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Cross-sectional study examining the association between diet quality and the prevalence of anxiety and depression in UK undergraduate students

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Abstract

The prevalence of mental health issues among UK undergraduate students is growing, and poor diet quality appears to be a risk factor for poor mental health although with limited research in this area. Therefore, the objective of this study was to examine the cross-sectional associations between diet quality and common mental disorders (CMD) such as depression and anxiety in UK undergraduate students. A cross-sectional survey consisting of demographic information and validated questionnaires (the Short-Form Food Frequency Questionnaire [SFFFQ] and the Hospital Anxiety and Depression Scale [HADS]) was conducted to measure diet quality and anxiety and depression in young adults in 44 UK-based universities. Multiple regression analysis adjusting for confounding factors was used to assess the associations between them. Undergraduate university students ($n = 202$, 67% female) with a mean age of 20.9 ± 3.6 years and a mean body mass index ($n = 170$) of $22.6 \pm 3.2\,kg/m^2$ took part in the study. Prevalence of anxiety was high, with 40% of the sample having an anxiety score in the severe range (≥12 points) while the prevalence of depression was lower, with 6% of the population having a depression score in the severe range (≥12 points). Diet quality was significantly higher for females than males ($p = 0.034$) and was poor for 38% of the sample, being more common in males compared to females, although not significantly so (43% and 36%, respectively). Diet quality was inversely associated with anxiety ($\beta = -0.427$; $p = 0.029$) and was more likely to be associated with anxiety in females than males ($\beta = 0.743$; $p = 0.043$). No significant relationship between diet quality and depression was found. Better self-reported health, father's qualification and smoking status were also associated with less anxiety and depression. This research supports other research suggesting that UK universities should explore whether the implementation of dietary interventions and improving the food environment would be a cost-effective option to reduce the high prevalence of anxiety among students.

KEYWORDS
anxiety, depression, diet quality, students, undergraduate

INTRODUCTION

Common mental disorders (CMD) are highly prevalent, with 322 million and 264 million people worldwide estimated to be suffering from depressive disorders and anxiety disorders respectively (World Health Organization, 2017). They are known to be a major cause of disability globally (Whiteford et al., 2013)

accounting for 21.2% of years lost to disability in 2013 (Vos et al., 2015). In the United Kingdom, the prevalence of CMDs has risen between 2017 and 2020 and has remained stable in all age groups between 2022 and 2023, with a prevalence of 21.7% for 20–25 year-olds (Newlove-Delgado et al., 2023). Mental health problems cost the UK economy at least £117.9 billion per year, due to the lost productivity and the support required from informal carers (McDaid & Park, 2022). The *Mental Health of Children and Young People in England* survey of 2370 children and young people, showed that about one in five children and young people aged 8–25 years had a mental disorder in 2023 (Newlove-Delgado et al., 2023). Prevalence of anxiety and depression has also increased from 21.7% in 2012 to 23.3% in 2023 and from 5.8% in 2013 to 13.2% in 2023, respectively (Department of Health and Social Care, 2023). Within the United Kingdom, more females are affected by mental health issues than males and this is consistent across age categories, but the difference is most profound among those aged between 16 and 24 years (Baker & Kirke Wade, 2024), possibly reflecting greater under-reporting of male mental health symptoms and reduced participation in research (Mental Health Foundation, 2016).

Poor mental health is a growing problem within the UK university undergraduate student population (Hughes & Spanner, 2019; Sivertsen et al., 2019). Mental health problems reported by UK students have increased from 0.7% in 2010/2011 to 4.5% in 2021/2022 (Office of National Statistics, 2023). Student Minds, a mental health charity, conducted a survey of 1037 UK students, 57% of students self-reported a mental health issue and 27% had a diagnosed mental health condition (Student Minds, 2022). The onset of CMD is most commonly reported between ages 18 and 25 years (Brown, 2016), and the recent COVID-19 pandemic has particularly affected the mental health of this age group (Campbell et al., 2022). Consequently, university undergraduate students are at a vulnerable stage in life with 80% of students within this age range (Kessler et al., 2007). Even before the emergence of COVID-19, students were reporting high levels of mental health issues, but the COVID-19 pandemic has led to a mental health crisis in this population (Hellemans et al., 2020; Li et al., 2022). Additionally, data from the Office of National Statistics show that students are more anxious and less happy than non-students of the same age (Brown, 2016), which may be due to the pressures associated with leaving home, as well as academic, financial and social pressures (Macaskill, 2012; National Union of Students, 2022). The number of students seeking help for mental health problems increased from 18 010 to 49 265 over 5 years (Universities UK, 2017), concurrently with an increase in the number of undergraduate students (Higher Education Statistics Agency, 2020). Almost all UK universities have reported an increase in demand for counselling services over 5 years (Spitzer-Wong, 2018), with 61% reporting an increase of over 25% (Thorley, 2017). This has resulted in increased waiting lists and delayed treatment (Macaskill, 2012) and an increase in NHS spending on mental health (Department of Health and Social Care, National Audit Office, 2023) In addition, it is thought that many more students choose not to disclose their mental health issues resulting in an increase in students dropping out of university, not fulfilling their academic potential, and having a poor quality of life (Thorley, 2017). Suicides resulting from severe mental health problems in England and Wales universities are increasing year on year from 75 cases in 2007 to 143 in 2016 (Office of National Statistics, 2016). The main mental health conditions affecting young adults are anxiety and depression (Mcmanus et al., 2016) with the issue of anxiety among female undergraduates of particular concern (Neves & Hillman, 2019). Reversing this trend is therefore a priority within higher education (Thorley, 2017), and it is important to know whether improving students' diet quality could ameliorate the situation.

Unhealthy eating patterns and poor diets within the undergraduate student populations are widespread (Sprake et al., 2018) and many individuals are known to put on weight in their first year at university (Finlayson et al., 2012). Investigating the impact of diet quality on mental health is a relatively new and rapidly growing research area with recent systematic reviews and meta-analyses of observation studies generally supporting a weak association between the risk of depression and adherence to healthy diets in adults (Lassale et al., 2018; Molendijk et al., 2017), and in children and adolescents (Khalid et al., 2017), although any relationship is likely to be bi-directional. Evidence is also emerging from randomised controlled trials (RCT). Notably, the *Supporting the Modification of Lifestyle In Lowered Emotional States* (*SMILES*) trial found mental health status significantly improved in 31 adults with severe depression following a 12-week intervention involving nutritional counselling to achieve dietary improvements based on the Mediterranean Diet, a healthy dietary pattern containing fresh, minimally processed foods with high intakes of fruit and vegetables, olive oil, legumes, fish and wholegrains (Jacka et al., 2017). No improvement was seen in the control group in which 25 adults received no dietary assistance. However, findings from the *SMILES* trial should be treated with caution since participants also received high levels of support in addition to the dietary intervention. The study was also conducted on adults with severe depression and is not necessarily generalisable to UK university students. More recently Firth et al. (2019) conducted a meta-analysis on 12 RCTs and found that dietary interventions had a small, positive effect on depressive symptoms. However, most studies included in this review focused on additional lifestyle changes such as exercise and

calorie restriction, and mental health measures were not the main outcome. Francis et al. (2019) demonstrated that improving diet quality using a 3-week intervention based on the Mediterranean Diet, reduced depressive symptoms in 38 university students compared with a habitual diet control group given no dietary advice. Francis's study was limited by the fact that no active control group was included and therefore results should be treated with caution. Nevertheless, there is emerging evidence that diet is a modifiable risk factor for depression and more research is needed to determine whether effectiveness varies with baseline level of depression (Firth et al., 2019). Several biological mechanisms are thought to be involved in CMD which can be affected by diet quality: chronic inflammation, brain plasticity, impaired neurotransmission, mitochondrial function, oxidative stress and gut microbiota (Chahwan et al., 2019; Marx et al., 2017) although further research is needed. The evidence is less convincing for the impact of diet quality on anxiety possibly due to the paucity of research (Opie et al., 2015).

