groups together and both mental health indicators, stratified by sex and adjusted for university. Hence, we were able to control for the effects of the other food groups while assessing the associations of any given food group.

## RESULTS

### Characteristics of the Sample

The current analysis employed data comprising 3,706 students (765 males, 2,699 females, 242 missing sex; M age 24.9 years  $\pm$  SD 8.6 years) from 7 universities in three countries of the UK: England – University of Gloucestershire (N = 970, 26.2% of the sample, M age = 23.36 years), Bath Spa University (N = 485, 13.1%, M age = 22.23), Oxford Brookes University (N = 208, 5.6%, M age = 31.63), University of Chester (N = 993, 26.8%, M age = 26.02), Plymouth University (N = 169, 4.6%, M age = 24.63); Wales – Swansea University (N = 406, 11.0%, M age = 25); and the Republic of Northern Ireland – University of Ulster

(N = 475, 12.8%, M age = 25.19). The sample comprised first year undergraduates (42.6%, N = 1,491), second year undergraduates (31.3%, N = 1,095), third year undergraduates (18.7%, N = 655), and a smaller proportion of  $\geq$  4th year students (7.5%, N = 262).

Within each of the universities, the sex distribution of the participating students varied by university, e.g. Chester (86.9% females), Gloucester (56.4%), Ulster (91.8%), Swansea (92.2%), Plymouth (63.9%), Oxford Brookes (89.2%), and Bath Spa (77.4%), reflecting the nature of the enrolled student populations at the Faculties/Schools where data was collected, being Schools of Health and Social Care/Nursing/Sports and Exercise etc.).

### Food Consumption Behaviour and Mental Health Indicators by University and by Sex

Across the universities, consuming sweets was more common in females, and conversely, consuming fast/canned foods was more common in males (Table 1). Females generally consumed cake/cookies more commonly than males (except at Ulster, Swansea, Plymouth, and Bath Spa). Females also consumed fresh fruits more commonly (except at Ulster), and also consumed salad/raw vegetables and cereal/cereal products more commonly than males. Conversely, consuming lemonade/soft drinks, meat/sausage products, fish/seafood was more common in males as well as eating dairy/dairy products which was more common in males (except at Plymouth and Bath Spa). For the mental health indicators, females generally exhibited higher perceived stress, and had higher depressive symptoms scores (except at Gloucestershire and Ulster). There were differences in perceived stress scores and depressive symptoms levels across the universities.

### Associations between Food Consumption Behaviour (Each Food Group Individually) and Mental Health Indicators by Sex (Univariable Analysis)

The univariable analysis suggested two features (Table 2). First, generally, significant associations (between more of the different food groups and perceived stress and depressive symptoms) were more evident for females (perceived stress – 8 significant food groups for females vs. 2 food groups for males; depressive symptoms – 7 significant food groups for females vs. 5 food groups for males). Secondly, for females, the significant associations between food groups and each of perceived stress and depressive symptoms were nearly equal (8 associations for perceived stress, 7 associations for depressive symptoms). However, for males, the significant associations between food groups and each of perceived stress and depressive symptoms were not equal (2 associations for perceived stress, 5 associations for depressive symptoms). These findings suggested that: a) the consumption of the different food groups were more broadly associated with both stress and depressive symptoms in females than in males; and, b) in males, associations of the different food groups seem relatively more prevalent with depressive symptoms than with perceived stress.

In addition, for females, some food groups were negatively associated with stress (fresh fruits, salad/raw vegetables, cooked vegetables, cereal/cereal products), while other food groups were positively associated with stress (sweets, snacks, fast food/canned food, lemonade/soft drinks) (Table 2). This same pattern of relationships with the specific food groups was also generally

