The association between diet quality and mental health of university students: a cross-sectional study

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I declare that this thesis is my own work and has not been submitted for the award of a higher degree elsewhere

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This thesis is dedicated to my parents Stavroula and Pantelis, for all they have done, and to my wife Eleftheria, for her constant love and support. I also dedicate this thesis to my daughters Sophia and Stavria, who were both born during my PhD journey.

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ABSTRACT

Background:

University students are at risk of experiencing mental health problems during the transition from home to university. This transition can also adversely affect their diet quality. There is a research gap in terms of understanding the relationship between diet quality and mental health of university students during their transition to universities in the UK.

Aim:

This study aimed to examine the bidirectional associations regarding the influence of diet quality on the mental health of university students, and vice versa. It also aimed to examine the impact of the transition to university on diet quality and mental health of university students.

Methods:

The study adopted a cross-sectional design. The study took place during the first semester of the academic year 2021-2022. Participants were first year undergraduate students at Lancaster University, University College London (UCL), Queen Mary University London (QMUL), and King's College London (KCL) living at student halls (university or private) for the first time. They were invited to participate by completing an online survey including a food frequency questionnaire, a mental health questionnaire, and a transition to university questionnaire.

Findings:

During the transition to university, a healthy diet of students was associated with better mental health in terms of depression, anxiety, and stress. Mental health issues experienced by university students were also associated with an unhealthy diet. A good quality of transition to university was associated with good mental health of students.

Conclusion:

There are implications for university policies and for health education research, as interventions to improve diet quality at the university level could reduce mental health issues; additionally, interventions to support students under stress may lead to healthier dietary habits when living on campuses. Further research including quasi-experimental studies, qualitative studies, longitudinal studies and intervention studies are needed to further investigate these implications.

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1 CHAPTER 1: Introduction

1.1 Background of the researcher

I am a psychiatry doctor (registrar) at NHS hospitals in North-Central London. I am currently doing a dual specialty in adult and old age psychiatry. I am also sub-specialising in liaison psychiatry and eating disorders. As well as a medical background, I also have a masters qualification in nutrition.

I am interested in public mental health, and specifically in the relationships between lifestyle and mental health difficulties. During my psychiatry training I have observed that university students often present to services with mental health issues. In combination with my interest in diet and nutrition, I wished to explore whether there are relationships between the diet quality and mental health of students during the transition to university.

1.2 Thesis structure

This thesis begins by describing the background to the research and some of the key concepts. These include the transition to university, the diet quality of students during the transition, the mental health of students during the transition, and the evidence for associations between diet and mental health in the general population. The thesis then moves on to describe the theoretical model (stress-diathesis model) that is used to understand the relationships between diet and mental health of students.

In order to identify gaps in the evidence worldwide but also specific to UK settings, the thesis then moves to a systematic literature review of the associations of diet quality with the mental health of students, as well as of the associations of mental health with the diet quality of students (chapter 2). This provides a reference point for the rest of the thesis, with findings from the review contributing to decisions about the methodology, as well as about the collection and analysis of primary data. A detailed description of the quantitative methodology is described in chapter 3.

Chapter 4 then presents the findings of the study. This chapter outlines the results of the study where the associations were explored by regression analysis, as well as by moderation.

These findings, and their implications for university policy, clinical practice and further research, are discussed with reference to existing literature in the discussion chapter (chapter 5). Strengths and limitations of the study are also considered.

The thesis ends with a short concluding chapter (chapter 6). Even though sufficient information for understanding and interpreting the results are included in the main sections, the thesis also includes an appendices section to provide further detail and clarification when needed.

1.3 Summary of the thesis focus

The transition to university life may affect diet quality, as well as mental health in general. We are observing a growing interest in the relationship of diet with mental health. However, there is a research gap in terms of the impact of diet on the mental health of university students, which is particularly important as students are at risk of adopting poor quality diets during their first year of university (Vadeboncoeur, Townsend, & Foster, 2015). Concurrently, there is an increased risk of mental health problems for first year university students (Kessler et al., 2005); the risk is particularly high for anxiety and depression (Westefeld et al., 2006). Current pharmacological and psychological approaches are not always successful at preventing or alleviating these issues. These approaches can also be expensive, which has wider implications if we can reduce the likelihood of mental health issues through diet; hence, diet could be a potential target for reducing the risk of developing anxiety and depression (Firth et al., 2019).

1.4 Definition of key constructs

1.4.1 Mental health

According to the World Health Organization (WHO), mental health is defined as "a state of mental well-being that enables people to cope with the stresses of life, realise their abilities, learn well and work well, and contribute to their community" (WHO, 2022). The definition also states that mental health exists on a complex continuum that different individuals can experience in various ways. Mental health conditions include mental disorders that are associated with significant distress, impairment in functioning, or risk of harm to self; individuals with mental health conditions are more

likely to experience lower levels of mental well-being, however this is not necessarily always the case (WHO, 2022).

1.4.2 Diet quality

When defining the concept of diet quality, a number of relevant heterogeneous terminologies have been in use by nutritional epidemiologists; these terms include " healthy diet, balanced diet, nutritious food, optimal nutrition, functional foods, overall health-promoting diet, nutrient-rich foods" (Alkerwi, 2014). Despite the existence of numerous definitions, a diet of good quality is perceived as a healthy diet that meets an individual's needs in order to reach optimal health (Elmadfa & Meyer, 2012). The term diet quality is also used in literature to define how compliant an individual is to dietary recommendations (Alkerwi, 2014). Such recommendations include those of the Food Standards Agency in the UK (FSA, 2022). For example, these guidelines include advice about the intake of fruit (≥2 servings/day), vegetables (≥3 servings/day), oily fish (≥200g/week), fat (≤85g/day), and non-milk extrinsic sugars (≤60g/day) (Cleghorn et al., 2016).

1.4.3 Transition

Although definitions of the term transition vary according to the focus of the discipline, it is overall recognised that transition is about how people respond during a period of change (Kralik, Visentin, & van Loon, 2006). Transition occurs over time and involves changes that can be of developmental, personal, relational, situational, societal or environmental nature. During the transition these changes require adaptation, and often a reconstruction of the perceived self-identity (Kralik et al., 2006).

1.5 The stress-diathesis model

The stress-diathesis model is a model that can facilitate our understanding of how pre-dispositional factors from various domains can cause susceptibility to psychopathology, and eventually lead to conditions that are sufficient for the development of a disorder, such as a mental health disorder (Ingram & Luxton, 2005). It encompasses multiple factors contributing to psychopathology, including biological vulnerabilities, psychological susceptibilities, social variables, environmental variables, as well as developmental experiences (Ingram & Luxton, 2005).

Stress can be viewed as "the occurrence of life events that are interpreted as being undesirable by the person experiencing these events" (Lazarus & Folkman, 1984). These life events may either be major or minor; when they happen, they disrupt the mechanisms that normally maintain the stability

of a person's emotion, physiology and cognition (Ingram & Luxton, 2005). Stress can strain the capability of a person to adapt, leading to interruptions in routine and functioning; hence, stress represents the factors that cause interference to physiological and psychological homeostasis of systems (Selye, 1998). In the context of my study, the stressor is considered to be the transition to university.

Another important concept is diathesis, otherwise known as vulnerability. The word diathesis is derived from the ancient Greeks, who had formed a theory in relation to body fluids, temperament and disease (Zuckerman & Riskind, 2000). Diathesis is considered to encompass a factor or a set of factors that predispose individuals to a possible disordered state (Ingram & Price, 2010). In the context of mental health, these factors were initially considered to either be genetic or biological. More factors were eventually considered, including psychological factors, interpersonal variables and cognitive variables (Monroe & Simons, 1991). Some consider diathesis to be permanent and enduring, such as when the vulnerability is of genetic nature (Zubin & Spring, 1977); in other cases there may be scope for modification of the vulnerability, for example when vulnerability is of psychological nature (Ingram & Luxton, 2005). It is generally thought that vulnerability is a trait that is stable but can change, is latent and endogenous to every individual (Ingram & Luxton, 2005). This means that a stressor can lead to instability of the trait, leading to the development of mental health issues; however, this process can vary from person to person.

Although the stress-diathesis model has traditionally been considered in the context of mental health, I am also considering this model in the context of diet quality. There are various factors, or vulnerabilities, that can pre-dispose individuals to following unhealthy diets. These vulnerabilities include poor mental health itself. For example, when a stressor presents during the transition period, such as loss of income or the cost of living crisis, individuals with mental health vulnerabilities may experience a deterioration of their mental health. This, in combination with food insecurity issues, can impede access to healthy foods, leading to following diets of poor quality. Previous studies are in support of this notion, for example it has been reported that students experiencing stress consume junk foods more frequently than students that do not experience stress (Almogbel, Aladhadh, Almotyri, Alhumaid, & Rasheed, 2019).

Vulnerabilities for developing mental health and/or diet quality issues may become unstable specifically during a transition- such as the transition to university. These vulnerabilities can be of biological, psychological or social nature. For the purpose of my study, I considered these vulnerabilities/diatheses to include poor diet quality, high BMI, low exercise levels, female sex, rural university location, and perfectionistic traits for the development of mental health difficulties (figure

1). I also considered these vulnerabilities/diatheses to include poor mental health, high BMI, low exercise levels, male sex, rural university location, and perfectionistic traits for the development of diet quality issues (figure 2).

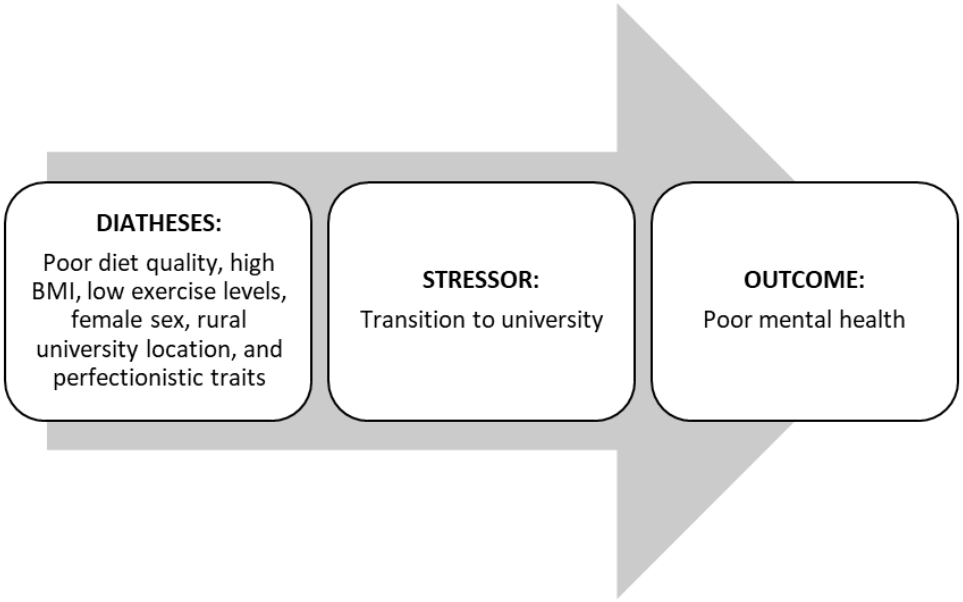


Figure 1. Diatheses for poor mental health considered by the study, as according to the stress-diathesis model

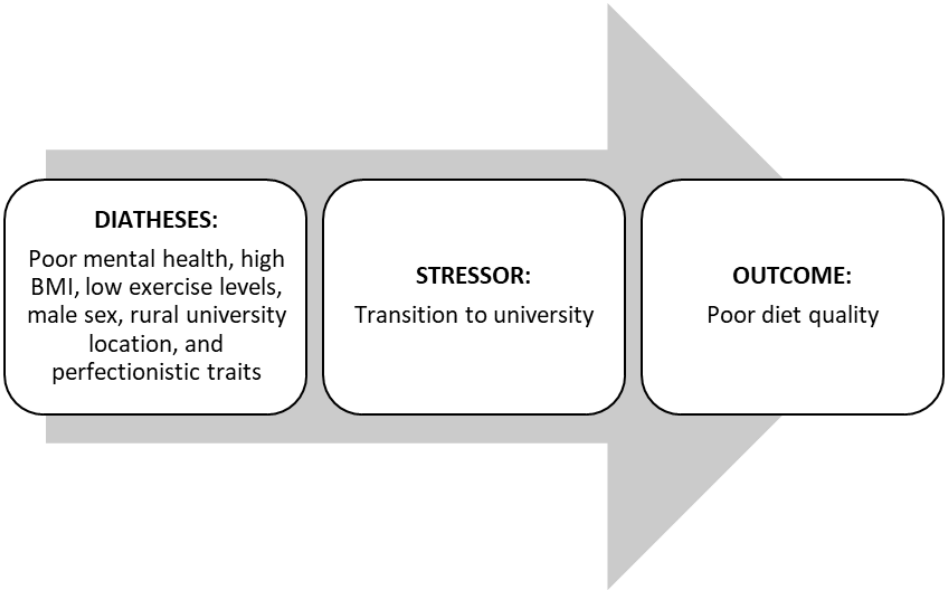


Figure 2. Diatheses for poor diet quality considered by the study, as according to the stress-diathesis model

Apart from the stress-diathesis model, I considered alternative models that could be applied for the purposes of the study. One of these models was the social identity theory of change (Tajfel & Turner, 2004). According to this model, social identity groups give a sense of belonging and a sense of comfort in terms of individuals feeling they are not alone in their experiences. The model also suggests that social identity groups give a sense of purpose, self-worth, and identity. When change occurs, such as during the transition to university, it might be the case that students lose their social identity groups, and as a consequence lose their sense of belonging, purpose, and self-worth, whilst experiencing a change in their identity. The reason I chose the stress diathesis model over the social identity model of change is that the stress diathesis model takes into consideration various dimensions of factors that are involved during the transition to university, including biological, psychological and social factors. On the contrary, the social identity model addresses the social factors that contribute to difficulties during the transition to university, but does not necessarily address the biological or psychological factors.