Given the growing prevalence of mental health issues within UK students and the unhealthy eating patterns and diets within this population (Sprake et al., 2018), dietary interventions may offer low-cost, risk-free prevention and treatment options. Therefore, the objectives of this cross-sectional study were to explore the prevalence of anxiety and depression in undergraduate students and to examine the relationship between diet quality and anxiety and depression and whether this is modified by gender, health, socio-economic status, alcohol, physical activity and smoking habits.

METHOD

Participants ($n = 202$) were recruited from 44 universities throughout the United Kingdom using convenience and snowball sampling methods (Etikan, 2016) between March 2019 and June 2019. Participants were included if they were aged over 18 years and studying at a UK university.

Demographic and lifestyle data was collected through an online survey including questions on alcohol intake (never, rarely, <14, 14–21, >21 units), smoking status (≤14 cigarettes a day, ≥15 cigarettes a day, an ex-smoker, never smoked) and self-reported physical activity (PA) level using a single question (none, light, moderate, vigorous). Mothers' and fathers' qualification levels and income were obtained as an indication of socio-economic status. Also included were self-reported height (m) and weight (kg) to determine body mass index (BMI) (kg/m^2), together with self-perceived health status, gender, age (years) and ethnicity.

Anxiety and depression were assessed using the Hospital Anxiety and Depression Scale (HADS) (Stern, 2014), a widely used, validated questionnaire that includes separate sub-scales for anxiety and depression. Seven statements of each disorder were included and rated using a 4-point rating score (0–3) with a higher score relating to a worse state (Stern, 2014). Studies have reported Cronbach's alpha coefficient as 0.83 for the anxiety sub-scale and 0.82 for the depression sub-scale (Bjelland et al., 2002).

Diet quality was assessed using the Short-Form Food Frequency Questionnaire (SFFFQ), previously validated as an inexpensive and quick tool for ranking diet quality in large UK populations (Cleghorn et al., 2016). Participants were asked to rate how often at least one portion of 20 food items was eaten during a typical week using a 6- or 8-point rate score, with higher scores indicating higher qualities of portions consumed. A diet quality score (DQS) of between 1 and 15, with scores of 1 and 15 representing the lowest and highest diet quality, respectively, was generated for each participant using a scoring spreadsheet provided by Cleghorn et al. (2016) for this purpose. Two additional questions were included to further investigate diet quality. One question was related to takeaway food (How often do you eat takeaway food as your main meal of the day?) with eight answer options (rarely or never; once a week; 2 times a week; 3 times a week; 4 times a week; 5 times a week; 6 times a week; at least once a day) and the second question was related to cooking (How often do you cook your main meal of the day from basic ingredients?) with five answer options (rarely or never, 1 or 2 times a week, 3 or 4 times a week, 5 or 6 times a week, at least once a day).

No financial incentive was offered for participation therefore, to maximise participation numbers, the questionnaire was designed to be quick to complete (approximately 10 minutes) with questions relating to parental income and education, height and weight being optional.

Statistical analysis

Descriptive statistics (means SD or % *n*) were used to analyse demographic and lifestyle characteristics and diet quality scores of study participants. Good- and poor-quality diets were defined as DQS ≥ 12 and ≤9, respectively (Cleghorn et al., 2016). Pearson's product correlation coefficients were used to assess the relationship between continuous variables. Independent *t*-tests were used to assess gender differences in depression, anxiety and DQS. Multiple linear regression using the enter method was used to test for an association between DQS and anxiety and depression scores, controlling for confounding factors: self-perceived health status, father's qualification level, gender, alcohol intake, smoking status and PA. Assumptions of normality were checked using the Shapiro–Wilk's test and by visual inspection of histograms. In addition, data

were checked for outliers, independence of residuals, linearity and homoscedasticity of residuals. Square root transformation was used as a method to transform data that were not normally distributed. To enable regression analysis, dummy variables were used for categorical variables with more than two categories. One way between groups analysis of covariance (ANCOVA) was conducted to explore the effect of takeaway meals consumed and meals cooked from basic ingredients on anxiety and depression scores, after controlling for smoking, PA and alcohol consumption since they are known behaviours that negatively impact common mental health disorders in students (Sprake et al., 2018). Post hoc comparisons were performed using the Tukey correction. Partial correlations were conducted to assess the relationship between takeaway meal consumption and cooking from basic ingredients while controlling for smoking, PA and alcohol consumption. Analysis was carried out using Statistical Package for Social Sciences (SPSS), version 24 (IBM Corp, 2017). A p-value < 0.05 was considered statistically significant.

RESULTS

Demographic and lifestyle characteristics of the study population are shown in Table 1. The sample consisted of more females than males (67% and 33%, respectively) and an ethnic mix approximately reflecting the general UK population (Office for National Statistics, 2018). The mean BMI ($n = 170$) was $22.6 \pm 3.2\,kg/m^2$, with 80% normal weight, 14% overweight or obese and 6% underweight (World Health Organization, 2018). The diet quality score was good for 21% and poor for 38% of the sample (Table 2). Seventeen per cent of students ($n = 34$) reported eating two or more takeaway meals a week, and 6% ($n = 12$) had more than three each week. Seventeen per cent of the population cooked meals from basic ingredients every day while 35% cooked less than two meals a week. The diet quality score was significantly higher for females than males ($p = 0.034$, Table 2).

Prevalence of anxiety was high (Table 3) with 40% of the sample with an AS in the severe range (AS ≥ 12), while the prevalence of depression was lower, with 6% of the population with a DS in the severe range (DS ≥ 12) (Stern, 2014). Females had significantly higher anxiety scores than males ($p = 0.048$, Table 3), but no significant differences in depression scores.

Self-reported bodyweight was provided by 170 participants and BMI was calculated only for this sample. Only 14% were classified as obese or overweight (compared to 37% in the general population of young adults), which might be due to under-reporting or social desirability bias. The relationship between BMI and DQS

TABLE 1 Demographic and lifestyle characteristics of study participants ($n = 202$ unless otherwise stated).

Characteristics	Data
Gender (n)	
Female	135
Male	67
Age (years, mean ± SD)	20.9 ± 3.6
Ethnicity (%)	
White	82.2
Asian and Asian British	3.0
Black and Black British	4.0
Multiple ethnic groups	6.9
Other ethnic group	4.0
Year in university (%)	
First year	30.2
Second year	20.3
Third year	47.0
Fourth year	2.5
Health (%)	
Excellent	7.4
Very good	26.2
Good	35.6
Fair	23.3
Poor	7.4
Physical activity (%)	
No exercise	5.0
Light exercise	25.7
Moderate exercise	27.7
Vigorous exercise	41.6
Smoking habit (%)	
Never smoked	82.2
Ex-smoker	4.01
Current smoker	37.1
Alcohol intake (%)	
Never or rarely	36.1
Less than 14 units	26.8
Over 14 units	
Weight (kg, mean ± SD), $n = 173$	66.0 ± 11.7
BMI (kg/m^2, mean ± SD), $n = 170$	22.6 ± 3.2
Parental income (%), $n = 127$	
Below £10 K	9.4
£10–25 K	12.6
£25–50 K	23.6
£50–100 K	32.3
>£100 K	22
Mother's highest qualification (%), $n = 181$	
None	3.0
GCSEs	18.8

TABLE 1 (Continued)

Characteristics	Data
A levels	24.9
Degree	39.2
Post-graduate degree	13.8
Father's highest qualification (%), $n=180$	
None	5.6
GCSEs	20.6
A levels	14.4
Degree	43.3
Post-graduate degree	16.1

Note: Values are means ± SD or %.