**Table 1. Food consumption and mental health indicators by university and sex**

	Chester		Gloucestershire		Ulster		Swansea		Plymouth		Oxford Brookes		Bath Spa	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
	N=755	N=114	N=511	N=393	N=425	N=38	N=367	N=31	N=108	N=61	N=174	N=21	N=356	N=103
Dietary Intake – Consumption of Food Groups*														
Sweets	3.00	2.87	2.91	2.86	3.26	3.24	3.02	2.97	2.87	2.77	2.94	2.86	3.00	2.92
Cake/cookies	2.41	2.37	2.47	2.42	2.62	2.70	2.44	2.48	2.35	2.49	2.55	2.40	2.42	2.53
Snacks	2.73	2.78	2.60	2.82	2.96	2.76	2.70	2.65	2.33	2.64	2.62	2.43	2.55	2.74
Fast food/ canned food	2.40	2.60	2.25	2.64	2.55	2.62	2.39	2.68	2.06	2.36	2.13	2.15	2.28	2.47
Fresh fruits	3.65	3.23	3.77	3.21	3.63	3.66	3.90	3.52	4.06	3.39	4.01	3.75	3.79	3.31
Salad/raw vegetables	3.31	3.08	3.50	3.06	3.28	3.08	3.48	3.19	3.82	3.39	3.82	3.43	3.50	3.04
Cooked vegetables	3.51	3.20	3.59	3.19	3.60	3.66	3.57	3.48	3.86	3.48	3.84	3.85	3.54	3.12
Lemonade/ soft drinks	2.75	2.94	2.64	2.82	2.92	3.14	2.70	2.87	2.21	2.38	2.47	2.50	2.55	2.62
Meat/sausage products	3.09	3.24	3.10	3.72	3.21	3.55	3.14	3.39	3.01	3.61	3.03	3.29	3.00	3.22
Fish/sea food	2.41	2.47	2.49	2.62	2.35	2.40	2.46	2.71	2.47	2.49	2.62	2.75	2.37	2.47
Dairy/dairy products	3.77	3.79	3.67	3.74	3.85	4.13	3.83	4.03	3.99	3.82	3.91	4.00	3.83	3.73
Cereal/cereal products	3.55	3.34	3.55	3.44	3.69	3.64	3.70	3.58	4.04	3.43	3.94	3.80	3.66	3.41
Mental Health – Perceived Stress and Depressive Symptoms														
PSS**	11.00	10.04	10.80	10.40	11.56	10.56	10.76	9.96	11.44	10.36	11.08	10.00	11.04	10.6
MBDI***	24.87	23.00	16.47	20.70	23.45	26.08	23.45	18.93	29.21	21.08	25.17	19.28	27.41	25.34

\*Mean of the consumption frequency scale (1 = never, 5 = several times/ day); \*\*Perceived Stress Scale by Cohen, higher scores indicate higher perceived stress; \*\*\*Modified Beck Depression Inventory, higher scores indicate stronger depressive symptoms; all cell values represent mean scores except MBDI where cell values are the sum of responses.

observed for depressive symptoms in females (except for cereal/cereal products).

In contrast, for males, the relationships between food consumption and mental health indicators were ‘narrower’. Only salad/raw vegetables were negatively associated with stress, and only fast food/canned food was positively associated with stress. For depressive symptoms, males exhibited a wider portfolio of associations, one that shared some similar features to that of the females (fresh fruits, salad/raw vegetables, cooked vegetables were negatively associated with depressive symptoms). However, for males, cake/cookies were positively associated with depressive symptoms; such relationship was not evident in females.

### Associations between Food Consumption Behaviour (All Food Groups Together) and Mental Health Indicators by Sex (Multivariable Analysis)

Table 3 shows the multivariable analysis between food consumption frequency and perceived stress and depressive symptoms, stratified by sex and controlled for all other variables under investigation. As for sweets/cookies/snacks/fast food, more frequent consumption of these foods was significantly associated with higher perceived stress (females only) and higher depressive symptoms for both males and females. Less frequent fruits/vegetables consumption (e.g. fresh fruits, salads, cooked vegetables)

was significantly associated with higher perceived stress and higher depressive symptoms for both sexes. In addition, there was a significant negative association between consuming fish/sea food and depressive symptoms among males only. For males and for females, consuming lemonade/soft drinks, meat/sausage products, dairy/dairy products, and cereal/cereal products was not associated with either perceived stress or depressive symptoms.

## DISCUSSION

Nutrition is a modifiable determinant of non-communicable diseases, and from the modifiable risk factors perspective, the role of nutrition in psychiatry is now more significant than initially considered (19). For instance, alternative non-pharmacological treatments for depressive symptoms (e.g. nutritional supplements) are significant treatment options (41). However, conflicting findings have increased people’s interest among the different domains of dietary composition and mood (31). Hence, there have been calls to understand the relationships between depression/depressive symptoms and other health behaviours such as eating and nutrition. Our current findings contribute to the evidence base of the relationships between food consumption behaviour and mental health indicators, expanding our awareness of these relationships and their associations with sex across these young adult populations.