1.6 Students' mental health during the transition to university

University students appear to be at risk of experiencing mental health problems during the transition to university. In the USA, it is estimated that up to 50% of the students living on university campuses can be affected by mental health problems (Blanco et al., 2008). This observation appears to be an international issue. A meta-analysis (Ibrahim, Kelly, Adams, & Glazebrook, 2013) of 34 international studies measuring the prevalence of depression in university students (of various years) between 1990 and 2010 showed an average prevalence of 30.6%. These rates are substantially higher than those found in the general population, where the prevalence has been found to be approximately 11% (Lim et al., 2018).

During their transition to university, students may experience stressors of family, personal or social nature; these include increased freedom, potential lack of social support, a heavier extra-curricular workload, high academic expectations, and the need to determine a vocational choice (Schwartz, Côté, & Arnett, 2005). Certain groups may be at increased risk of mental health deterioration during the transition period to adulthood. For example, a Canadian study involving first year university students identified female and LGBT students as being at increased risk of depressive symptoms (Villatte, 2017).

1.7 Students' diet during the transition to university

Previous studies have reported the diet quality of students to be adversely affected during the transition period to university. Reports from the Netherlands state that 40% of students change their eating patterns during their first semester (de Vos et al., 2015), such as increasing the consumption of fast food, relying more on take-out food, and less on fresh food (Graham & Jones, 2002; Lowry et al., 2000). These modifications of diet quality can lead to a phenomenon called "Freshman 15", which refers to gaining 15 lb (6.8 kg) of weight during the first year of university (Brown, 2008). This phenomenon has been observed in various countries. For example, a meta-analysis included studies from the United States, Canada, United Kingdom and Belgium and showed a weight gain of 1.4 kg over two terms (Vadeboncoeur et al., 2015). This weight gain is five times higher compared to the general population over a year and has been observed in at least two thirds of students during their first year of university (Levitsky, Halbmaier, & Mrdjenovic, 2004).

In the UK, it was found that first year students gained a significant amount of weight (2.55kg) over their first semester, resulting in an increase in body mass index (BMI) of 0.93 kg/m2 (Cockman, O'Reilly, & Mellor, 2013). Interestingly, this phenomenon was not observed in final year students, whose weight did not change during the first semester of their final year. These observations suggest that the first year of university (and particularly the first semester) is a critical period where lifestyle changes can affect diet quality and lead to non-favourable weight changes.

A study of first year students in the UK found that 56% of the participants consumed at least "a few" takeaways or fast food meals each week (Sprake, Lavin, Russell, Grabowski, & Barker, 2015); moreover, only 20% consumed fruit and vegetables daily (Sprake et al., 2015). Hence, frequent takeaways and lack of fruit and vegetable consumption appear to characterise the diet of first year UK university students.

Students living on campus for the first time may be particularly susceptible to unfavourable diet changes, as they are exposed to high availability of unhealthy foods. For example, in the USA most students move to the campus of the university, where they typically have "all-you-can-eat" meal plans (Levitsky, Garay, Nausbaum, Neighbors, & Dellavalle, 2006). This means that apart from diet quality, diet quantity may also be affected.

Other factors of relevance to diet quality include alcohol consumption, as UK students who reported a weight gain of 3.2-6.4 kg were more likely to consume alcohol on one or two nights of the week (Sprake et al., 2015). Moreover, UK students reporting extremes of weight gain were more likely to attribute a lack of "knowledge or skills to cook healthily" to their weight gain (Sprake et al., 2015).

1.8 Association of mental health with diet quality: current evidence

Studies investigating the effect of mood on diet quality are limited for students, as well as for the general population. Most available studies have been observational and investigated the effects of stress on diet quality. For example, high school students were found to have significantly higher energy intake on their exam day compared to a stress-free day (Michaud et al., 1990). A study followed 65,342 adults for 3.6 years and found that high stress was associated with poorer diet quality, however the associations were weak (Schweren et al., 2021). Additionally, a study of 1634 adults found that diet quality was significantly worse among subjects with a current depressive or anxiety disorder compared to healthy controls (Gibson-Smith, Bot, Brouwer, Visser, & Penninx, 2018).

It has been suggested that lack of motivation in depressed individuals could be of relevance, as healthy foods may require more time and cooking skills compared to unhealthy foods which may be easier and quicker to prepare (Gibson-Smith et al., 2018).

1.9 Association of diet quality with mental health: current evidence

Even though there is a scarcity of studies investigating the association of diet quality with mood in university students, relevant studies involving the general population are more abundant. These studies have mainly focused on the effects of diet on depression. A meta-analysis (Firth et al., 2019) of randomised controlled trials (RCT) examined the efficacy of dietary interventions for symptoms of depression in both clinical and non-clinical populations. Evidence was found that dietary interventions had a small-moderate effect on improvement of depressive symptoms. The results are summarised in table 1.

The findings described above were in agreement with the findings of another systematic literature review (Nicolaou et al., 2019), which examined cross-sectional studies from Italy, Netherlands, Australia and the UK. Depressive symptoms were investigated in relation to a-priori dietary measures. Inverse associations of small-moderate effect size were found between diet quality scores and depressive symptoms. The results are summarised in table 2.

Additionally, the findings of another systematic literature review (Lassale et al., 2019) were also in agreement to the findings of the above reviews, as adherence to a high quality diet was associated with reduced risk for depression. The review included 20 longitudinal and 21 cross-sectional studies, and the results are summarised in table 3.

Table 1. Results of a meta-analysis of RCT by Firth et al. (2019) investigating the effect size of dietary interventions for symptoms of depression

Studies included	Effect size	95% CI	p	n
All 16 studies (taking publication bias into account)	g = 0.408 (small-moderate)	0.2 to 0.60	< 0.01	45,826
11 studies with high quality assessment scores	g =0.321 (small-moderate)	0.12 to 0.53	=0.002	45,469
Studies comparing dietary interventions with habitual diet	g=0.308 (small-moderate)	0.02 to 0.6	= 0.038	44,319
Studies comparing dietary interventions to active control	g = 0.174 (small)	0.01 to 0.34	<0 .001	1,948

Table 2. Results of cross-sectional and prospective analyses for the associations of diet quality measures with depressive symptoms (Nicolaou et al., 2019).

Mediterranean diet score (MDS), Alternative Healthy Eating Index (AHEI-2010), Dietary Approaches to Stop Hypertension (DASH)

Diet quality measure	Type of analysis	OR	95% Confidence interval	Effect size
MDS	Cross-sectional	0.87	0.84–0.91	Small-moderate
AHEI-2010	Cross-sectional	0.93	0.88–0.98	Small
DASH	Cross-sectional	0.94	0.87-1.01	Small
MDS	Prospective	0.88	0.80–0.96	Small-moderate
AHEI-2010	Prospective	0.95	0.84-1.06	Small
DASH	Prospective	0.90	0.84-0.97	Small

Table 3. Results of a systematic review of observational studies by Lassale et al. (2019): effects of adherence to a high quality on depression risk.

Mediterranean diet score (MDS), Dietary inflammatory index (DII), Healthy eating index (HEI), Alternative Healthy Eating Index (AHEI)

Diet quality measure	Combined relative risk estimate for depression of highest vs. lowest adherence	95% Confidence Interval	Effect size	Type and location of studies
MDS	0.67	0.55–0.82	Moderate	Four longitudinal studies (Australia, France, Spain)
DII	0.76	0.63–0.92	Small-moderate	Five longitudinal studies (UK, US, France, Australia, Spain)
HEI/AHEI	0.65	0.50–0.84	Moderate	Three longitudinal cohort studies (UK, Spain, France)

Overall, the above reviews suggest that adhering to a healthy diet and avoiding a pro-inflammatory diet can reduce the risk of experiencing depressive symptoms or clinical depression. Effect sizes were small or moderate.

The actual mechanisms by which dietary changes may affect mental health have not currently been fully established. Previous studies have suggested some potential biological mechanisms that may moderate the associations of diet with mental health. For example, the favourable impact of high quality diets could be related with the high content of antioxidants in fruits and vegetables (Y. Li et al., 2017). There is also increased consensus that inflammation may have adverse effects, especially as inflammation is a core feature of aetiological models of depression (Köhler et al., 2017). It has been shown that reducing the body mass index of adolescents through a healthy diet can decrease both inflammation and depression risk (Oddy et al., 2018). However, good diet quality has a positive effect on mental health even without altering the weight of the participants (Jacka et al., 2017). This means that there may be additional relevant mechanisms, such as gut microbiota dysbiosis (Marx, Moseley, Berk, & Jacka, 2017), oxidative stress and mitochondrial dysfunction (Morris et al., 2017), as well as effects on endothelial cells (Sánchez-Villegas et al., 2009).

There may also be relevant psychological and social mechanisms. Hence, the focus of this thesis is on relevant psychological and social mechanisms that may moderate the associations of diet with mental health of students, which are considered in the context of the stress-diathesis model. My study considers the transition to university as the stressor, and explores various parameters that could act as vulnerabilities during the transition to university, examples of which are discussed in the next sections.

1.10 Transition to university: a stressor for students

The transition to university can be challenging and can have both positive and negative effects. Positive effects include developing independence, life-long friendships, and networking. However, life transitions can have adverse effects on the students' wellbeing. Even when the outcome of the life transition is positive (such as gaining new skills and paid employment), the change process can still be unpleasant and associated with life dissatisfaction (Jetten, O'Brien, & Trindall, 2002).

The transition to university involves changes necessitating academic adjustment, social adjustment, personal-emotional adjustment, and institutional adjustment (Baker & Siryk, 1984). Change is often a cause of uncertainty and is associated with a lack of knowledge, which in turn can induce stress and anxiety (Schweiger & Denisi, 1991). When change happens, students are unlikely to have mastered skills and knowledge necessary to achieve success in their new environment- a process which requires time and experience (Robbins et al., 2004).

Life transitions also involve a change in group membership (Iyer, Jetten, Tsivrikos, Postmes, & Haslam, 2009). Students have previously reported low well-being two months after starting university (Iyer et al., 2009); they were more likely to perceive their university identity as incompatible with their old identity, and also had fewer group memberships (Iyer et al., 2009).

Another issue during the transition to university is that students can lose their usual routines and rhythms, and are faced with the challenge of establishing their own schedules and social rhythms, whilst at the same time having to deal with academic demands and their own personal tasks (Fischer et al., 2020). The loss of the home practical and social rituals can also impair the body's capacity to maintain biological rhythms- such as appetite rhythms (Frank, Swartz, & Boland, 2007).