Abbreviations: GCSEs, General Certificate of Secondary Education; *n*, number of participants.

TABLE 2 Diet information ($n=202$ unless otherwise stated).

Characteristics	Data
DQS[a] (mean ± SD)	
All participants	10.00 ± 1.93
Female ($n=135$)	10.17 ± 1.93*
Male ($n=67$)	9.64 ± 1.90
DQS[a] % split for all participants	
Poor-quality diet, ≤9	38
Medium-quality diet, 10–11	41
Good-quality diet, ≥12	21
DQS[a] % split for females	
Poor-quality diet, ≤9	36
Medium-quality diet, 10–11	41
Good-quality diet, ≥12	23
DQS[a] % split for males	
Poor-quality diet, ≤9	43
Medium-quality diet, 10–11	40
Good-quality diet, ≥12	17
Takeaways meals/week (%)	
Rarely or never	54.0
Once a week	29.2
Twice a week	10.9
Three times a week	4.0
Four times a week	1.5
Five times a week	0.5
Cooking meals from basic ingredients/week (%)	
Rarely or never	12.9
1–2 times a week	21.8
3–4 times a week	22.3
5–6 times a week	26.2
At least once a day	16.8

Abbreviations: DQS, diet quality score; *n*, number of participants; SD, standard deviation.

[a]Short-form food frequency questionnaire (Stern, 2014).

*Significance at $p<0.05$.

TABLE 3 Depression and anxiety scores for all participants, split by gender.

	All ($n=202$)	Female ($n=135$)	Male ($n=67$)
Anxiety score[a]			
Mean ± SD	9.4 ± 4.6	9.8 ± 4.5*	8.7 ± 3.4
% No anxiety[b]	36.6	31.9	46.3
% Mild anxiety[c]	23.3	25.2	19.4
% Severe anxiety[d]	40.1	43.0	34.3
Depression score[a]			
Mean ± SD	4.5 ± 3.5	4.6 ± 3.6	4.3 ± 3.4
% No depression[b]	78.7	79.3	77.6
% Mild depression[c]	15.3	13.3	19.4
% Severe depression[d]	5.9	7.4	3.0

Abbreviation: SD, standard deviation.

[a]HADS (Stern, 2014).

[b]HADS scores ≤ 7.

[c]HADS scores 8–11 inclusive.

[d]HADS ≥ 12.

*Significance at $p<0.05$.

was not significant and therefore BMI was not included in the subsequent regression analysis (r (170) = −0.46, ns). Regression analysis models found that predictor variables accounted for 24.7% of the variance observed in anxiety ($R^2_{adj}=0.25$) and were significant ($F=4.87$, $p<0.005$); and 22.8% of the variance observed in depression ($R^2_{adj}=0.23$) and were significant ($F=4.50$, $p<0.005$) (Table 4). Self-perceived health was a significant predictor of anxiety ($p<0.05$). Good, fair and poor self-perceived health significantly predicted anxiety compared to excellent health ($p=0.014$, $p=0.001$ and $p=0.001$, respectively). Only fair self-perceived health was a significant predictor of depression compared to excellent health ($p<0.001$). Father's qualification at degree level significantly predicted lower anxiety and depression compared to post-graduate level ($\beta=-0.20$, $p=0.014$ and $\beta=-0.20$, $p=0.016$, respectively), while a qualification level of A level significantly predicted higher depression compared to post-graduate level ($\beta=0.14$, $p=0.048$). Smoking was a significant predictor of anxiety and depression. The diet quality score was a significant predictor of anxiety ($\beta=-0.43$, $p=0.029$) but not depression. The interaction term DQS*gender added statistically to the anxiety ($\beta=-0.43$, $p=0.029$) but not the depression model ($\beta=0.37$, $p=0.313$), indicating that gender moderated the relationship between DQS and anxiety, but not DQS and depression.

Consumption of takeaway meals was significantly associated with DQS and this remained significant after adjusting for smoking, physical activity and alcohol intake ($r=-0.22$, $p<0.01$). Higher consumption of takeaway meals was associated with poorer diet quality. Cooking from basic ingredients was positively and significantly associated with DQS and this remained

TABLE 4 Multiple regression analysis with DVs: anxiety and depression ($n = 202$).

	Anxiety			Depression		
Variable	**Adj R^2**	**Beta**	***p* Value**	**Adj R^2**	**Beta**	***p* Value**
Model: DQS*gender	0.247		0.000	0.228		0.000
Health						
Excellent		Ref			Ref	
Very good		0.187	0.106		0.035	0.766
Good		**0.257**	**0.014**		0.213	0.095
Fair		**0.501**	**0.000**		**0.474**	**0.000**
Poor		**0.306**	**0.000**		0.170	0.067
Father's qualification						
Post-graduate		Ref			Ref	
Degree		**−0.198**	**0.014**		**−0.196**	**0.016**
A level		−0.023	0.750		**0.144**	**0.048**
GCSE		−0.115	0.123		0.061	0.431
None		−0.020	0.769		−0.056	0.419
Alcohol						
More than 14 units/week		Ref			Ref	
Less than 14 units/week		0.005	0.953		−0.025	0.761
Never/Rarely		0.122	0.133		0.078	0.344
Physical activity						
Vigorous		Ref			Ref	
Moderate		0.020	0.786		−0.015	0.840
Light		−0.830	0.261		−0.031	0.679
None		−0.117	0.075		−0.095	0.153
Smoking		**0.276**	**0.000**		**0.180**	**0.015**
Gender (male)		**−0.868**	**0.013**		−0.418	0.232
DQS		**−0.427**	**0.029**		−0.201	0.308
DQS*gender		**0.743**	**0.043**		0.374	0.313

Note: Significant values are in bold.

Abbreviations: Adj, adjusted; beta, beta standardised coefficient; DQS, diet quality score; DV, dependant variable; ref, reference dummy variable.

significant after adjusting for smoking, physical activity and alcohol intake ($r = 0.36$, $p < 0.001$). Additional analysis using one-way ANOVA showed significant main effects of takeaways on anxiety and depression ($F(3,198) = 5.2$ $p < 0.01$ and $F(3,198) = 5.66$, $p < 0.01$, respectively) with medium effect sizes for both AS and DS ($\eta^2 = 0.07$) and DS ($\eta^2 = 0.08$) (data not shown in tables). These effects remained significant after adjusting for smoking, alcohol consumption and PA. Post-hoc comparisons for anxiety indicated the adjusted mean scores for no takeaway meals (M = 8.50, SE = 0.43) were significantly lower than having one takeaway meal once a week (M = 10.45, SE = 0.57), while post hoc comparisons for depression showed the adjusted mean scores for no takeaway meals (M = 3.75, SE = 0.33) were significantly lower than having two take-away meals each week (M = 5.08, SE = 0.44). There were no other significant differences between groups for either anxiety or depression, and there was no significant main effect of cooked meals on anxiety or depression.