**Table 2.** Associations between food consumption behaviour and perceived stress and depressive symptoms (univariable analysis)

	Perceived Stress Score (PSS)				Depressive Symptoms Score (M-BDI)			
	Female		Male		Female		Male	
Food group	p-value	Estimate*	p-value	Estimate*	p-value	Estimate*	p-value	Estimate*
Sweets (chocolate, candy, etc.)	<b>0.001</b>	<b>0.053</b>	0.288	-0.029	< <b>0.001</b>	<b>0.081</b>	0.071	0.066
Cake/cookies	0.155	0.024	0.845	-0.006	0.168	0.027	<b>0.007</b>	<b>0.099</b>
Snacks (chips, peanuts, etc.)	<b>0.024</b>	<b>0.038</b>	0.819	-0.007	<b>0.001</b>	<b>0.068</b>	0.058	0.069
Fast food/canned food**	< <b>0.001</b>	<b>0.095</b>	<b>0.008</b>	<b>0.084</b>	< <b>0.001</b>	<b>0.106</b>	< <b>0.001</b>	<b>0.183</b>
Fresh fruits	< <b>0.001</b>	<b>-0.085</b>	0.168	-0.036	< <b>0.001</b>	<b>-0.111</b>	<b>0.047</b>	<b>-0.074</b>
Salad/raw vegetables	< <b>0.001</b>	<b>-0.048</b>	<b>0.013</b>	<b>-0.065</b>	< <b>0.001</b>	<b>-0.071</b>	<b>0.014</b>	<b>-0.091</b>
Cooked vegetables	< <b>0.001</b>	<b>-0.061</b>	0.127	-0.042	< <b>0.001</b>	<b>-0.072</b>	<b>0.017</b>	<b>-0.089</b>
Lemonade/soft drinks	<b>0.003</b>	<b>0.038</b>	0.840	-0.005	<b>0.002</b>	<b>0.060</b>	0.573	0.021
Meat/sausage products	0.665	0.006	0.748	-0.010	0.680	0.008	0.942	-0.003
Fish/sea food	0.138	-0.023	0.500	0.019	0.824	0.004	0.133	0.055
Dairy/dairy products	0.249	-0.017	0.840	0.006	0.050	-0.038	0.517	0.024
Cereal/cereal products***	<b>0.001</b>	<b>-0.049</b>	0.518	-0.017	0.073	-0.035	0.740	-0.012

Each food group adjusted only for university; separate models for males and females and for both mental health indicators; estimates are the Standardized Coefficients; \*change in the corresponding score (PSS or M-BDI) per one unit of the food group frequency scale; \*\*e.g. pizza, hamburger, french fries, canned ravioli, etc.; \*\*\*e.g. whole-wheat bread, cereals, oatmeal, etc.; bolded cells indicate significant relationships.

**Table 3.** Associations between food consumption behaviour and perceived stress and depressive symptoms (multivariable analysis)

	Perceived Stress Score (PSS)				Depressive Symptoms Score (M-BDI)			
	Female		Male		Female		Male	
Food group or subscale	p-value	Estimate#	p-value	Estimate#	p-value	Estimate#	p-value	Estimate#
Sweets/cookies/snacks/fast food*	<b>0.017</b>	<b>0.051</b>	0.853	0.008	<b>0.001</b>	<b>0.072</b>	< <b>0.001</b>	<b>0.158</b>
Fruits/vegetables**	<b>0.002</b>	<b>-0.067</b>	<b>0.025</b>	<b>-0.092</b>	< <b>0.001</b>	<b>-0.081</b>	<b>0.004</b>	<b>-0.115</b>
Lemonade/soft drinks	0.207	0.027	0.949	-0.003	0.128	0.032	0.270	-0.047
Meat/sausage products	0.950	0.001	0.398	-0.035	0.788	-0.006	0.112	-0.065
Fish/sea food	0.894	-0.003	0.156	0.057	0.196	0.027	<b>0.006</b>	<b>0.108</b>
Dairy/dairy products	0.873	-0.003	0.582	0.023	0.095	-0.036	0.339	0.039
Cereal/cereal products***	0.059	-0.042	0.869	-0.007	0.976	-0.001	0.872	0.007

Each food group adjusted for university and for all other variables in the table, separate models for males and females and for both mental health indicators; estimates are the Standardized Coefficients; #change in the corresponding score (PSS or MBDI) per one unit of the food group frequency scale; \*Sweets/cookies/snacks/fast food subscale: mean of four items (sweets, cakes/cookies, snacks, fast food); \*\*Fruits/vegetables subscale: mean of three items (fresh fruits, salads, cooked vegetables); \*\*\*e.g. whole-wheat bread, cereals, oatmeal, etc.; bolded cells indicate significant relationships.