1.11 Vulnerabilities of students during the transition to university

1.11.1 Vulnerabilities of students: Financial difficulties, food security, loss of home

During the transition to university, the loss of home food can mean that students are now faced with the challenge of preparing their own meals, as well as having to shop by themselves. Food security and financial difficulties are known issues during university studies (Archuleta, Dale, & Spann, 2013), which can affect the quality of food and ingredients that students choose to buy and cook.

The loss of "the tastes of home" may be of particular relevance to students moving from other countries to study in the UK. International students might be faced with dietary acculturation (Shi, Lukomskyj, & Allman-Farinelli, 2021), which can have an impact on their wellbeing. For example, this phenomenon has been observed by studies of immigrants, who attempt to alleviate their depression with foods familiar of their upbringing (Harris, Lyon, & McLaughlin, 2005).

1.11.2 Perfectionistic traits: a vulnerability

In addition to the above vulnerabilities, perfectionism may also be a relevant vulnerability of students during the transition to university life, as students often feel pressure to achieve the perfect university experience. Perfectionism is a personality trait that involves striving for flawlessness and perfection (Stoeber & Childs, 2010). When perfectionism occurs within normal limits, perfection is pursued without compromising self-esteem; however when perfectionism becomes self-critical, unrealistic goals are pursued followed by disappointment once not achieved (Hamachek, 1978).

Perfectionism is prevalent in university students that are highly motivated (Curran & Hill, 2019), and may increase the risk of developing mental health difficulties. A downward-spiral model with self-critical perfectionism may explain why self-critical perfectionism is related to poor mental-health outcomes during the transition to university (Levine, Milyavskaya, & Zuroff, 2020). According to this model, perfectionism leads to experiencing stress and depression in an additive manner, with outcomes becoming sustained over time (Levine et al., 2020).

1.11.3 Healthy cooking competencies among university students: a vulnerability

In the USA, a survey by the American College Health Association reported that 21.7% of college students were found to be overweight and 12% were found to be obese (American College

Health Association, 2013); moreover, only 5.6% of students were found to eat five or more servings of fruits and vegetables on a daily basis.

Previous research has suggested that as students mostly eat away from home, their ability to cook meals for themselves may be influenced by their level of confidence about food preparation, cooking skills, and time constraints (Escoto, Laska, Larson, Neumark-Sztainer, & Hannan, 2012). For example, students may find it easier to purchase pre-prepared meals from supermarket freezers or take-aways, rather than preparing their meals themselves (Murray et al., 2016).

Research has shown that when students cooked meals socially in the company of roommates or friends, this led to more frequent preparation of healthy meals (Hartman, Wadsworth, Penny, van Assema, & Page, 2013). However, there are barriers to this, such as planning meals that everyone likes, and finding a convenient time for everyone to cook and eat together (Blichfeldt & Gram, 2013).

Studies have suggested that factors that can contribute to unhealthy eating habits in the student population include the lack of culinary and basic nutritional knowledge, as well as high accessibility to low-cost convenience and fast foods; these factors can limit feelings of control when students make dietary choices (Garcia, Sykes, Matthews, Martin, & Leipert, 2010). Research also suggests that a hands-on involvement in food preparation can enhance the diet quality of students (Larson, Perry, Story, & Neumark-Sztainer, 2006); moreover, it has been found that young people raised in a family environment with hands-on food preparation can demonstrate feelings of efficacy and superior dietary habits (Larson, Neumark-Sztainer, Hannan, & Story, 2007).

In line with the above findings, a study involving focus groups of students in the USA have identified three major themes that may limit the students' ability to prepare and consume healthy meals (Murray et al., 2016); specifically, the themes were health perceptions, life influences, and barriers to cooking and eating healthy. In more detail, students may struggle to maintain a high quality diet due to facing the effects of limited personal time and resources, including money and shopping/preparing time. They may also experience the effects of limited access to food, difficult work and school schedules, as well as experience the effects of inheriting familial meal patterns including low family engagement in food preparation and dining, They may also struggle to create a cohesive food group with friends and roommates due to differing schedules.

1.12 The relevance of health education

Current practices for addressing the mental health of university students include counselling (McKenzie, Murray, Murray, & Richelieu, 2015), as well as cognitive, behavioural and mindfulness

interventions (Regehr, Glancy, & Pitts, 2013), and pharmacological therapy. Dietary practices include dietary counselling with nutritionists/dietitians (Akiki et al., 2023).

In addition to these practices, health education could help raise the awareness of students in regard to how diet and mental health are related, so that a positive attitude is maintained towards both good mental health and healthy diets. Understanding this relationship between the diet quality and mental health of students during the transition to university could have important implications in health education practice; it may enable students to improve and preserve their well-being during the transition to university, by taking action to protect their mental health and by maintaining healthy diets.

1.13 Chapter summary

This study is about the associations of diet quality with mental health (and vice versa) of students during their transition to university. Previous research involving the general population suggests a beneficial effect of good diet quality on mental health. These relationships have not been extensively studied in student populations during their transition to university.

The transition to university can be a stressful period for students in terms of psychological, social and academic adjustments. Previous research suggests that during the transition to university the diet quality of students deteriorates, often relying on unhealthy take away food and less on freshly prepared healthy meals which can lead to gaining weight. Previous research also suggests that students are prone to developing mental health issues, such as anxiety and depression, during the transition to university. In order to understand the relationships between diet and mental health during the transition to university, I am interrogating data in the context of the stress-diathesis model, where the transition acts as the stressor for students that may have a vulnerability for following poor quality diets and/or developing mental health difficulties. Examples of vulnerabilities of students during the transition to university include financial difficulties, food security, loss of home, perfectionism, lack of knowledge to shop and cook healthily.

2 CHAPTER 2: Systematic Literature Review

This chapter has been published as a paper (Solomou, Logue, Reilly, & Perez-Algorta, 2023) at the Health Education Research journal (Impact factor 2.365):

Solomis Solomou and others, A systematic review of the association of diet quality with the mental health of university students: implications in health education practice, *Health Education Research*, Volume 38, Issue 1, February 2023, Pages 28–68, https://doi.org/10.1093/her/cyac035

2.1 Introduction

The transition to university can have both positive and negative effects. Positive effects include developing independence, life-long friendships and networking. But even when the outcome of the life transition is positive (such as gaining new skills and paid employment), this experience can still be unpleasant and associated with life dissatisfaction (Jetten et al., 2002). Some examples of challenges refer to academic, social, personal-emotional, and institutional adjustments (Baker & Siryk, 1984). Change is often a cause of uncertainty, which in turn can induce higher levels of stress and anxiety (Schweiger & Denisi, 1991).

The transition to university may affect mood and overall mental health. This is a period of increased risk of onset of mental health problems (Kessler et al., 2005), particularly for the onset of depression and anxiety (Westefeld et al., 2006).

In the USA, it is estimated that up to 50% of the students living on university campuses can be affected by mental health problems (Blanco et al., 2008). This observation appears to be an international issue. A meta-analysis of 34 international studies with university students of various years between 1990 and 2010, showed an average prevalence of depression of 30.6% (Ibrahim et al., 2013). Rates were substantially higher than those found in the general population (~ 11%) (Lim et al., 2018). However, there are studies that have not detected differences in the mental health of students and non-students (Tabor, Patalay, & Bann, 2021). The differences in the findings examining mental health prevalence statistics could be attributed to the various methods used by studies, as ways in which symptoms have been assessed are not always appropriate for establishing prevalence per se.

Definitions of mental health may also vary. The World Health Organisation (WHO) defines mental health as “our emotional, psychological, and social well-being” (WHO, 2018). The terms mental health and mental illness may be used interchangeably, however a person may experience poor mental health even without being diagnosed with a mental illness (CDC, 2022). For this reason, in order to better understand the various dimensions of mental health, it may be appropriate to look for a broad range of studies that use constructs assessing for 'mental health'; these may vary from specific symptom measures, to well-being measures, to positive self-concept, as well as include constructs such as resilience and self-concept.

The transition to university also appears to affect the diet quality of students, as this period is characterised by students adopting poor quality diets (Vadeboncoeur et al., 2015). A meta-analysis of studies conducted in the United States, Canada, United Kingdom and Belgium, showed a student weight gain of 1.4 kg over two terms (Vadeboncoeur et al., 2015). This increment in weight is five times higher than the weight gain expected in the general population over a period of one year. In the USA, this has been observed in at least two thirds of students during their first year of university (Levitsky et al., 2004). These changes in diet quality are characterised by increments in the consumption of fast food, relying more on take-out food, and less on fresh food (Graham & Jones, 2002; Lowry et al., 2000).

Organisations, such as the Food Standards Agency in the UK have issued guidelines as to what a good quality diet should consist of (FSA, 2022). For example, these guidelines include advice about the intake of fruit (≥2 servings/day), vegetables (≥3 servings/day), oily fish (≥200g/week), fat (≤85g/day), and non-milk extrinsic sugars (≤60g/day) (Cleghorn et al., 2016). There are also specific types of diets that are in line with the above recommendations, such as the Mediterranean diet which consists of fruits, vegetables, whole grains, seafood, beans, and nuts, and whose health benefits have been reported in previous literature (Martínez-González et al., 2015). Various diet quality measures have been devised to capture the quality of a diet according to guidelines such as the ones mentioned above, although studies often use food frequency questionnaires without considering a diet quality instrument.

Although not the only factor, poor quality diet has been considered as a risk factor of mental health problems (Lassale et al., 2019), and some argue that mental health issues could impact diet quality too (Lyzwinski, Caffery, Bambling, & Edirippulige, 2018). Understanding this relationship could have important implications in health education practice. Current practices for addressing the mental health of university students include counselling (McKenzie et al., 2015), as well as cognitive,

behavioural and mindfulness interventions (Regehr et al., 2013). More recently, the above interventions are being available via the internet in addition to sessions in person by university counsellors (Harrer et al., 2019; Regehr et al., 2013). Educating students about mental health has also been shown to be effective (Merritt, Price, Mollison, & Geddes, 2007). In some cases, students utilise pharmacological options, such as antidepressants prescribed by general practitioners or psychiatrists (Collin, Simard, & Collin-Desrosiers, 2013). However, pharmacological and psychological interventions may not always be able to prevent or resolve mental health issues, hence diet could be a potential target for the prevention and adjunct treatment of anxiety and depression of students (Firth et al., 2019).

Even though there is a scarcity of studies investigating the association of diet quality with mood in university students, relevant studies involving the general population are more abundant. These studies have mainly focused on the effects of diet on depression. Reviews of cross-sectional studies have shown inverse associations of small-moderate effect size between diet quality scores and depressive symptoms (Lassale et al., 2019; Nicolaou et al., 2019). Moreover, a recent meta-analysis of randomised controlled trials examined the efficacy of dietary interventions for symptoms of depression in both clinical and non-clinical populations (Firth et al., 2019). This review showed evidence that dietary interventions had a small-moderate effect on improvement of depressive symptoms. Examples of dietary interventions that were used included individualised dietary counselling, group dietary classes, and standardised dietary prescription. In view of the above evidence, there is scope to understand the influence of diet on mental health of students and vice versa by performing a systematic literature review of relevant observational studies. Moreover, establishing a link between diet quality and mental health may be used for practical support involving interventions that could improve both diet quality and mental health of students.

To better understand the associations between diet and mental health, this review aimed to interpret study findings in the context of the stress-diathesis model (Schotte, Van Den Bossche, De Doncker, Claes, & Cosyns, 2006). Stress-diathesis models are models that can facilitate our understanding of how predispositional factors from various domains can cause susceptibility to psychopathology, and eventually lead to conditions that are sufficient for the development of a mental health disorder (Ingram & Luxton, 2005). These models may encompass multiple factors contributing to psychopathology, including biological vulnerabilities, psychological susceptibilities, social variables, environmental variables, as well as developmental experiences (Ingram & Luxton, 2005).

The review aimed to interpret findings whilst taking into consideration the various risk factors that can affect students with a biological, psychological, or social vulnerability to mental illness or to bad diet quality. This in line with both the stress-diathesis model, as well as the biopsychosocial model of health and illness (Engel, 1977; Papadimitriou, 2017). Biopsychosocial factors linked to mental health include stress, stressful life events, body image, physical activity, sleep, social support, use of alcohol or illicit drugs. There are also biopsychosocial factors linked to diet, such as availability and access of pre-prepared meals/fast foods on campus, lack of cooking skills, lack of culinary and basic nutritional knowledge, no previous hands-on involvement in food preparation in the family environment, limited resources including money for shopping, no easy access to healthy food, and lack of companionship during meal times (Murray et al., 2016). Hence, we aimed to look for moderators or mediators of the association between diet and mental health, in recognition that mental health and diet quality difficulties are multifaceted and underpinned by complex biopsychosocial processes.