DISCUSSION

Key results

This cross-sectional study aimed to explore the association between diet quality and CMD in undergraduates and to determine if this association was moderated by gender. It was found that diet quality had a small but significant association with anxiety symptoms; moreover, diet quality was found to have a stronger association with anxiety in females than in males. Mental health disorders are twice as high for young females

compared to males (Newlove-Delgado et al., 2023) and the prevalence of anxiety disorders is significantly higher in females compared to males (Farhane-Medina et al., 2022). Research has also shown that females are more preoccupied with their weight and body image, factors that are linked to psychological distress (Sarigiani et al., 2020) and might be a contributory factor to the higher levels of anxiety observed. Future studies should explore the relationship between diet quality, eating disorders and mental health conditions in undergraduate students. No significant association was found between diet quality and depression.

Diet quality

The proportion of the sample population consuming a healthy diet, classified as achieving a DQS of more than or equal to 12, was low at 21% and was roughly consistent with the findings from a study in which 19% of British university students were found to have a healthy diet (Tanton et al., 2015). The takeaway meal consumption reported in the present study had a strong association with the DQS, consistent with other studies (Thorpe et al., 2014). This is unsurprising given takeaway meals are known to be energy dense compared to ready meals and home-cooked meals (Blackham et al., 2012; Hillier-Brown et al., 2017), and, as such, the quality of takeaway meals consumed can be considered a rough indicator of diet quality (Crawford et al., 2012). The frequency of cooking meals from basic ingredients was found to be low within the population, with only 17% of respondents cooking from basic ingredients most days. The Mental Health Foundation reported 29% of young people cooked from basic ingredients in 2006 (Cornah & van de Weyer, 2006) suggesting a reduction in student cooking as an everyday activity. This is a concerning trend given cooking meals has been found to be associated with healthier diets (Wolfson & Bleich, 2015). There are known barriers to cooking in the university environment including practical considerations such as lack of clean facilities and limited food storage, social issues involving peer groups and lack of confidence and ability to cook (Sprake, 2016; Tanton et al., 2015) which may explain the reported decrease in diet quality during the transition from school to university (Winpenny et al., 2019). In addition, the stress of academic deadlines and examinations is known to affect diet quality with students reporting cooking less and putting on weight during these periods (Sprake, 2016).

Diet quality was lower in males compared to females, shown by the lower mean DQS and a higher percentage of male participants scoring in the lower tertile, (DQS < 9) compared to females. Similar results were found in other studies on student populations (Sprake et al., 2018; Vidal et al., 2018) and in the general population (Cornah & van de Weyer, 2006) potentially due to women placing more importance on healthy eating than men (El Ansari et al., 2011).

Diet quality and anxiety

The prevalence of anxiety in this study population was considerably greater than in the general population of young adults (40.1% and 6.3%, respectively) (Mcmanus et al., 2016) possibly reflecting the greater anxiety in the run-up to the end of year exams period and further emphasising the higher risk of mental health issues in the student population. In addition, the significant gender difference in anxiety prevalence was consistent with the general population (Mcmanus et al., 2016) and other student populations (Thorley, 2017).

The present study found a significant association between diet quality and anxiety. This is consistent with the *SMILES* trial (Jacka et al., 2017), a single-blind RCT showing the dietary support group to demonstrate significantly greater improvement from baseline to 12 weeks than the social support control group on the HADS anxiety subscale. In addition, two large cross-sectional studies of the general Iranian adult population ($n = 3363$ and 3846) demonstrated inverse associations between anxiety, as measured using HADS, and diet quality (Saneei et al., 2016; Valipour et al., 2017). An earlier study observing 1046 women in the general Australian population found that adjusting for energy intake attenuated the relationship between diet quality and anxiety (Jacka et al., 2010). The authors postulated that the absolute quantity of poor-quality food leads to increased anxiety rather than the proportion of the overall intake. In addition, studies on student populations using perceived stress as a measure of mental health, synonymous with anxiety, have found similar results to the present study (Papier et al., 2015; Vidal et al., 2018). Vidal et al. (2018) looked at the relationship between fat intake and perceived stress in 523 first-year undergraduate students in Peru. They found that those with the highest perceived stress levels had higher fat intakes compared with those with the lowest perceived stress levels after controlling for gender, age, place of birth, living alone and depressive symptoms. Papier et al. (2015), in a cross-sectional study of 728 first-year Australian students, found that there was a significant positive dose–response trend in the relationship between stress level and consumption of foods higher in fat and sugar, and a negative dose–response trend when looking at the relationship between stress levels and healthy foods such as fruit and vegetables (Papier et al., 2015). Although observational studies consistently demonstrate an association between diet quality and mental health in university students (Solomou et al., 2023), more observational studies and RCTs are needed to consolidate the effectiveness of potential interventions to improve the diet and mental health of students.

The moderating effect of gender on the association between diet and anxiety found in the present study was consistent with a large population-based study of 5731 Norwegian adults (Jacka et al., 2011) which also found that gender moderated the relationship between diet quality and anxiety. They found that diets scoring high on a traditional, high-quality, Norwegian diet index were inversely related to anxiety in women but not men. Additionally, they found adherence to the western diet, which is high in salt, fat and sugar was positively associated with anxiety in women but not men.

Further evidence of the modulating effect of gender on the association between anxiety and diet quality comes from a meta-analysis of 16 RCTs studying the impact of dietary interventions on CMDs (Firth et al., 2019). They found that dietary interventions using a whole diet approach resulted in significantly reduced anxiety in studies using mainly female samples, whereas they found non-significant findings in studies with male samples. Although the number of studies included in this meta-analysis was low, the consistent results give strength to the conclusion that poor diet quality is a risk factor for anxiety in females but not males. It is possible that these gender differences were a result of females following the interventions more carefully than males. It has also been postulated that these differences may be explained by hormonal differences impacting oxidative stress and the inflammation process, thought to be involved in mediating anxiety (Firth et al., 2019). However, further research is needed to explore these mechanisms of action.

Diet quality and depression

The prevalence of severe depression 5.9% in this study was greater than the general population of young adults (2.3%), and no significant gender differences were found, consistent with the general population (Mcmanus et al., 2016).

The lack of association between diet quality and depression found in the present study contradicts the majority of other recent observational studies (Lassale et al., 2018), although there are conflicting results in this area of research (Jacka et al., 2011). The small number of cases of depression in the present study may explain the lack of association. In addition, large between-study heterogeneity currently existing in this area of research may account for inconsistent results (Molendijk et al., 2017). Studies vary in the baseline level of depression measured and whether it is symptomatic or clinical depression, potentially leading to differing outcomes and making it difficult to make comparisons (Firth et al., 2019). Inconsistent results may also be due to different types of depression possessing distinct metabolic parameters; atypical depression is associated with increased appetite while melancholic depression is associated with decreased appetite (Winpenny et al., 2018). Many studies currently use convenient scoring systems such as HADS to gauge the level of depression but which do not detect different types of depression (Rahe et al., 2015). Therefore, future research should consider using the gold standard clinical psychiatric assessments to enable adjustment for depression types.

Age may moderate the effect of diet quality on mental health. Although there is limited research in this area, Saneei et al. (2016) found protective associations between adhering to a good-quality diet and mental disorders in younger individuals (≤40 years) but not in older individuals (≥40 years) in a large cross-sectional study. While a longitudinal study looking at three age groups (20+, 40+ and 60+ years) found that unhealthy dietary patterns showed larger increases in the risk of depression in the older group compared to the younger groups (Jacka et al., 2014). This research indicates that although the moderating effect of age was not shown in the present study probably due to the small age range within the population, engaging with young adults and creating healthy eating habits before they get older may be beneficial to their future mental health.