For the current study, we found that across all the participating universities, the consumption of sweets was more common in females. This is in agreement with research of university students in Germany, Denmark, Poland, and Bulgaria (34) that used the same (food frequency and mental health) research instruments as employed in the present study, and reported that overall, more women reported frequent consumption of sweets. In our sample of students, females also consumed fresh fruits more commonly (except at Ulster), and generally ate salad/raw vegetables products more commonly than males. Earlier reports similarly found that female students ate more fruits than males (42), and our findings were again consistent with a European study where largely, more women reported frequent consumption of fruits and salads (34). We are also in agreement with the study conducted in Hong Kong (43), where females had better nutritional habits than men (were

more likely to report eating fruit/vegetables), postulating support that women behaved 'healthier' than men in terms of consuming fruit (44). Conversely, we found that consumption of meat/sausage products and fish/seafood were more common in males, in support of research (34) where more men reported frequent consumption of meat and fish. Indeed, El Ansari and colleagues (34) found that irrespective of the four countries they examined, more men regularly ate meat than women, which is also in agreement with Turkish males adolescents who reported significantly more meat serving per day compared to females (45).

Regarding the differences between the participating universities in terms of their students' nutritional behaviours and mental health levels, it is not straightforward to tease out the factors that could explain such differences. Such factors might include student-level variables and/or university-level features (32).

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Similar difficulties have been noted in the relationships between student health outcomes and well-being and student- and school-level factors (46). Understanding the different dimensions of the university characteristics warrants further consideration, particularly as these dimensions relate to determinants of student health/well-being. Few multi-level studies collected sufficient student- and university-level information to be able to further our understandings of such relationships. Others (46) also noted the scarcity of multi-level studies that explored the manner in which schools may affect student health/well-being. Likewise, El Ansari et al. (32, 35) suggested that differences between participating universities in terms of health practices could be related to many features, e.g., university characteristics and its environment, policies, student selection, and resultant composition of the student population; or related to the region where a university is located; or the country and its political and health stances. Many confounding factors that could confound such complex associations are usually not measured.

In connection with objectives two and three, we assessed the associations between food consumption behaviour and two mental health indicators by sex twice: first employing each food group individually (univariable analysis); and then by employing all the food groups together (multivariable analysis). Our initial univariable analysis shed light on the relationships between each food group (individually) and two mental health indicators. However, as it was equally critical to understand the relationships between the various food groups (collectively) and the mental health indicators, hence we subsequently undertook multivariable analysis to control for all the other variables under investigation. This is in agreement with others who have voiced that it is more important to study the overall dietary pattern than isolated nutrients (47).

As for sweets/cookies/snacks/fast food, for our UK sample, more frequent consumption of these food groups was significantly positively associated with higher perceived stress in females only. This is in agreement with research across Germany, Poland and Bulgaria that employed the same instruments as the current study and reported the same findings: in females only, perceived stress was associated with more frequent consumption of sweets/cookies/snacks/fast food (24). However, for depressive symptoms, whilst our findings indicated that more frequent consumption of sweets/cookies/snacks/fast food were positively significantly associated with higher depressive symptoms for both males and females, others (24) reported this relationship only for females. This discrepancy in findings might be due to two points. First, our much larger sample (3,706 students) than that of the European study (1,839 students) possibly rendered enough power for the current study to pick up findings that other research with relatively smaller sample sizes did not (24). Second, the discrepancy in findings might also be due to the extent of 'diversity' of the sample, as previous work (31) suggested that research on nutrition and on the correlation between depression and food consumption should be conducted across diverse student populations. In the European study (24), the diversity was between Germany, Poland and Bulgaria; in our study, it was England, Wales and Northern Ireland. Because our sample had more universities from England than the other two nations, it is possible that the extent of diversity is different than that of the European study. Nevertheless, we are also in partial agreement with other research that examined the association of food consumption behaviour with one or both mental

health indicators among college students across seven cities (31), and found an increase of perceived stress with the increase of the intake frequency level of ready-to-eat food and snack food for the whole sample. However, Liu et al. (31) did not explore relationships by sex, therefore, the overall associations they observed might have resulted from associations limited to females only.