Scoping searches did not identify any previous systematic literature reviews appraising both directions of the influence of diet quality on the mental health of university students, and vice versa. However, one previous systematic review appraising the association of mental health with the diet quality of students (Lyzwinski et al., 2018) was identified, which was published in 2018; further scoping searches showed that at least eight relevant studies were published since 2018. In 2021, another systematic review appraised the opposite direction of the association, i.e. the influence of diet on the mental health of students (Saha, Okafor, Biediger-Friedman, & Behnke, 2021); further scoping searches showed that at least six relevant studies were published since the data search of this review was done. None of these reviews assessed both directions of the association between diet quality and mental health. Even though studies have been treating associations with diet and mental health, and associations with mental health and diet as separate, in reality most research cannot establish whether one is predicting the other, as they are associations. In view of this, I feel that a full picture can only be obtained by including studies in the review that have assessed either direction of the association.

Hence, the current review aims to provide knowledge by appraising studies investigating the influence of diet quality on the mental health of university students, and vice versa. This is important as findings may have implications in health education practice. The review aims to appraise studies that have been assessed by the previous reviews (Lyzwinski et al., 2018; Saha et al., 2021), as well as studies that have never been appraised before.

Given the fact that scoping searches indicated the majority of studies to be cross-sectional, the review did not aim to answer the question of causation in regard to the relationship between diet and mental health. Instead, the review aimed to examine the bidirectional associations from observational studies regarding the influence of diet quality on the mental health of university students, and vice versa. The review hypotheses were as follows:

1. Good diet quality will have a beneficial effect on mental health parameters, and/or bad diet quality will have a detrimental effect on mental health parameters.
2. Good mental health will have a beneficial effect on diet quality, and/or bad mental health will have a detrimental effect on diet quality.

2.2 Methods

This systematic review followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2009) and was registered in the PROSPERO International Prospective Register of Systematic Reviews (number CRD42020196336 at www.crd.york.ac.uk/PROSPERO). There were no discrepancies between the initial protocol and the processes that were followed.

2.2.1 Search strategy:

A search of the literature was performed on the 1st of July 2020 (date range for searches was from inception to 1st of July 2020). The searches were re-run on the 15th of July 2022 in order to update the review with recent studies (figure 1). The databases PubMed, CINAHL, EMBASE, PsycINFO, The Cochrane Library and Web of Science were searched by using the following search terms:

Student* AND (Diet* OR Nutrition OR Eat* OR Food OR Weight gain) AND (Mood OR Depress* OR Anxiety OR Stress OR Mental health).

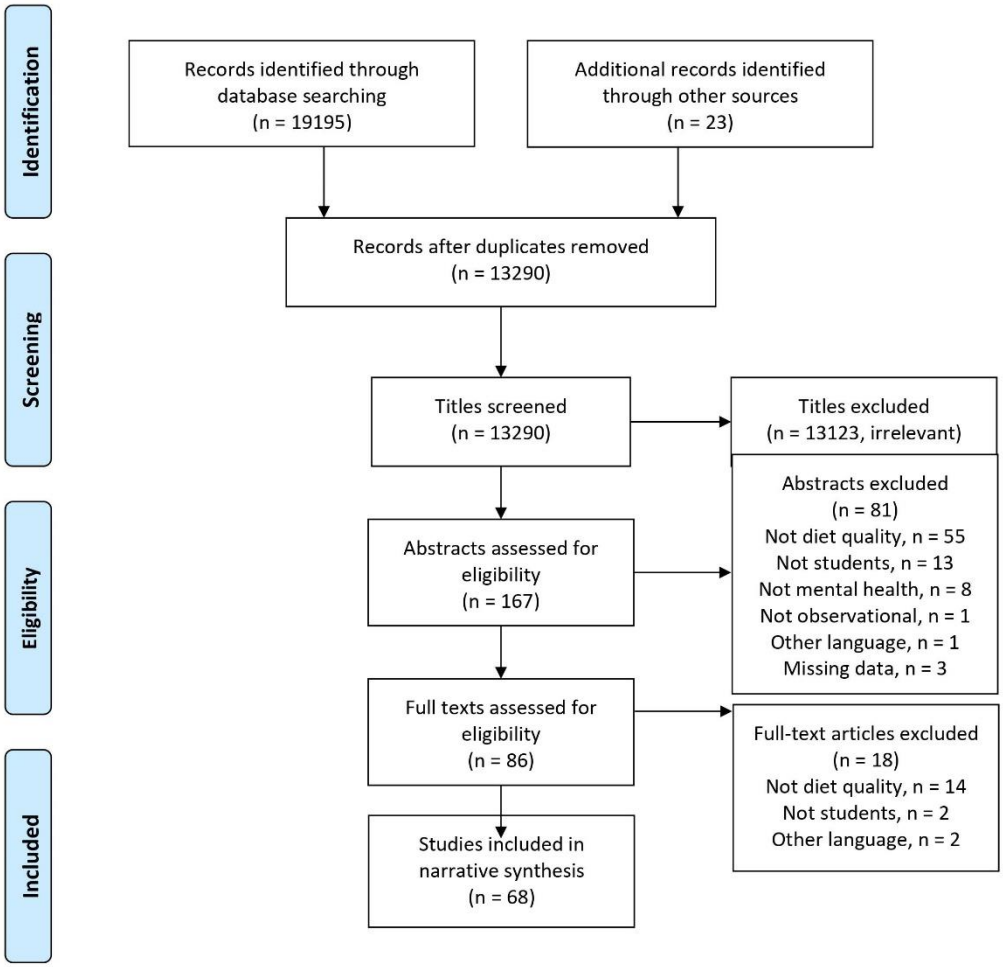


Figure 3. Flowchart of selected studies

"Weight loss" was not included in search terms as previous studies have reported a weight gain (rather than weight loss) in students transitioning to university. Moreover, weight loss in depression would be more relevant to lack of appetite, which is not the focus of this review.

Both medical subject headings (MeSH) and free-text terms were incorporated, which were adapted according to the database searched. Google Scholar, OpenGrey and ResearchGate were also searched in order to identify any relevant grey literature. This strategy was followed in order to ensure a broad coverage of studies. The reference lists of the included studies and reviews were hand searched in order to identify any additional papers of relevance. Where further information was required, authors of retrieved studies were contacted.

2.2.2 Inclusion and exclusion criteria:

The review included studies published in peer reviewed journals or grey literature, including cross-sectional and longitudinal studies, as well as review studies of observational evidence. Scoping searches did not identify any relevant intervention studies, randomised controlled trials, or qualitative studies. Intervention studies examining only individual foods/nutrients or focusing only on a single food component were not considered eligible, as the focus is on whole of diet associations and effects. Hence, the focus was on observational studies, as the review aimed to gain insight into the associations of diet quality with the mental health (and vice-versa) of university students in their natural environment without any external interventions.

Publication languages included English, Greek, and Spanish (as these are the authors' languages). There were no publication period restrictions.

Studies were included if they involved participants that were university students of any ethnic origin, gender and age, studying in any country, with or without a mental health diagnosis (such as depression and/or anxiety).

Studies were excluded if they involved participants that were not university students, if they studied associations of mental health with single macro/micronutrients rather than overall diet quality, or if they studied associations of mental health with nutritional supplements rather than diet quality. Studies were also excluded if they focused on disordered eating behaviours rather than on diet quality.

2.2.3 Main outcomes:

The main outcomes included depression or anxiety or depressive/anxiety symptoms or other mental health symptoms (assessed by relevant scales, or as experienced subjectively by participants, or as diagnosed by health professionals), and diet quality. The review included studies using diet measures (such as food frequency questionnaires) and/or diet quality scores obtained from diet quality instruments.

2.2.4 Screening:

Titles were screened by author SS for inclusion, followed by screening of abstract and then content. Full texts were obtained in cases where abstract eligibility was considered uncertain, or if title eligibility was considered uncertain and abstracts were not available. Studies were included at the abstract screening stage if abstracts were in English, Spanish or Greek, but studies were excluded if their full texts were in other language. Authors of studies were contacted when there was not enough information to decide whether a study met the inclusion criteria. All screening steps were discussed with author GPA. The studies meeting the inclusion criteria were selected for the review as summarised in Figure 1.

2.2.5 Data extraction:

Data were extracted from observational studies by using the relevant sections of the Cochrane good practice data extraction form. Data were extracted from reviews by using a modified version of the NICE extraction form (NICE, 2021). The data were extracted in an electronic format in order to achieve effective time management and reduce any errors during data entry.

The extracted data included the following: authors, year of publication, setting, study design, sample size, geographical location, follow-up time (if applicable), demographic and clinical characteristics of participants, measures used (where applicable) and main findings (dietary assessment tool used and score used, assessment of depression and/or anxiety, depressive and anxiety symptoms scale and threshold used), confounders used, and relevant statistics. In cases where various analyses were completed, the analysis that had taken the largest number of confounders into consideration was used.

2.2.6 Risk of bias/quality assessment:

The quality of studies was scored into high, medium and low quality by using the Newcastle-Ottawa Quality Assessment Scale (adapted for cross-sectional studies) (Modesti et al., 2016). This instrument has a highest score of ten, with 5 points being allocated to selection (representativeness of the sample, sample size, non-respondents, ascertainment of the exposure), 2 points being allocated to comparability, and 3 points being allocated to outcome (including assessment of outcome and statistical tests). The guidance of the Centre for Reviews and Dissemination (Centre for Reviews and Dissemination, 2009) was used for appraising the quality of review papers. Where appropriate, discussion between the authors was used to resolve any uncertainties.

2.2.7 Strategy for data synthesis:

A narrative synthesis review (Popay et al., 2006) of observational studies (and of reviews of observational studies) reporting associations of diet quality with mood and mental health of university student populations (with or without an established mental health diagnosis), and vice-versa, was performed. This was considered to be the best approach to analyse the observational data available.

2.3 Results

Following title screening of 13290 articles, 167 abstracts were read in full and assessed against the inclusion and exclusion criteria. 86 full-text articles that met the inclusion criteria were then retrieved, and the full texts were subsequently screened against the criteria. Authors of three papers were contacted to obtain further information (Aceijas, Waldhäusl, Lambert, Cassar, & Bello-Corassa, 2017; Sánchez-Villegas et al., 2009, 2015). The final number of papers that were included in the review was 68 (Figure 1).

Of the included studies, 44 primary studies investigated the influence of diet on mental health (of which 43 were cross-sectional, and one was longitudinal). There was also one review identified that investigated this direction of the association. In terms of study quality (as measured by the Newcastle-Ottawa Quality Assessment Scale and the guidance of the Centre for Reviews and Dissemination), 15 studies were evaluated as of high quality, 29 were of medium quality, and one was of low quality (table A.1, table A.3). There were no relevant randomised controlled trials, intervention studies, or qualitative studies identified.

In terms of studies investigating the influence of mental health on diet, one systematic review and 22 primary studies were evaluated (of which 18 were cross-sectional and four were longitudinal). Three studies were considered of high quality, 19 studies were of medium quality, and one study was of low quality (table A.2, table A.3). The inclusion criteria were not met by any relevant randomised controlled trials, intervention studies, or qualitative studies.

Where diet quality instruments were used, the most common measure was the Healthy Eating Index (HEI). HEI is a measure of diet quality that assesses how well food intake aligns with key recommendations of the Dietary Guidelines for Americans (FNS, 2022). In terms of mental health instruments, the most frequently used instrument was the depression, anxiety and stress scale (DASS-21), which is a set of three self-report scales designed to measure the emotional states of depression, anxiety and stress (Lovibond & Lovibond, 1995).

2.3.1 Diet quality associations with mental health

In regards to geographical settings of studies investigating the influence of diet quality on mental health, 38% of the studies took place in Europe, 31% in USA and Canada, 12% in Asia, 12% in the Middle East, 5% in Latin America, and 2% in Africa. The studies also varied in terms of the number of study participants, from 36 to 68559 (table 4).