A new area of research that may impact mental health is ultra-processed foods (UPF) since although consumption of UPF was not directly measured in the present study, the low level of cooking among students possibly indicates high reliance on UPF. Notably, a recent longitudinal study involving 20 380 adults has shown that higher proportions of UPF in the diet were directly associated with increased depressive symptoms (Adjibade et al., 2019). Ultra-processed food generally have low nutrient density and high levels of sugar, fat and salt (Monteiro et al., 2019), therefore high dietary levels of UPF would reduce overall diet quality, although our study found no association between diet quality and depression. However, it has been postulated that UPF have additional, non-nutrient elements such as emulsifiers and artificial sweeteners, which may impact functioning of the gut microbiome, causing gut inflammation and potentially chronic inflammatory diseases including depressive symptoms (Shi, 2019). Future research should explore the effects of UPF and the role of gut microbiome on mental health.

The amount of time required to observe the effects of diet quality on mental health, if any, is unknown with some studies showing that improved diets with high fruit and vegetable consumption led to the better mood within 24 h (Ocean et al., 2019), while others suggest that it takes years to see the impact of diet quality on mental health (Jacka et al., 2013). This may be due to studies investigating the impact of different nutrients, foods and dietary patterns, and therefore, different biomechanics may be at play in this complex area. Designing future studies to observe specific, well-specified dietary patterns, such as the

Mediterranean Diet, may lead to more consistent results.

In this study, anxiety and depression increased significantly with a medium effect size between those consuming no takeaway meals and those consuming one or more takeaways each week, consistent with other studies which have found an association between fast food/take-away consumption and mental health problems (Khalid et al., 2017). The close association between takeaway consumption and DQS corroborates the potential link between diet quality and CMDs in students, even after adjusting for other health behaviours known to negatively impact CMDs in students such as smoking, PA or alcohol intake (Sprake et al., 2018). Due to the cross-sectional nature of the study, we cannot infer causality and it is possible that anxiety and low mood leads to less interest in cooking and a higher intake of less healthy food and consequently poor diet quality. It is also possible that the imminent exams may have both reduced time for cooking and increased the anxiety being felt by the students at that time. More longitudinal studies are needed to further explore the relationship between take-away food consumption and mental health.

Study limitations

Several limitations may have impacted the results of this study. Firstly, selection bias may exist with motivated students more likely to complete the survey (Sprake et al., 2018). Fewer males than females took part in the study, a known issue with online survey participation (Smith, 2008). The small sample size is a further limitation although the racial and socioeconomic profiles of this study sample are approximately representative of the UK population (Office for National Statistics, 2018). The study was conducted during the period in the run-up to end-of-year exams when students spend more time in revision and are more prone to anxiety and stress. This might also have impacted on their time to cook and their reliance on takeaways. Also, we did not collect information on whether students were in catered or self-catered accommodation which may also affect students' dietary practices and should be explored in future research. Measurement bias is likely to have been present since, although the HADS measure of anxiety and depression is validated, it may not match the validity of clinical interviews (Winpenny et al., 2018). The SFFFQ is designed and validated to be a quick measure of diet quality, however, full food frequency questionnaires or repeated food diaries may offer more validity and accuracy (Johnson, 2002). Nevertheless, all self-reported assessment methods are prone to misreporting, recall bias and social desirability bias with strong evidence that those who have obesity tend to underreport their weight (King et al., 2018) and, particularly relevant to this study, evidence exists showing individuals with CMD are also more likely to misreport (Rahe et al., 2015). Weight and height were also self-reported and this might explain the low percentage of people with overweight or obese in the current study compared to national obesity statistics for 16–25-year-olds (14% and 37%, respectively) (Baker, 2019) and the lack of a relationship between BMI and CMD in this present study, contrary to the existing literature (Cabout et al., 2017).

The cross-sectional design is a further limitation since it limits inference for causation or directionality. Although there is some evidence from RCTs showing causality (Firth et al., 2019; Francis et al., 2019; Jacka et al., 2017), depression is also thought to affect food choice through physiological changes that alter appetite, and through behaviours such as meal skipping, and disordered eating (Gibson, 2006). More prospective studies and RCTs are required to further explore the complex relationship between overall diet quality and CMD and the moderating effect of BMI.

Practical implications

Universities are well placed to improve the food environment and catering facilities on campus and to promote healthier options in vending machines and restaurant food purchases (Hillier-Brown et al., 2017). Given the increase in spending on counselling services at universities over the last few years (Thorley, 2017), dietary interventions potentially offer a cost-effective method to improve and maintain mental health and well-being for the university student population, without compromising autonomy and choice (Ejlerskov et al., 2018; Segal et al., 2020; Watson & Wyness, 2013). Therefore, dietary interventions could offer students a non-intrusive method which may help to reduce symptoms of some CMD, although the content, format and duration of a dietary intervention targeting university students need further investigation. Previous research has found a short 3-week intervention to reduce depressive symptoms in university students (Francis et al., 2019) and interventions run by dietitians being more effective than those run by other health professionals (Teasdale et al., 2018). In addition, interventions which included a strong social, and peer-support element were found to be more likely to be effective at improving students' diet quality and should be considered in future interventions (Deliens et al., 2014). It is envisaged that interventions for students should include healthy eating on a budget, shopping and cooking skills, and information on the impact nutrition may have on mental and physical well-being (BDA Obesity Specialist Group, 2018). Behaviour change techniques should

also be integrated into interventions (Sainsbury et al., 2018) to improve self-regulatory skills around eating. Future research should also explore the barriers and facilitators to healthy eating in undergraduate students and design and develop theory-based lifestyle interventions to improve mental health/well-being and diet quality.

CONCLUSION

In this study, good diet quality was significantly associated with reduced anxiety, but not with reduced depression in undergraduate students after adjusting for smoking status, PA, alcohol consumption, self-perceived health and father's qualification level. Poor diet quality was significantly associated with higher anxiety in females than male students. If future studies support a causal association, lifestyle interventions targeting diet quality and eating behaviour may be beneficial in improving university students' mental health. Future research is required to determine the structure and type of lifestyle interventions that may be effective among undergraduate students.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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REFERENCES

Adjibade, M., Julia, C., Allès, B., Touvier, M., Lemogne, C., Srour, B. et al. (2019) Prospective association between ultra-processed food consumption and incident depressive symptoms in the French NutriNet-Santé cohort. *BMC Medicine*, 17(1), 1–13. Available from: https://doi.org/10.1186/s12916-019-1312-y

Baker & Kirke-Wade (2024) *Mental health statistics: prevalence, services and funding in England, House of Commons Library*. Available from: https://researchbriefings.files.parliament.uk/documents/SN06988/SN06988.pdf [Accessed 5th June 2024].

Baker, C. (2019) *Obesity statistics*. House of Commons Briefing Paper, 3336 (6 August 2019), p. 1. Available from: https://researchbriefings.parliament.uk/ResearchBriefing/Summary/SN03336 [Accessed 10th June 2024].

BDA Obesity Specialist Group. (2018) Dietetic obesity management interventions in adults: evidence review and clinical application. *Science and Engineering Indicators*, 2018, 2756–2765. Available from: https://doi.org/10.1002/ejoc.201200111

Bjelland, I., Dahl, A.A., Haug, T.T. & Neckelmann, D. (2002) The validity of the hospital anxiety and depression scale: an updated literature review. *Journal of Psychosomatic Research*, 52(2), 69–77.