In connection to fresh fruits, salads and cooked vegetables, the current study found that less frequent consumption of these food groups was significantly associated with higher perceived stress and higher depressive symptoms scores for both sexes. Again this finding is in partial agreement with others (24) where higher fruits/vegetables consumption was associated with lower levels of depressive symptoms among females. We are also in agreement with research (31) that found an increase of depression with the decrease of the frequency level of eating fruits, although they did not stratify their findings by sex, so it is not absolutely clear whether the overall associations they found was true for both males and females or could have again resulted from associations limited to females or males only. Others have also reported that psychological stress has been associated with less fruit and vegetable intake (48).

As for fish/sea food, the current study found a significant positive association between the consumption of fish/sea food and depressive symptoms among males only. This is congruent with others (46) who have reported that fish consumption (rich in omega-3 fatty acids) might be causally associated with mood stabilization. We are also in partial agreement with Hakkarainen et al. (22), where dietary intake of omega-3 fatty acids showed no association with low mood level (we found no relationship between stress and fish/sea food for both sexes; and no relationship between fish/sea food and depressive symptoms in females).

For both sexes, we found that the consumption of meat/sausage products, dairy/dairy products, and cereal/cereal products were not associated with either perceived stress or depressive symptoms. This is in partial agreement with others who researched university students (24) and found that for both sexes, milk products and cereal products were not associated with either perceived stress or depressive symptoms.

In understanding the food consumption behaviour-mental health associations, generally, the links between depressive symptoms and health behaviours consider a two-way feature: depressive symptoms can be associated with increased 'health-compromising' behaviours that place individuals at risk for other health consequences beyond the psychological domain; and, depressive symptoms can be associated with decreased 'health-promoting' behaviours and may prevent full-health potential across multiple domains of health (49). For instance, in adolescents, depression/negative mood was related to health-compromising attitudes/behaviours, e.g., weight dissatisfaction, negative body image, while a significant negative relationship between depressed mood and health-promoting eating behaviours, e.g. eating breakfast and lunch has also been reported (50–52).

This study has limitations and generalization needs to be cautious. Across the 7 universities, data were collected employing the same method and research tool, and data processing was the same across universities. However, as there could be regional variations and/or systematic differences between the selected universities, students' data from each given university may not be representative of the whole university. Nevertheless, a high

response rate at each site suggested that selection bias was not a probable danger to the study's internal validity. The study is a cross-sectional survey, hence the direction of the association between food consumption and mental health cannot be ascertained. We did not have enough information on social class and entry tariff across the university courses that participants were studying on, which could have been useful. Participants self-reported the levels of mental health indicators and dietary food consumption where such responses may be subject to sociability and social desirability. We did not assess serving sizes, which might be different across sites. The food frequency questionnaire was not compared against objective methods of food consumption measurement. Nonetheless, the tool was comparable to other published food frequency questionnaires that have been validated (36, 37). Future research would need to consider such limitations. In addition, studies are needed to clarify the temporal relationship between the emotional/mental and nutritional domains (53). Significant associations between food and mood warrant further research to determine causality.

## CONCLUSION

In summary, the frequencies of consumption of the various food groups as well as depressive symptoms and perceived stress differed by university and sex. Consuming 'unhealthy' foods (e.g. sweets/cookies/snacks/fast food) was significantly positively associated with perceived stress (females only) and depressive symptoms for both males and for females. Conversely, consuming 'healthy' foods (e.g. fresh fruits, salads, cooked vegetables) was significantly negatively associated with perceived stress and depressive symptoms scores for both sexes. There was a significant positive association between the consumption of fish/sea food and depressive symptoms among males only. For both males and females, the consumption of lemonade/soft drinks, meat/sausage products, dairy/dairy products, and cereal/cereal products were not associated with either perceived stress or depressive symptoms. The study findings should support the implementation of health promotion and prevention programmes at universities. Positive effects on food consumption behaviours can be expected from interventions aimed at decreasing or preventing depressive symptoms and/or reducing perceived stress levels among students, and vice versa. Efforts to reduce depressive symptoms and stress among female students may lead to the consumption of healthier foods and/or vice versa. Strategies might include stress management programmes, university environment enabling relaxation and wellbeing, health-oriented courses, and the organization of studies and curricula with a focus on stress reduction.

## Acknowledgements

The authors wish to acknowledge the universities, faculties and students who participated in this study. In addition, we acknowledge the UK Student Health Group (J. John, P. Deeny, C. Phillips, S. Snelgrove, X. Hu, S. Parke, M. Stoate, A. Mabhalala).

## Conflict of Interest

None declared

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*Received July 18, 2013*

*Accepted in revised form April 24, 2014*