In order to describe the results, the studies were organised into those that used a diet quality tool as a predictor of diet quality and those that used other kinds of tools, such as food frequency questionnaires. The results were also organised in terms of outcomes, including depression, anxiety and stress (table 5).

There were 25 studies that investigated the influence of diet quality on depression. Of these studies, 20 suggested diet quality to be negatively associated with depression. Out of the nine studies that used a diet quality score, six found a significant negative association of diet quality with depression scores (Açik & Çakiroğlu, 2019; Faghih, Babajafari, Mirzaei, & Akhlaghi, 2020; Jeffers, Mason, & Benotsch, 2020; Quehl, Haines, Lewis, & Buchholz, 2017; Rossa-Roccor, Richardson, Murphy, & Gadermann, 2021; Sakai et al., 2017). The remaining studies used questionnaires, and there was evidence to suggest that healthy diet was associated with lower depression scores (El Ansari, Adetunji, & Oskrochi, 2014; Hamazaki et al., 2015; C. Liu et al., 2007; Oleszko, Szczepańska, Janion, & Jośko-Ochojska, 2019; Peltzer & Pengpid, 2017a, 2017b; Romijn, 2019; Smith-Marek, Durtschi, Brown, & Dharnidharka, 2016; Wattick, Hagedorn, & Olfert, 2018), as well that unhealthy diet was associated with higher depression scores (El Ansari et al., 2014; Lee, Ting, Bellissimo, &

Khalesi, 2022; C. Liu et al., 2007; Mikolajczyk, El Ansari, & Maxwell, 2009; Peltzer & Pengpid, 2017a; Romijn, 2019; Rossa-Roccor, 2019; Stanton et al., 2021; Tran et al., 2017).

Nine studies examined the influence of diet quality on anxiety, of which eight found significant associations. Of these studies, four used a diet quality measure and all found a negative association of diet quality with anxiety (Attlee et al., 2022; Faghih et al., 2020; Ramón-Arbués et al., 2019; Rossa-Roccor et al., 2021). Studies using questionnaires also showed that unhealthy diet was positively associated with anxiety (Lee et al., 2022; Romijn, 2019; Rossa-Roccor, 2019; Wattick et al., 2018).

13 studies looked into the influence of diet quality on stress, of which 11 found significant associations. Six studies using a diet quality measure found a negative association of diet quality with stress (Alfreeh et al., 2020; Attlee et al., 2022; El Ansari, Suominen, & Berg-Beckhoff, 2015b; Faghih et al., 2020; Ramón-Arbués et al., 2019; Saharkhiz et al., 2021). Additionally, studies using questionnaires found that unhealthy diets were positively correlated with stress (El Ansari et al., 2014; Lee et al., 2022; C. Liu et al., 2007; Mikolajczyk et al., 2009; Stanton et al., 2021), as well as that healthy diets were negatively correlated with stress (El Ansari et al., 2014; C. Liu et al., 2007; Mikolajczyk et al., 2009).

There were 13 identified studies investigating the influence of diet quality on general mental wellbeing, of which 12 found significant associations . Out of the six studies that used a diet quality measure, four concluded that poor diet quality was negatively associated with mental wellbeing (Aceijas et al., 2017; El Ansari, Suominen, & Berg-Beckhoff, 2015a; Faghih et al., 2020; Hendy, 2012), and one concluded that good diet quality was positively associated with mental wellbeing (Lo Moro et al., 2021). One study found a positive association of diet quality with positive emotional state, but no association with negative emotional state (López-Olivares, Mohatar-Barba, Fernández-Gómez, & Enrique-Mirón, 2020). Studies using questionnaires reported unhealthy diets to be associated with bad mental wellbeing (Knowlden, Hackman, & Sharma, 2016; Mochimasu, Miyatake, & Hase, 2016; Peltzer & Pengpid, 2017a), as well as healthy diets to be associated with good mental wellbeing (Knowlden et al., 2016; Lesani, Mohammadpoorasl, Javadi, Esfeh, & Fakhari, 2016; Peltzer & Pengpid, 2017a; Piqueras, Kuhne, Vera-Villarroel, van Straten, & Cuijpers, 2011; Schnettler et al., 2015).

Other mental health parameters that were examined by studies to determine whether they are influenced by diet included post-traumatic stress disorder, academic stress, positive self-concept, and psychological resilience. All of these studies reported results towards the expected direction. Specifically, two studies reported that a healthier diet was associated with fewer post-traumatic stress symptoms in university students (Peltzer & Pengpid, 2017a; Smith-Marek et al., 2016), one study

reported that high adherence to the Mediterranean diet decreased academic stress in regards to students communicating their own ideas (Chacón-Cuberos, Zurita-Ortega, Olmedo-Moreno, & Castro-Sánchez, 2019), two studies reported that the Mediterranean diet was associated with more positive self-concept (Chacón-Cuberos, Zurita-Ortega, Olmedo-Moreno, Padial-Ruz, & Castro-Sánchez, 2018; Zurita-Ortega, San Román-Mata, Chacón-Cuberos, Castro-Sánchez, & Muros, 2018), and one study suggested that better diet quality was associated with better psychological resilience (Lutz et al., 2017).

In terms of effect sizes for studies investigating the association of diet quality with mental health, it was possible to retrieve information for 31 out of the 35 studies that found significant associations (table 5). It was observed that effect sizes were small for 22 studies, moderate for five studies, and large for four studies (table 5).

Table 4. Baseline characteristics (for studies investigating association of diet quality with mental health parameters)

Author, year	Mental health parameter	Design	Country	Age details	N students, sex
Açik & Cakiroglu, 2019 (Açik &	Depression	Cross-sectional	Turkey	Aged 19-24 years	N= 134 students, All females
Jeffers et al., 2019 (Jeffers et al., 2020)	Depression	EMA	USA	Mean age=21 years	N= 30, Females: n=15, Males: n=15
Faghih et al., 2020 (Faghih et al., 2020)	Depression, Anxiety, Stress, General mental wellbeing	Cross-sectional	Iran	Mean age=21.5 years	N=274, Females: n=238, Males: n=36
Ramón-Arbués et al., 2019 (Ramón-	Depression, Anxiety, Stress	Cross-sectional	Spain	Mean age=21.74 years	N= 1055, Females: n=311, Males: n=744
Abramson 2017 (Abramson, 2017)	Depression	Cross-sectional	USA	Age range= 18-31 years	N=36, Females: n=22, Males: n=14
Quehl et al., 2017 (Quehl et al., 2017)	Depression	Cross-sectional	Canada	Mean age=19.1 years	N=141, All females
Sakai et al. 2017 (Sakai et al., 2017)	Depression	Cross-sectional	Japan	Mean age=18 years	N=3963, All females
Hamazaki et al., 2015 (Hamazaki et al.,	Depression	Cross-sectional	Japan	Mean age= 20.5 years	N=4190, Females: n=2066, Males: n=2124
Liu et al., 2007 (C. Liu et al., 2007)	Depression, Stress	Cross-sectional	China	Mean age= 20.4 years	N=2579, Females: n=1086, Males: n=1493
Peltzer & Pengpid, 2017a (Peltzer & Pengpid, 2017a)	Depression, General mental wellbeing, PTSD	Cross-sectional	Various	Mean age=20.5 years	N=3357, Females: n=2112, Males: n=1245
Peltzer & Pengpid, 2017b (Peltzer &	Depression	Cross-sectional	Various	Mean age=20.9 years	N=18522, Females: n=10708, Males: n=7758
Smith-Marek et al., 2016 (Smith-Marek	Depression, PTSD	Cross-sectional	USA	89% were between the age of 18 and 21	N=321, Females: n=245, Males: n=76
Breiholz, 2010 (Breiholz, 2010)	Depression	Cross-sectional	USA	Age not stated	N=188, sex not stated
El Ansari et al., 2014 (El Ansari et al.,	Depression, Stress	Cross-sectional	UK	Mean age=24.9 years	N=3.706, Females: n=2699, Males: n=765, Other: n=242
Mikolajczyk et al., 2009 (Mikolajczyk et	Depression, Stress	Cross-sectional	Various	Mean age=20.6 years	N=1839, Females: n=1200, Males: n=639
Oleszko et al., 2019 (Oleszko et al.,	Depression	Cross-sectional	Poland	Age not stated	N= 959, Females: n=576, Males: n=383
Romijn, 2020 (Romijn, 2019)	Depression, Anxiety	Cross-sectional	UK	Mean age=18 years	N=280, Females:n=231, Males: n= 49

Rossa-Rocor, 2019 (Rossa-Roccor, 2019)	Depression, Anxiety, General mental wellbeing	Cross-sectional (thesis)	Canada	Mean age=19.5 years	N=339, Females: n=224, Males: n=109, Other: n=6
Jaalouk et al., 2019 (Jaalouk, Matar	Depression	Cross-sectional	Lebanon	Mean age=21.3 years	N=457, Females: n=170, Males: n=287
Tran et al., 2017 (Tran et al., 2017)	Depression, Anxiety	Cross-sectional	France	69% were less than 20 years old	N=4184, Females: n=2403, Males: n=1781
Wattick et al., 2018 (Wattick et al.,	Depression, Anxiety	Cross-sectional	USA	59.4% aged 19-21 years	N=1956, Females: n=1320, Males: n=636
Rossa-Rocor et al., 2021 (Rossa-Roccor	Depression, anxiety, QoL	Cross-sectional	Canada	Mean age 19.5 years, SD 1.9	N= 339 students, n= 224 females
Stanton et al., 2021 (Stanton et al., 2021)	Depression, anxiety, stress	Cross-sectional	Australia	18 – 24 years (n = 183) 25–34 years (n = 159), ≥ 35 (n = 158)	N= 500 students, n= 472 females
Attlee et al., 2022 (Attlee et al., 2022)	Depression, anxiety, stress	Cross-sectional	UAE	Mean age 20.3 years, SD 1.8	N= 260, all female
Lee et al., 2022 (Lee et al., 2022)	Depression, anxiety, stress	Cross-sectional	Canada	88.4% were 18-24 years	N= 146, n= 127 females
Saharkhiz et al., 2021 (Saharkhiz et al.,	Depression, anxiety, stress	Cross-sectional	Iran	Mean age 20.7 years, SD 2.2	N= 181, all female
Fabian et al., 2013 (Fabián et al., 2013)	Stress	Cross-sectional	Puerto-Rico	Aged 21 to 30 years old	N=252, Females: n=170, Males:n=82
El Ansari et al., 2015ª (El Ansari et al.,	Stress	Cross-sectional	Finland	Median age= 21 years	N=1076, Females: n=762, Males: n=314
Lockhart, 2017 (Lockhart, 2017)	Stress	Secondary data	USA	Mean age=21.04 years	N= 68,559, Females: n=44403, Males: n=23,517
Alfreeh et al., 2020 (Alfreeh et al., 2020)	Stress	Cross-sectional	Saudi Arabi	Age range 19-35 years	N= 401, all female
Lo Moro et al., 2021 (Lo Moro et al.,	Mental well-being	Cross-sectional	Italy	Median age 23 years	N= 502, 76% Females
Aceijas et al., 2017 (Aceijas et al., 2017)	General mental wellbeing	Cross-sectional	UK	Mean age=23.6 years	N=468, Females: n=328, Males: n=140
El Ansari et al., 2015b (El Ansari et al.,	General mental wellbeing	Cross-sectional	Finland	Median age=21 years	N=1027, Males: n=302, Females: n=725
Hendy, 2012 (Hendy, 2012)	General mental wellbeing	Longitudinal	USA	Mean age= 24.4 years	N=44, Females: n=33, Males: n=11
Lopez-Olivares, 2020 (López-Olivares et	General mental wellbeing	Cross-sectional	Spain	Mean age= 20.97 years	N=272, Females: n=176, Males: n=96
Mochimasu et al., 2016 (Mochimasu et	General mental wellbeing	Cross-sectional	Japan	Mean age= 18.78 years	N=62, All females
Knowlden et al., 2016 (Knowlden et al.,	General mental wellbeing	Cross-sectional	USA	67% were 19-20 years	N=195, Females: n=138, Males: n=57