Blackham, T., Abayomi, J.C. & Davies, I.G. (2012) Comparison of the nutritional quality of Indian take away and supermarket ready meals. *Proceedings of the Nutrition Society*, 71(OCE2), 2019. Available from: https://doi.org/10.1017/s0029665112002169

Brown, P. (2016) *The invisible problem? Improving students' mental health*. Available from: https://www.hepi.ac.uk/2016/09/22/3592/ [Accessed 10 December 2023].

Cabout, M., Brouwer, I.A. & Visser, M. (2017) The MooDFOOD project: prevention of depression through nutritional strategies. *Nutrition Bulletin*, 42(1), 94–103. Available from: https://doi.org/10.1111/nbu.12254

Campbell, F., Blank, L., Cantrell, A., Baxter, S., Blackmore, C., Dixon, J. et al. (2022) Factors that influence mental health of university and college students in the UK: a systematic review. *BMC Public Health*, 22(1), 1–22. Available from: https://doi.org/10.1186/s12889-022-13943-x

Chahwan, B., Kwan, S., Isik, A., van Hemert, S., Burke, C. & Roberts, L. (2019) Gut feelings: a randomised, triple-blind, placebo-controlled trial of probiotics for depressive symptoms. *Journal of Affective Disorders*, 253, 317–326. Available from: https://doi.org/10.1016/j.jad.2019.04.097

Cleghorn, C.L., Harrison, R.A., Ransley, J.K., Wilkinson, S., Thomas, J. & Cade, J.E. (2016) Can a dietary quality score derived from a short-form FFQ assess dietary quality in UK adult population surveys? *Public Health Nutrition*, 19(16), 2915–2923. Available from: https://doi.org/10.1017/S1368980016001099

Cornah, D. & van de Weyer, C. (2006) *Feeding Minds – The impact of food on mental health*. Available from: https://www.mentalhealth.org.uk/publications/feeding-minds [Accessed September 2023].

Crawford, G.B., Khedkar, A., Flaws, J.A., Sorkin, J.D. & Gallicchio, L. (2012) Depressive symptoms and self-reported fast food intake in midlife women. *Preventive Medicine*, 52(3–4), 254–257. Available from: https://doi.org/10.1016/j.ypmed.2011.01.006.Depressive

Deliens, T., Clarys, P., de Bourdeaudhuij, I. & Deforche, B. (2014) Determinants of eating behaviour in university students: a qualitative study using focus group discussions. *BMC Public Health*, 14(1), 1–12. Available from: https://doi.org/10.1186/1471-2458-14-53

Department of Health and Social Care. (2023) *Health trends England*. Available from: https://fingertips.phe.org.uk/static-reports/health-trends-in-england/England/mental_health_and_wellbeing.html [Accessed 10th June 2024].

Department of Health and Social Care, National Audit Office. (2023) *Progress in improving mental health services in England*. Available from: https://www.nao.org.uk/wp-content/uploads/2023/02/Progress-in-improving-mental-health-services-CS.pdf [Accessed 10th June 2024].

Ejlerskov, K.T., Stead, M., Adamson, A., White, M. & Adams, J. (2018) The nature of UK supermarkets' policies on checkout food and associations with healthfulness and type of food displayed: cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity*, 15(1), 1–10. Available from: https://doi.org/10.1186/s12966-018-0684-2

El Ansari, W., Stock, C., John, J., Deeny, P., Phillips, C., Snelgrove, S. et al. (2011) Health promoting behaviours and lifestyle characteristics of students at seven universities in the UK. *Central European Journal of Public Health*, 19(4), 197–204. Available from: https://doi.org/10.21101/cejph.a3684

Etikan, I. (2016) Comparision of snowball sampling and sequential sampling technique. *Biometrics & Biostatistics International Journal*, 3(1), 55–56. Available from: https://doi.org/10.15406/bbij.2016.03.00055

Farhane-Medina, N.Z., Luque, B., Tabernero, C. & Castillo-Mayén, R. (2022) Factors associated with gender and sex differences in anxiety prevalence and comorbidity: a systematic review. *Science Progress*, 105(4), 1–30. Available from: https://doi.org/10.1177/00368504221135469

Finlayson, G., Cecil, J., Higgs, S., Hill, A. & Hetherington, M. (2012) Susceptibility to weight gain. Eating behaviour traits and physical activity as predictors of weight gain during the first year of university. *Appetite*, 58(3), 1091–1098. Available from: https://doi.org/10.1016/j.appet.2012.03.003

Firth, J., Marx, W., Dash, S., Carney, R., Teasdale, S.B., Solmi, M. et al. (2019) The effects of dietary improvement on symptoms of depression and anxiety a meta-analysis of randomized controlled trials. *Psychosomatic Medicine*, 81(3), 265–280. Available from: https://doi.org/10.1097/PSY.0000000000000673

Francis, H.M., Stevenson, R.J., Chambers, J.R., Gupta, D., Newey, B. & Lim, C.K. (2019) A brief diet intervention can reduce symptoms of depression in young adults – a randomised controlled trial. *PLoS ONE*, 14(10), e0222768. Available from: https://doi.org/10.1371/journal.pone.0222768

Gibson, L.E. (2006) Emotional influences on food choice: sensory, physiological and psychological pathways. *Physiology & Behavior*, 89(1), 53–61. Available from: https://doi.org/10.1016/J.PHYSBEH.2006.01.024

Hellemans, K., Abizaid, A., Gabrys, R., McQuaid, R. & Patterson, Z. (2020) *For university students, COVID-19 stress creates perfect conditions for mental health crises*. The Conversation. 2020. Available from: https://theconversation.com/for-university-students-covid-19-stress-creates-perfect-conditions-for-mental-health-crises-149127.

Higher Education Statistics Agency. (2020) *Who's studying in HE*. Available from: https://www.hesa.ac.uk/data-and-analysis/students/whos-in-he [Accessed 2nd September 2020].

Hillier-Brown, F.C., Summerbell, C.D., Moore, H.J., Routen, A., Lake, A.A., Adams, J. et al. (2017) The impact of interventions to promote healthier ready-to-eat meals (to eat in, to take away or to be delivered) sold by specific food outlets open to the general public: a systematic review. *Obesity Reviews*, 18(2), 227–246. Available from: https://doi.org/10.1111/obr.12479

Hughes, G. & Spanner, L. (2019) *The university mental health charter*. Leeds: Student Minds.

IBM Corp. (2017) *IBM SPSS statistics for mac*. Armonk, NY: IBM Corp.

Jacka, F., Pasco, J.A., Mykletun, A., Williams, L.J., Hodge, A.M., O'Reilly, S.L. et al. (2010) Assoc of Western and Traditional diets with depression and anxiety in women. *The American Journal of Psychiatry*, 167(3), 305–311.