Lesani et al., 2016 (Lesani et al., 2016)	General mental wellbeing	Cross-sectional	Iran	Mean age= 24.14	N=541, Females: n=403, Males: n=138
Piqueras et al., 2011 (Piqueras et al.,	General mental wellbeing	Cross-sectional	Chile	Mean age= 19.89 years	N=3461, Females: n=1595, Males: n=1866
Schnettler et al., 2015 (Schnettler et al.,	General mental wellbeing	Cross-sectional	Chile	Mean age= 20.9 years	N=369, Females: n=198, Males: n=171
Chacon-Cuberos et al. 2019 (Chacón-	Academic stress	Cross-sectional	Spain	Mean age=21.58 years	N=515, Females: n=253, Males: n=262
Chacon-Cuberos et al., 2018 (Chacón-	Self-concept	Cross-sectional	Spain	Mean age=22.2 years	N=775, Females: n=320, Males: n=455
Zurita-Ortega et al., 2018 (Zurita-Ortega	Self-concept	Cross-sectional	Spain	Mean age= 18.99 years	N=597, Females: n=44, Males: n=156
Lutz et al., 2017 (Lutz et al., 2017)	Psychological resilience	Cross-sectional	USA	Mean age= 21 years	N=656, Females : n=273, Males : n=383

Table 5. Results (for studies investigating association of diet quality with mental health parameters)

MENTAL HEALTH PARAMETER: DEPRESSION													
Author, year	**Diet quality tool**	**Depression tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients, or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Açik & Cakiroglu,, 2019 (Açik & Çakiroğlu, 2019)	DII	ZSRDS	3-day food records	Multivariate logistic regression analysis	Age, smoking, alcohol, physical activity level, anthropometric measurements	Poor diet quality was positively associated with depression scores	OR= 2.90 (95% CI 1.51-5.98)	X			X		
Jeffers et al., 2019 (Jeffers et al., 2020)	General estimating equations of dietary quality	PANAS	EMA	Generalised estimating equations	Each food item was examined as a predictor in separate models, and each of the negative affect and positive affect was used as separate dependent variables.	There was a positive association between fruits and positive affect (1). There was a positive association between sugary foods and negative affect (2)	1. Estimate= 1.37 (SE 0.49, p<0.005) 2. Estimate= 0.06 (SE 0.03, p<0.02)	X			X		
Faghih et al., 2020 (Faghih et al., 2020)	DASH	DASS-21	Semi-quantitative FFQ	Pearson's correlation coefficients	Socio-economic, lifestyle, and anthropometric characteristics	There was a negative correlation between diet quality and depression	Pearson's coefficient= -0.434 (P<0.001)	X				X	
Ramón-Arbués et al., 2019 (Ramón-Arbués et al., 2019)	HEI	DASS-21	N/A	Pearson's correlation coefficients	Age, sex, study area, habitual residence, relationship status, height, weight,	There was no significant association between HEI and depression.	N/A			X			

					perceived economic situation, smoking, alcohol consumption, physical activity and sedentary lifestyle								
Attlee et al., 2022 (Attlee et al., 2022)	E-DII	DASS-21	24h dietary recall	Logistic regression analysis	Body habitus measures (BMI and WC), nutrient intakes and specific food groups, smoking status, physical activity categories	No significant association	N/A			X			
Lee et al., 2022 (Lee et al., 2022)	N/A	DASS-21	FFQ	Linear regression	Age, gender, ethnicity, relationship status, employment, income, living arrangements, number of children, education	The likelihood of more severe depression increased with higher consumption of grain (cereal) food (i) and lower consumption of dairy products (ii)	(i) (β = 1.61, 95% CI, 0.22, 3.01 (ii) (β = -3.38, 95% CI, -5.39, -1.38),	X					X
Stanton et al., 2021 (Stanton et al., 2021)	N/A	DASS-21	Previously validated Australian FFQ	Multivariate regression analysis	Gender, age, enrolment, ethnicity, relationship status, living arrangement, work, health conditions	Intake of snack-foods was associated with higher depression scores	$\beta = 8.66$, $p < 0.05$	X					X

Abramson 2017 (Abramson, 2017)	HEI	BDI	FFQ (5-day)	Spearman and partial correlations	Age, gender	There was no significant association between HEI and depression.	N/A			X			
Quehl et al., 2017 (Quehl et al., 2017)	HEI	CES-D	3-day food records	Linear regression	Age	Diet quality was negatively associated with depression scores	β= -0.016 (95% CI -0.029 to -0.003, p=0.017)	X			X		
Sakai et al. 2017 (Sakai et al., 2017)	DQS	CES-D	Diet history question-naire	Multivariate analysis	BMI, current smoking, medication use, self-reported level of stress, dietary reporting status, physical activity, energy intake and living alone	Diet quality was negatively associated with depression	OR for depression in highest vs lowest quintiles of diet quality was 0.65 (95 % CI 0.50-0.84, P=0.0005)	X			X		
Hamazaki et al., 2015 (Hamazaki et al., 2015)	N/A	CES-D	Customary intake frequency	Multivariate logistic analysis	Age, gender, academic performance, friendships, financial matters, smoking status, consumption of alcohol, physical activity	Fish intake was negatively associated with depression	OR= 0.65, (95% CI 0.46–0.92) of highest vs lowest category of fish consumption.	X			X		
Liu et al., 2007 (C. Liu et al., 2007)	N/A	CES-D	FFQ	Stepwise logistic regression	Gender, grade, city, perceived weight, smoking level and alcohol use	Risk of depression was increased with low fruit frequency and decreased with low ready to eat	OR for depression was 1.62 (p< 0.0001) for low fruit frequency, frequency, 0.70 (p< 0.0001) for low ready to eat food frequency,	X			X		

						food, low snack food frequency and low fast food frequency. BMI was not significantly associated with depression scores	0.73 (p< 0.05) for low snack food, and 0.40 (p< 0.05) for low fast food frequency.						
Peltzer & Pengpid, 2017a (Peltzer & Pengpid, 2017a)	N/A	CES-D	FFQ	ANCOVA, descriptive statistics	Age, sex, subjective socioeconomic status, country, body mass index (BMI), and physical activity	Fruit consumption was negatively associated with depression. Unhealthy dietary behaviours were positively associated with depression.	Depression score was 13.28 for no fast food vs 13.70 for highest fast food consumption.	X					
Peltzer & Pengpid, 2017b (Peltzer & Pengpid, 2017b)	N/A	CES-D .	FFQ	Stepwise multiple linear regression	Fruit and vegetable consumption, sociodemographic, and health related factors	Depression decreased with any increase in fruit and vegetable consumption	Strongest decrease in depression was with 6 servings of fruit and vegetables, b= -1.04 (p<0.001).	X			X		
Smith-Marek et al., 2016 (Smith-Marek et al., 2016)	N/A	CES-D	Three items taken from the Family Transitions Project survey	Path analysis	Trauma, diet, and exercise	A healthier diet was positively associated with lower depression scores	b= 2.57 (p < 0.001)	X			X		
Breiholz, 2010 (Breiholz, 2010)	N/A	CES-D	FFQ	Independent samples t-tests	Gender	There was no association between high consumption of fruits/vegetables and depression	N/A						
El Ansari et al 2014 (El	N/A	BDI	FFQ (12-item)	Regression analyses	University, sex	Unhealthy food was positively	1. Coefficient=	X			X		

Ansari et al., 2014)						correlated with depression scores (1) Fruit/vegetable intake was negatively correlated with depression scores (2)	0.072 for females, 0.158 for males. 2. Coefficient= -0.081 for females, -0.115 for males.						
Miko-lajczyk et al., 2009 (Mikolajczyk et al., 2009)	N/A	BDI	FFQ	Multivariable linear regression analysis	Gender and country	In females only, poor diet quality was positively associated with depression.	Estimates for change in BDI per unit of food group frequency scale was -1.69 (p= 0.002), -1.62, (p= 0.003), -1.47 (p=0.003) for less frequent consumption of fruits, vegetables and meat respectively.	X			X		
Oleszko et al., 2019 (Oleszko et al., 2019)	N/A	BDI	FFQ (for 30 days before study)	Non parametric Tau Kendall's test	N/A	Diet quality was negatively associated with depression	Tau Kendall's= -0.09 (p <0.01)	X			X		
Rossa-Rocor et al., 2021 (Rossa-Roccor et al., 2021)	DSQ	PHQ-9	One item dietary preference	Multivariate regression analysis	Age, gender, ethnicity, physical activity, sleep, weight satisfaction, stress, stressful life events, social support	The junk food component was positively associated with depression	$\beta = 0.26$, $p<0.001$	X				X	
Romijn, 2020 (Romijn, 2019)	N/A	PHQ-9	FFQ	Pearson's correlation coefficients	Gender, ethnicity, year of study, eating disorder	Diet quality was negatively associated with depression	Pearson's coefficient = -0.38 ($p<0.001$)	X				X	

Rossa-Roccor, 2019 (Rossa-Roccor, 2019)	N/A	PHQ-9	Posteriori self-reported diet	Multiple linear regression	Social support, physical activity, stress, body image, and stressful life events	The processed food diet pattern was positively associated with depression scores (z-score β=0.21, p ≤.001).	z-score β= 0.21 (p≤.001)	X			X		
Jaalouk et al., 2019 (Jaalouk et al., 2019)	N/A	PHQ-9	73-item FFQ	Multivariable linear regression analyses	Age, sex, income, physical activity, BMI, family history of mental illness, alcohol consumption, stressful life events, worrying about loss of control over how much they eat, use of anti-depressants	There was no association of identified dietary patterns (traditional Lebanese, Western fast food, dairy, Lebanese fast food, fruits) with depression scores.	N/A			X			
Tran et al., 2017 (Tran et al., 2017)	N/A	Clinical screening	Dietary question-naire	Multivariate logistic regression models	Age, gender, blood pressure, heart rate, BMI, presence of depressive disorder, anxiety disorder and panic attack disorder	Poor diet quality was associated with increased risk for depression .	OR 1.49 (p<0.0001)	X			X		
Wattick et al., 2018	N/A	Centre for Disease Control and	Dietary question-naire	Logistic regression	Gender, housing, and food security	Fruit and vegetable intake were negatively	OR 0.68 (95% CI 0.50–0.89)	X			X		

(Wattick et al., 2018)		Prevention's Healthy Days Measure				associated with depression in males							
MENTAL HEALTH PARAMETER: ANXIETY													
Author, year	**Diet quality tool**	**Anxiety tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients, or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Faghih et al., 2020 (Faghih et al., 2020)	DASH	DASS-21	Semi-quantitative FFQ	Pearson's correlation coefficients	Socioeconomic, lifestyle, anthropometric characteristics	Diet quality was negatively associated with anxiety scores	Pearson's correlation coefficient= -0.325 (P<0.001)	X				X	
Ramón-Arbués et al., 2019 (Ramón-Arbués et al., 2019)	HEI	DASS-21	N/A	Pearson's correlation coefficients	Age, sex, study area, habitual residence, relationship status, height, weight, perceived economic situation, smoking, alcohol consumption, physical activity and sedentary lifestyle	Diet quality was negatively associated with anxiety scores	Pearson's correlation coefficient= -0.10 (p<0.01)	X			X		
Attlee et al., 2022 (Attlee et al., 2022)	E-DII	DASS-21	24h dietary recall	Logistic regression analysis	Body habitus measures (BMI and WC), nutrient intakes and specific food	Each point increase in the E-DII score was associated with symptoms of anxiety.	OR = 1.35; 95% CI: 1.07–1.69; p = 0.01	X			X		

					groups, smoking status, physical activity categories								
Lee et al., 2022 (Lee et al., 2022)	N/A	DASS-21	FFQ	Linear regression	Age, gender, ethnicity, relationship status, employment, income, living arrangements, number of children, education	The likelihood of more severe anxiety increased with higher consumption junk food.	β = 0.62, 95% CI, 0.01, 1.22	X					X
Rossa-Rocor et al., 2021 (Rossa-Roccor et al., 2021)	DSQ	GAD-7	One item dietary preference	Multivariate regression analysis	Age, gender, ethnicity, physical activity, sleep, weight satisfaction, stress, stressful life events, social support	The junk food component was positively associated with anxiety.	β = 0.18, p = 0.001	X				X	
Romijn, 2020 (Romijn, 2019)	N/A	GAD-7	FFQ	Pearson's correlation coefficients	Gender, ethnicity, year of study, eating disorder	Diet quality was negatively correlated with anxiety scores	Pearson's correlation coefficient = -0.31 (p<.001)	X				X	
Rossa-Roccor, 2019 (Rossa-Roccor, 2019)	N/A	GAD-7	Posteriori self-reported dietary patterns	Multiple linear regression	Social support, physical activity, stress, body image, and stressful life events	The processed food diet pattern was positively associated with anxiety	β= 0.14 (p≤.001)	X			X		

Wattick et al., 2018 (Wattick et al., 2018)	N/A	Centre for Disease Control and Prevention Healthy Days Measure	DSQ	Logistic regression	Gender, housing, and food security	Higher added sugars intake was positively associated with anxiety in females	OR = 1.18 (95% CI 1.05–1.32)	X			X		
Tran et al., 2017 (Tran et al., 2017)	N/A	Clinical screening	Question-naire about dietary behaviour	Multi-variate logistic regression models	Age, gender, blood pressure, heart rate, BMI, presence/absen ce of depressive disorder, anxiety disorder and panic attack disorder	There was no association between bad dietary behaviour and anxiety.	N/A			X			
MENTAL HEALTH PARAMETER: STRESS													
Author, year	**Diet quality tool**	**Stress tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients, or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Faghih et al., 2020 (Faghih et al., 2020)	DASH	DASS-21	Semi-quantitative FFQ	Pearson's correlation coefficients	Socio-economic, lifestyle, anthropometric characteristics	Diet quality was negatively correlated with stress score	Pearson's coefficient= -0.408 ($p<0.001$)	X				X	
Saharkhiz et al., 2021 (Saharkhiz et al., 2021)	DASH score	DASS-21	FFQ	Multinomial logistic regression	Age, BMI, energy intake	Adherence to DASH style-pattern was associated with a lower stress score	OR = 0.32; 95%CI: 0.14–0.71, p = 0.009; 2nd tertile with 1st DASH tertile	X				X	
Ramón-Arbués et al., 2019 (Ramón-	HEI	DASS-21	N/A	Pearson's correlation coefficients	Age, sex, study area, habitual residence, relationship	Diet quality was negatively correlated with stress score	Pearson's coefficient= -0.07 ($p < 0.05$)	X			X		

Arbués et al., 2019)					status, height, weight, perceived economic situation, smoking, alcohol consumption, physical activity and sedentary lifestyle								
Attlee et al., 2022 (Attlee et al., 2022)	E-DII	DASS-21	24h dietary recall	Logistic regression analysis	Body habitus measures (BMI and WC), nutrient intakes and specific food groups, smoking status, physical activity categories	Each point increase in the E-DII score was associated with symptoms of stress.	OR = 1.41; 95% CI: 1.12–1.77; p = 0.003	X			X		
Stanton et al., 2021 (Stanton et al., 2021)	N/A	DASS-21	Previously validated Australian FFQ	Multivariate regression analysis	Gender, age, enrolment, ethnicity, relationship status, living arrangement, work, health conditions	Intake of snack-foods was associated with higher stress scores	β = 3.92, p = 0.055	X					X
Lee et al., 2022 (Lee et al., 2022)	N/A	DASS-21	FFQ	Linear regression	Age, gender, ethnicity, relationship status, employment, income, living arrangements, number of children, education	The likelihood of more severe stress increased with lower consumption of dairy products	β = -1.94, 95% CI, -3.65, -1.23	X					X

Fabian et al., 2013 (Fabián et al., 2013)	Dietary guideline adherence index	27-item stress question-naire	FFQ	Pearson's chi-squared test.	Age, gender, household income, school, BMI	Dietary patterns were not associated with stress levels	N/A			X			
Alfreeh et al., 2020 (Alfreeh et al., 2020)	E-DII	PSS-10	FFQ (Saudi)	Multiple linear regression analyses	Age, marital status, education level, course, income, financial status, sleep, physical activity, previous weight reduction diet	Pro-inflammatory diets were associated with increased stress.	A higher E-DII score per 1SD (1.8) was associated with a 2.4-times higher PSS score. 95% CI: 1.8, 3.1 Pearson's partial correlation coefficient of the relationship between E-DII scores and PSS scores was (r = 0.46).	X				X	
El Ansari et al., 2015ª (El Ansari et al., 2015b)	Dietary guideline adherence index	PSS	12-item FFQ	Spearman rank coefficients	Age, sex, living situation, economic situation, moderate PA, and BMI.	Diet quality was negatively correlated to stress	Males: r = -0.21, p<0.001 Females: r= -0.13, p<0.001 Normal weight: r= -0.13, p<0.001 Overweight: r= -0.21, p= 0.002	X			X		
El Ansari et al., 2014 (El Ansari et al., 2014)	N/A	PSS	12-item FFQ	Regression analyses	University, sex	Unhealthy foods were positively correlated with stress for females (1) Fruits and vegetables were negatively correlated with stress (2)	Coefficient= 0.051 2. Coefficient= -0.067 for females, -0.092 for males	X			X		

Liu et al., 2007 (C. Liu et al., 2007)	N/A	PSS	FFQ	Stepwise logistic regression	Gender, grade, city, perceived weight, smoking level and alcohol use	Low fruit frequency was positively correlated with stress (1). Low ready to eat food frequency (2) and low snack food frequency (3) were negatively correlated with stress. There was no association between BMI and stress scores.	OR= 1.53 ($p< 0.01$) 2. OR 0.69 ($p< 0.01$) 3. OR 0.75 ($p< 0.05$)	X			X		
Miko-lajczyk et al., 2009 (Mikolajczyk et al., 2009)	N/A	PSS	12-item FFQ	Multi-variable linear regression analysis	Gender and country	In females only, consumption of sweets was positively associated with stress (1). In females only, consumption of fruits (2) and vegetables (3) was negatively associated with stress.	Estimate = 0.54 ($p= 0.04$) 2. Estimate= -1.17 ($p<0.001$) 3. Estimate= -0.82 ($p=0.003$)	X			X		
Lockhart, 2017 (Lockhart, 2017)	N/A	5 items emotional distress scale	FFQ	Multiple linear regression	Exercise and rest	No correlation between consumption of fruits and vegetables and emotional distress.	N/A			X			

MENTAL HEALTH PARAMETER: GENERAL MENTAL WELLBEING													
Author, year	**Diet quality tool**	**Mental wellbeing tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Aceijas et al., 2017 (Aceijas et al., 2017)	REAP-S	SWEMWBS	N/A	Multi-variate analysis	Gender, lack of help-seeking behaviour in case of distress, negative attitudes towards nutriti on-related activities, financial difficulties	Low diet quality almost doubled the risk of low mental well-being	OR=1.7 (95% CI 1.0-2.7, p=0 .04).	X			X		
Lo Moro et al., 2021 (Lo Moro et al., 2021)	MEDAS	WEMWBS	N/A	Linear regression analysis	Age, gender	The mental wellbeing and adherence to Mediterranean diet were positively associated	AdjB 0.676, 95% CI 0.277 - 1.075, P= 0.001	X					X
El Ansari et al., 2015b (El Ansari et al., 2015a)	Dietary guideline adherence index	Assessment of self-reported health complaints (22 items)	12-item FFQ	Multi-nomial logistic regression model	Age group, living situation, economic situation, physical activity, BMI	There was a negative correlation between diet quality and psychological health complaints	beta coefficient= 0.06	X			X		
Hendy, 2012 (Hendy, 2012)	Scores for total calories, carbo-hydrate per-centage of calories,	PANAS	Anonymous seven day record of foods	Multiple regression analyses	Restrained eating scores and gender	Consumption of calories (1), saturated fat (2) and sodium (3) was significantly associated with increased	1. b=0.45 2. b=0.43 3. b=0.45	X			X		

	grams saturated fat, and milligrams of sodium.					negative affect. There was no association for carbohydrate consumption.							
Lopez-Olivares, 2020 (López-Olivares et al., 2020)	PRE-DIMED Question-naire	PANAS	N/A	Multiple regression models	Age, sex, physical activity, general state of health	A strict adherence to the Mediterranean diet was positively associated with positive emotional state. There was no association with negative emotional state.	Coefficient=0.018 (p=0.009)	X			X		
Faghih et al., 2020 (Faghih et al., 2020)	DASH	GHQ-12	Validated 168-item semi-quantitative FFQ	Pearson's correlation coefficient	Socioeconomic, lifestyle, anthropometric characteristics	Diet quality was positively correlated with mental health wellbeing.	Pearson's correlation coefficient= -0.431, (P<0.001).	X				X	
Mochi-masu et al., 2016 (Mochimasu et al., 2016)	N/A	GHQ-12	FFQ	Multiple regression an alysis	BMI, Physical activity level (PAL), energy and sucrose	Confectionaries intake was negatively associated with mental wellbeing, and was the determining factor for the GHQ12 scores	b=0.160, (p = 0.042)	X			X		
Knowlden et al., 2016 (Knowlden et al., 2016)	N/A	K-6	FFQ (24 hour)	Pearson's correlation and Cronbach Alphas	Optimism, self-esteem and social support	Frequent fruit consumption (1) and infrequent consumption of sugar-sweetened beverages (2) was associated with	1.H2 = 7.268 (p=0.026) 2. H2=18.15 (p<0.001)	X			X		

						low levels of mental distress. No associations with BMI.							
Lesani et al., 2016 (Lesani et al., 2016)	N/A	Oxford Happiness Questionnaire (OHQ)	FFQ	Analysis of co-variance	BMI, marital status, socio-economic status, physical activity, experience of stress in the last 6 months and having a defined disease	Amount of fruit and vegetable consumption was positively associated with mental wellbeing	P < 0.045 for 1 vs 3 servings per day	X					
Peltzer & Pengpid, 2017a (Peltzer & Pengpid, 2017a)	N/A	SHS	FFQ	Analysis of covariance	Age, sex, subjective socioeconomic status, country, body mass index (BMI), and physical activity	Diet quality was positively associated with happiness and high life satisfaction.	SHS score was 2.87 for no fruit consumption vs 3.03 for consuming three fruits per day	X					
Piqueras et al., 2011 (Piqueras et al., 2011)	N/A	SHS	FFQ	Multi-variate binary logistic regression	Gender, age, perceived stress and health behaviours	Intake of fruits and vegetables intake was positively associated with happiness	Adjusted OR= 1.34, (p=0.000)	X			X		
Schnettler et al., 2015 (Schnettler et al., 2015)	N/A	SWLS	SWFL and FFQ	Dunnett's T3 multiple compar-isons test	Sex, age, residence, socioeconomic factors	Students with healthful eating habits had higher levels of life satisfaction and satisfaction with food-related life.	The group "satisfied with their life and their food-related life" had a higher percentage of fruit (41.7%) and vegetable (57.6%) consumption daily	X					

Rossa-Rocor 2019 (Rossa-Roccor, 2019)	N/A	Quality of life (QOL): Single item	Posteriori self-reported dietary patterns	Multiple linear regression	Social support, physical activity, stress, body image, and stressful life events	There was no association between diet preference categories and mental wellbeing.	N/A			X			
MENTAL HEALTH PARAMETER: ACADEMIC STRESS													
Author, year	**Dietary score**	**Academic stress tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Chacon-Cuberos et al. 2019 (Chacón-Cuberos et al., 2019)	KIDMED	Validated Scale of Academic Stress	N/A	Regression model	Sex, BMI	MD adherence decreased stress in "Communication of own ideas" for high vs low MD adherence.	F= 2.801 (p=0.045)	X					X
MENTAL HEALTH PARAMETER: SELF-CONCEPT													
Author, year	**Dietary score**	**Self-concept tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Chacon-Cuberos et al., 2018 (Chacón-Cuberos et al., 2018)	KIDMED	AF-5	N/A	Structural Equation Model, Pearson Chi-square test)	Task and Ego Climate), Tobacco consumption, adherence to Mediterranean diet), Physical Activity), Alcohol consumption, VO2MAX, Self-Concept, gender	MD was positively associated with self-concept	b=0.08, (p< 0.05 for males) b=0.17, (p<0.01) for females).	X			X		