Jacka, F.N., Cherbuin, N., Anstey, K.J. & Butterworth, P. (2014) Dietary patterns and depressive symptoms over time: examining the relationships with socioeconomic position, health Behaviours and cardiovascular risk. *PLoS ONE*, 9(1), e87657. Available from: https://doi.org/10.1371/journal.pone.0087657

Jacka, F.N., Mykletun, A., Berk, M., Bjelland, I. & Tell, G.S. (2011) The association between habitual diet quality and the common mental disorders in community-dwelling adults: the hordaland health study. *Psychosomatic Medicine*, 73(6), 483–490. Available from: https://doi.org/10.1097/PSY.0b013e318222831a

Jacka, F.N., O'Neil, A., Opie, R., Itsiopoulos, C., Cotton, S., Mohebbi, M. et al. (2017) A randomised controlled trial of dietary improvement for adults with major depression (the 'SMILES' trial). *BMC Medicine*, 15(1), 1–13. Available from: https://doi.org/10.1186/s12916-017-0791-y

Jacka, F.N., Rothon, C., Taylor, S., Berk, M. & Stansfeld, S.A. (2013) Diet quality and mental health problems in adolescents from East London: a prospective study. *Social Psychiatry and Psychiatric Epidemiology*, 48(8), 1297–1306. Available from: https://doi.org/10.1007/s00127-012-0623-5

Johnson, R.K. (2002) Dietary intake-how do we measure what people are *really* eating? *Obesity Research*, 10(S11), 63S–68S. Available from: https://doi.org/10.1038/oby.2002.192

Kessler, R.C., Angermeyer, M., Anthony, J.C., de Graaf, R., Demyttenaere, K., Gasquet, I. et al. (2007) Lifetime prevalence and age-of-onset distributions of mental disorders in the World Health Organization's world mental health survey initiative. *World Psychiatry*, 6, 168–176. Available from: https://doi.org/10.1001/archpsyc.62.6.593

Khalid, S., Williams, C.M. & Reynolds, S.A. (2017) Is there an association between diet and depression in children and adolescents? A systematic review. *British Journal of Nutrition*, 116(12), 2097–2108. Available from: https://doi.org/10.1017/S0007114516004359

King, B.M., Cespedes, V.M., Burden, G.K., Brady, S.K., Clement, L.R., Abbott, E.M. et al. (2018) Extreme under-reporting of body weight by young adults with obesity: relation to social desirability. *Obesity Science & Practice*, 4, 129–133. Available from: https://doi.org/10.1002/osp4.153

Lassale, C., Batty, G.D., Baghdadli, A., Jacka, F., Sánchez-Villegas, A., Kivimäki, M. et al. (2018) Healthy dietary indices and risk of depressive outcomes: a systematic review and meta-analysis of observational studies. *Molecular Psychiatry*, 24, 965–986. Available from: https://doi.org/10.1038/s41380-018-0237-8

Li, W., Zhao, Z., Chen, D., Peng, Y. & Lu, Z. (2022) Prevalence and associated factors of depression and anxiety symptoms among college students: a systematic review and meta-analysis. *Journal of Child Psychology and Psychiatry*, 63(11), 1222–1230. Available from: https://doi.org/10.1111/jcpp.13606

Macaskill, A. (2012) The mental health of university students in the United Kingdom. *British Journal of Guidance and Counselling*, 41(4), 426–441. Available from: http://shura.shu.ac.uk/6449/.

Marx, W., Moseley, G., Berk, M. & Jacka, F. (2017) Nutritional psychiatry: the present state of the evidence. *Proceedings of the Nutrition Society*, 76(4), 427–436. Available from: https://doi.org/10.1017/S0029665117002026

McDaid, D. & Park, A.-L. (2022) *The economic case for investing in the prevention of mental health conditions in the UK (summary)*. Mental Health Foundation and Care Policy and Evaluation Centre, Department of Health Policy, London School of Economics and Political Science. Available from: https://www.mentalhealth.org.uk/sites/default/files/2022-06/MHF-Investing-in-Prevention-Report-Summary.pdf [Accessed 10th June 2024].

McManus, S., Bebbington, P., Jenkins, R. & Brugha, T. (2016) Mental health and wellbeing in England – adult psychiatric morbidity survey 2014. *NHS Digital*, 95-B, 1–405. Available from: https://doi.org/10.1302/0301-620X.95B2.28383

Mental Health Foundation. (2016) *Fundamental facts about mental health 2016*. London: Mental Health Foundation. Available from: https://www.mentalhealth.org.uk/publications/fundamental-facts-about-mental-health-2016 [Accessed 10th July 2023].

Molendijk, M., Molero, P., Ortuño Sánchez-Pedreño, F., van der Does, W. & Angel Martínez-González, M. (2017) Diet quality and depression risk: a systematic review and dose-response meta-analysis of prospective studies. *Journal of Affective*

Disorders, 226, 346–354. Available from: https://doi.org/10.1016/j.jad.2017.09.022

Monteiro, C.A., Cannon, G., Levy, R.B., Moubarac, J.C., Louzada, M.L.C., Rauber, F. et al. (2019) Ultra-processed foods: what they are and how to identify them. *Public Health Nutrition*, 22(5), 936–941. Available from: https://doi.org/10.1017/S1368980018003762

National Union of Students. (2022) *Student cost of living report*. Available from: https://assets.nationbuilder.com/nus/pages/37/attachments/original/1666093713/Student_Cost_of_Living_-_NUS_report.pdf?1666093713 [Accessed 10th June 2024].

Neves, J. & Hillman, N. (2019) *HEPI student academic experience survey*. [Online] Available from: https://www.hepi.ac.uk/wp-content/uploads/2019/06/Student-Academic-Experience-Survey-2019.pdf [Accessed 10th June 2024].

Newlove-Delgado, T., Marcheselli, F., Williams, T., Mandalia, D., Dennes, M., McManus, S. et al. (2023) *Mental health of children and young people in England, 2023*. Leeds: NHS England. Available from: https://digital.nhs.uk/data-and-information/publications/statistical/mental-health-of-children-and-young-people-in-england/2023-wave-4-follow-up#resources [Accessed 10th June 2024].

Ocean, N., Howley, P. & Ensor, J. (2019) Lettuce be happy: a longitudinal UK study on the relationship between fruit and vegetable consumption and well-being. *Social Science & Medicine*, 222, 1–11. Available from: https://doi.org/10.1016/j.socscimed.2018.12.017

Office for National Statistics. (2018) *Ethnicity facts and figures*. Available from: https://www.ethnicity-facts-figures.service.gov.uk/uk-population-by-ethnicity/national-and-regional-populations/population-of-england-and-wales/latest#by-ethnicity [Accessed 20th October 2023].

Office of National Statistics. (2016) *Suicides in full-time students aged 18 years and above, by region, England and Wales, 2012 to 2016*. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/adhocs/007631suicidesinfulltimestudentsaged18yearsandabovebyregionenglandandwales2012to2016 [Accessed 20 October 2023].

Office of National Statistics. (2023) *Analysis of data of students reporting a mental health condition*. Available from: https://www.officeforstudents.org.uk/media/d68b0704-1e61-4bf6-97af-fbad2d23e68f/ofs2023_55.pdf [Accessed 10th June 2024].

Opie, R.S., O'Neil, A., Itsiopoulos, C. & Jacka, F.N. (2015) The impact of whole-of-diet interventions on depression and anxiety: a systematic review of randomised controlled trials. *Public Health Nutrition*, 18(11), 2074–2093. Available from: https://doi.org/10.1017/S1368980014002614

Papier, K., Ahmed, F., Lee, P. & Wiseman, J. (2015) Stress and dietary behaviour among first-year university students in Australia: sex differences. *Nutrition*, 31(2), 324–330. Available from: https://doi.org/10.1016/j.nut.2014.08.004

Rahe, C., Baune, B.T., Unrath, M., Arolt, V., Wellmann, J., Wersching, H. et al. (2015) Associations between depression subtypes, depression severity and diet quality: cross-sectional findings from the BiDirect study. *BMC Psychiatry*, 15(1), 1–9. Available from: https://doi.org/10.1186/s12888-015-0426-9

Sainsbury, K., Evans, E.H., Pedersen, S., Marques, M.M., Teixeira, P.J., Lähteenmäki, L. et al. (2018) Attribution of weight regain to emotional reasons amongst European adults with overweight and obesity who regained weight following a weight loss attempt. *Eating and Weight Disorders*, 24(2), 351–361. Available from: https://doi.org/10.1007/s40519-018-0487-0

Saneei, P., Hajishafiee, M., Keshteli, A.H., Afshar, H., Esmaillzadeh, A. & Adibi, P. (2016) Adherence to alternative healthy eating index in relation to depression and anxiety in Iranian adults. *British Journal of Nutrition*, 116(2), 335–342. Available from: https://doi.org/10.1017/s0007114516001926

Sarigiani, P.A., Olsavsky, A.L., Camarena, P.M. & Sullivan, S.M. (2020) Obesity and depressive symptoms in college women: analysis of body image experiences and comparison to non-obese women. *International Journal of Adolescence and Youth*, 25(1), 765–779. Available from: https://doi.org/10.1080/02673843.2020.1740751

Segal, L., Twizeyemariya, A., Zarnowiecki, D., Niyonsenga, T., Bogomolova, S., Wilson, A. et al. (2020) Cost effectiveness and cost-utility analysis of a group-based diet intervention for treating major depression–the HELFIMED trial. *Nutritional Neuroscience*, 23(10), 770–778.

Shi, Z. (2019) Gut microbiota: an important link between western diet and chronic diseases. *Nutrients*, 11(10), 10–12. Available from: https://doi.org/10.3390/nu11102287

Sivertsen, B., Hysing, M., Knapstad, M., Harvey, A.G., Reneflot, A., Lønning, K.J. et al. (2019) Suicide attempts and non-suicidal self-harm among university students: prevalence study. *BJPsych Open*, 5(2), e26. Available from: https://doi.org/10.1192/bjo.2019.4

Smith, W.G. (2008) *Does gender influence online survey participation?: a record-linkage analysis of University Faculty Online Survey Response Behavior*. Available from: https://www.researchgate.net/publication/234742407_Does_Gender_Influence_Online_Survey_Participation_A_Record-Linkage_Analysis_of_University_Faculty_Online_Survey_Response_Behavior/stats [Accessed 30th July 2019].

Solomou, S., Logue, J., Reilly, S. & Perez-Algorta, G. (2023) A systematic review of the association of diet quality with the mental health of university students: implications in health education practice. *Health Education Research*, 38(1), 28–68.

Spitzer-Wong, G. (2018) *More students seek mental health support, analysis shows*. BBC News. Available from: https://www.bbc.co.uk/news/uk-england-45824598 [Accessed 30th July 2019].

Sprake, E.F. (2016) *Dietary intake and eating practices of university students in the UK*.

Sprake, E.F., Russell, J.M., Cecil, J.E., Cooper, R.J., Grabowski, P., Pourshahidi, L.K. et al. (2018) Dietary patterns of university students in the UK: a cross-sectional study. *Nutrition Journal*, 17(1), 1–17. Available from: https://doi.org/10.1186/s12937-018-0398-y

Stern, A.F. (2014) The hospital anxiety and depression scale. *Occupational Medicine*, 64(5), 393–394. Available from: https://doi.org/10.1093/occmed/kqu024

Student Minds. (2022) *Mental health and wellbeing*. Available from: https://www.studentminds.org.uk/uploads/3/7/8/4/3784584/student_minds_insight_briefing_feb23.pdf [Accessed 30th July 2024].

Tanton, J., Dodd, L.J., Woodfield, L. & Mabhala, M. (2015) Eating behaviours of British university students: a cluster analysis on a neglected issue. *Advances in Preventive Medicine*, 2015, 639239. Available from: https://doi.org/10.1155/2015/639239

Teasdale, S.B., Latimer, G., Byron, A., Schuldt, V., Pizzinga, J., Plain, J. et al. (2018) Expanding collaborative care: integrating the role of dietitians and nutrition interventions in services for people with mental illness. *Australasian Psychiatry*, 26(1), 47–49. Available from: https://doi.org/10.1177/1039856217726690

Thorley, C. (2017) *Not by degrees: Improving student mental health in the UK's universities*, *Instiute for Public Policy Research*. Available from: www.ippr.org/publications/not-by-degrees [Accessed 30th July 2019].

Thorpe, M.G., Kestin, M., Riddell, L.J., Keast, R.S.J. & McNaughton, S.A. (2014) Diet quality in young adults and its association with food-related behaviours. *Public Health Nutrition*, 17(8), 1767–1775. Available from: https://doi.org/10.1017/S1368980013001924

Universities UK. (2017) *Minding our future*. Universities UK. Available from: https://www.universitiesuk.ac.uk/minding-our-future [Accessed 30th July 2019].

Valipour, G., Esmaillzadeh, A., Azadbakht, L., Afshar, H., Hassanzadeh, A. & Adibi, P. (2017) Adherence to the DASH diet in relation to psychological profile of Iranian adults. *European Journal of Nutrition*, 56(1), 309–320. Available from: https://doi.org/10.1007/s00394-015-1081-0

Vidal, E., Alvarez, D., Martinez-Velarde, D., Vidal-Damas, L., Yuncar-Rojas, K.A., Julca-Malca, A. et al. (2018) Perceived stress and high fat intake: a study in a sample of undergraduate students. *PLoS ONE*, 13(3), e0192827. Available from: https://doi.org/10.1371/journal.pone.0192827

Vos, T., Barber, R.M., Bell, B., Bertozzi-Villa, A., Biryukov, S., Bolliger, I. et al. (2015) Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: a systematic analysis for the global Burden of disease study 2013. *Lancet*, 386(9995), 743–800. Available from: https://doi.org/10.1016/S0140-6736(15)60692-4.Global

Watson, R. & Wyness, L. (2013) 'Don't tell me what to eat!' – ways to engage the population in positive behaviour change. *Nutrition Bulletin*, 38(1), 23–29. Available from: https://doi.org/10.1111/nbu.12003

Whiteford, H.A., Degenhardt, L., Rehm, J., Baxter, A.J., Ferrari, A.J., Erskine, H.E. et al. (2013) Global burden of disease attributable to mental and substance use disorders: findings from the global Burden of disease study 2010. *Lancet*, 382(9904), 1575–1586. Available from: https://doi.org/10.1016/S0140-6736(13)61611-6

Winpenny, E., Smith, M., Penney, T., Foubister, C., Guagliano, J.M., Love, R. et al. (2019) Changes in physical activity, diet and body weight across the education and employment transitions of early adulthood: A systematic review and meta-analysis. *Obesity Reviews*, 21, e12962. Available from: https://doi.org/10.1111/obr.12962

Winpenny, E.M., van Harmelen, A.L., White, M., van Sluijs, E.M.F. & Goodyer, I.M. (2018) Diet quality and depressive symptoms in adolescence: no cross-sectional or prospective associations following adjustment for covariates. *Public Health Nutrition*, 21(13), 2376–2384. Available from: https://doi.org/10.1017/S1368980018001179

Wolfson, J.A. & Bleich, S.N. (2015) Is cooking at home associated with better diet quality or weight-loss intention? *Public Health Nutrition*, 18(8), 1397–1406. Available from: https://doi.org/10.1017/S1368980014001943

World Health Organisation. (2018) *Obesity and overweight*. Available from: http://www.who.int/en/news-room/fact-sheets/detail/obesity-and-overweight [Accessed 5th December 2019].

World Health Organization. (2017) *Depression and other common mental disorders*. WHO. Available from: https://www.who.int/mental_health/management/depression/prevalence_global_health_estimates/en/ [Accessed 5th December 2019].

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