Zurita-Ortega et al., 2018 (Zurita-Ortega et al., 2018)	KIDMED	AF-5	N/A	Chi-square analysis and ANOVA	MD, physical activity, gender, religious belief, university campus, and place of residence	Adherence to MD was positively associated with academic self-concept and physical self-concept There were no associations for social, emotional, and family self-concept	Academic self-concept (p =0.001) and physical self-concept (p = 0.005) were more positive with high MD adherence (M = 3.67 and M=3.39 respectively) compared to medium adherence (M = 3.45 and M=3.16 respectively).	X					
MENTAL HEALTH PARAMETER: PSYCHOLOGICAL RESILIENCE													
Author, year	**Dietary score**	**Psycho-logical resilience tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Lutz et al., 2017 (Lutz et al., 2017)	Healthy Eating Index (HEI)	CDRS	The Block FFQ	Logistic regression	Race, ethnicity, education, smoking, age, body mass index, sex, and military branch	Higher diet quality was associated with an increased likelihood of a participant being in the high-resilience group	OR 1.02 (95% CI 1.01-1.04)	X			X		
MENTAL HEALTH PARAMETER: PTSD													
Author, year	**Dietary score**	**PTSD tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**

Peltzer & Pengpid, 2017a (Peltzer & Pengpid, 2017a)	N/A	B7ISQ	Food frequency questionnaire (FFQ)	Analysis of covariance (ANCOVA)	Age, sex, subjective socioeconomic status, country, body mass index (BMI), and physical activity	Fruit consumption were negatively associated with traumatic stress symptoms	B7ISQ scores were 19.25 for consumption of 4 or more fruits vs 19.91 for no fruit consumption	X					
Smith-Marek et al., 2016 (Smith-Marek et al., 2016)	N/A	PCL-5	Three items taken from the Family Transitions Project survey	Path analysis	Trauma, diet, and exercise	A healthier diet was significantly associated with lower posttraumatic stress scores	b=1.60 ($p < 0.01$)	X			X		

Note: Studies ordered according to diet quality tool used; if no diet quality tool used, studies were ordered according to depression tool.
Dietary measures: Diet inflammatory score (DII), Dietary Approaches to Stop Hypertension score (DASH), Energy-adjusted Dietary Inflammatory Index (E-DII), Healthy eating index (HEI), Diet quality score (DQS), Food frequency questionnaire (FFQ), Ecological Momentary Assessment (EMA), Dietary Screener Questionnaire (DSQ), Rapid Eating and Activity Assessment for Patients-Short Version (REAP-S), PREvención con DIeta MEDiterránea questionnaire (PREDIMED), Satisfaction with Food-related Life Scale (SWFL), Test of Adherence to Mediterranean Diet (KIDMED), Mediterranean diet (MD)
Mental health scores: Zung Self-Rating Depression Scale (ZSRDS), Positive and Negative Affect Scale (PANAS), Depression, anxiety, and stress scale (DASS-21), Beck Depression Inventory (BDI), Centre for Epidemiologic Studies Depression Scale (CES-D), Patient health questionnaire (PHQ-9), Cohen's Perceived Stress Scale (PSS), General anxiety disorder 7 (GAD-7), Warwick–Edinburgh Mental Wellbeing Scale short version (SWEMWBS), Positive and Negative Affect Scale (PANAS), 12-item general health questionnaire (GHQ-12), Kessler-6 Psychological Distress Scale (K-6), Subjective happiness scale (SHS), Satisfaction with Life Scale (SWLS), Connor-Davidson Resilience Scale (CDRS), Breslau's 7-item screening questionnaire (B7ISQ), Post-traumatic stress Checklist (PCL-5), Five-Factor Self-Concept Questionnaire (AF-5)
Statistics: Odds Ratio (OR), Hazard Ratio (HR), Relative Risk (RR), Confidence Interval (CI), Standard Error (SE), Analysis of covariance (ANCOVA), Between group differences (H2), Mean (M), Regression coefficient (F)
Not applicable (N/A)
Hypothesis: Good diet quality will have a beneficial effect on mental health parameters, and/or bad diet quality will have a detrimental effect on mental health parameters
Hypothesis outcomes:
1. Hypothesis accepted; 2. Hypothesis rejected- good diet quality had an adverse effect on mental health; 3. Hypothesis rejected- no association between diet quality and mental health
*If applicable

2.3.2 Mental health associations with diet quality

22 primary studies and one systematic literature review investigated the associations of mental health with diet quality. The identified studies took place in various locations (table 6). Specifically, 32% of the studies were conducted in USA and Canada, 29% in the Middle East, 14% in Europe, 10% in Latin America, 10% in Asia, and 5% in Australia. The number of study participants varied from 88 to 2810 (excluding the systematic literature review). The main findings of these studies are summarised in table 7.

Out of the four studies investigating the influence of depression on diet quality, two found significant associations. In particular, one study found evidence that depressed women were more likely to follow unhealthy diets, however no associations were found for men (Lazarevich et al., 2018). Moreover, one study found that increased sugar intake was associated with more symptoms of depression, but there were no associations of depression scores with the overall diet quality scores (Hall, Tejada-Tayabas, & Monárrez-Espino, 2017; Keck et al., 2020).

Thirteen studies investigated the influence of stress on diet quality, of which 12 found significant associations. Of the studies that showed significant associations, two used a diet quality tool and found that high perceived stress was associated with low diet quality scores (El Ansari & Berg-Beckhoff, 2015), as well as that low perceived stress was associated with high diet quality scores (Kotecki, Kandiah, Greene, & Khubchandani, 2019). The remaining ten studies used questionnaires, and similarly showed that high perceived stress was associated with unhealthy diets (Ahmed, Al-Radhwan, Al-Azmi, & Al-Beajan, 2014; Almogbel et al., 2019; Dalton & Hammen, 2018; Errisuriz, Pasch, & Perry, 2016; Kandiah, Yake, Jones, & Meyer, 2006; Oliver & Wardle, 1999; Papier, Ahmed, Lee, & Wiseman, 2015; Peker & Bermek, 2011), as well as that low perceived stress was associated with healthy diets (Almogbel et al., 2019; Nastaskin & Fiocco, 2015). Moreover, evidence from two longitudinal studies suggested that increasing stress over a period of time can be detrimental on diet (Daigle Leblanc & Villalon, 2008; Dalton & Hammen, 2018).

Other mental health conditions that have been investigated to determine whether they can influence diet quality included anxiety, test anxiety, academic stress, and menstrual distress. In particular, three cross-sectional studies investigated the influence of anxiety on diet quality by using a diet quality tool. One found that anxiety was associated with a greater risk of low macronutrient quality (Hall et al., 2017); the other two studies found no associations of stress with the overall diet quality score (Carlos, Elena, & Teresa, 2020; Keck et al., 2020).

In terms of the influence of test anxiety and academic stress on diet quality, all four studies showed significant associations with diet quality (AlJaber, Alwehaibi, Algaeed, Arafah, & Binsebayel, 2019; Mansoury, McCullough, & Swift, 2015; Pollard, Steptoe, Canaan, Davies, & Wardle, 1995; Trigueros et al., 2020). Specifically, it was found that test anxiety and academic stress negatively predicted adherence to the Mediterranean diet (Trigueros et al., 2020); there was also evidence from two longitudinal studies to suggest that as test anxiety/academic stress increased, the intake of unhealthy food also increased (Mansoury et al., 2015; Pollard et al., 1995). The above findings were also supported by the results of a cross-sectional study (AlJaber et al., 2019).

Finally, one study investigated the influence of menstrual distress on diet (Bu et al., 2019) and found that negative mood during the menstrual/premenstrual phases was associated with diet changes. For example, negative mood was positively associated with ingestion of tea, coffee, and carbonated drinks, as female students may have been trying to stimulate their nervous system to alleviate their negative mood through these diet changes.

In terms of effect sizes, it was possible to retrieve information about effect sizes for 10 studies (table 7). The effect sizes observed were small for eight studies, and moderate for two studies.

Table 6. Baseline characteristics (for studies investigating association of mental health parameters with diet quality)

Author, year	Mental health	Country	Design	Age details	N students, sex
Hall et al., 2017 (Hall et al., 2017)	Depression, Anxiety	Mexico	Cross-sectional	Mean age=21 years	N=450, three-quarters were females
Lazarevich et al., 2018 (Lazarevich et	Depression	Mexico	Cross-sectional	Mean age=19.6 years	N=1104, Females: n=659, Males: n=445
Dalton & Hammen, 2018 (Dalton &	Depression, Stress	USA	Longitudinal	Mean age=19.11 years	N=127, Females: n=100, Males: n=26, Other: n=1
Keck et al., 2020 (Keck et al., 2020)	Depression, Stress	USA	Cross-sectional	Mean age= 18.91 years, Age range= 18-25 years	N=225, Females: n=139, Males: n=86
Kotecki et al., 2019 (Kotecki et al.,	Stress	USA	Cross-sectional	Age range=18-20 years	N=1198, Females: n=791, Males: n=407
El Ansari & Berg-Beckhoff, 2015 (El	Stress	Egypt	Cross-sectional	Age range=16-30 years	N=2810, Females: n=1483, Males: n=1327
Leblanc & Villalon, 2008 (Leblanc DD	Stress	Canada	Longitudinal	Age range=19-22 years	N=94 at start, N=63 at end, Females: 83%, Males: 17%
Natascin & Fiocco, 2015 (Nastaskin &	Stress	Canada	Cross-sectional	Age details not available	N=136, Females: n=111, Males: n=19
Peker & Bermek, 2011 (Peker &	Stress	Turkey	Cross-sectional	Mean age=19.43 years	N=111, Females: n=56, Males: n=55
Cheng & Mohd Kamil, 2020 (Cheng &	Stress	Malaysia	Cross-sectional	Mean age=21.27 years	N=100, Females: n=50, Males: n=50
Ahmed et al., 2014 (Ahmed et al.,	Stress	Kuwait	Cross-sectional	Aged ≥ 18 years	N=407, Females: n=164, Males: n=243
Almogbel et al., 2019 (Almogbel et al.,	Stress	Saudi	Cross-sectional	59.8% between 18-20 years	N=614, Females: n=220, Males: n=394
Papier et al., (2015) (Papier et al.,	Stress	Australia	Cross-sectional	Mean age=21.5 years	N=728, Females: n=397, Males: n=331
Errisuriz et al., 2016 (Errisuriz et al.,	Stress	USA	Cross-sectional	Mean age= 18.9 years	N=736, Females:n=433, Males: n=303
Kandiah et al., 2006 (Kandiah et al.,	Stress	USA	Cross-sectional	Age range 17-26 years	N=272, All females
Oliver & Wardle, 1999 (Oliver &	Stress	UK	Cross-sectional	Mean age= 24.4 years	N=212, Females: n=149, Males: n=63
Carlos et al., 2020 (Carlos et al., 2020)	Anxiety	Spain	Cross-sectional	Mean age 21.42 years, SD 4.73	N= 252, n females= 191, n males= 61
Pollard et al., 1995 (Pollard et al.,	Test anxiety	UK	Case-control study	Mean group age range =21.7-23.8 years	N=180, Females: n=100, Males: n=80

Trigueros et al., 2020 (Trigueros et al.,	Test anxiety, Academic	Spain	Cross-sectional	Mean age= 23.58 years	N=1347, Females: n=733, Males: n=614
Aljaber et al., 2019 (AlJaber et al.,	Academic stress	Saudi	Cross-sectional	Mean age= 21 years	N=105, All males
Mansoury et al., 2015 (Mansoury et	Academic stress	Saudi	Longitudinal	Median age 21.6 years	N=491 at start, N=322 end, All females
Bu et al. 2019 (Bu et al., 2019)	Menstrual distress	China	Cross-sectional	Mean age= 21 years	N=88 , All females

Table 7. Results (for studies investigating association of mental health parameters with diet quality)

MENTAL HEALTH PARAMETER: DEPRESSION													
Author, year	**Diet quality tool**	**Depression instrument**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients, or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Hall et al., 2017 (Hall et al., 2017)	Macro-nutrient and micro-nutrient scores (based on dietary guideline)	GDAAS	Twenty-four hour dietary recalls	Binary logistic regression	University, diet perception, breakfast consumption, energy intake, soda consumption, weekly vigorous exercise	Depression had no effect on diet quality scores.	N/A			X			
Keck et al., 2020 (Keck et al., 2020)	HEI	PHQ-9	ASA24	Multigroup path analysis	Race, marital status, college status, GAD-7 severity, PHQ-9 severity	There was a significant association of adverse PHQ-9 score with decreased total caloric intake and increased sugar intake. There was no effect on total HEI score.	Total caloric intake: b=−27.44, SE (10.67) p<0.01 Sugar HEI component: b=−0.17, SE=0.05 p<0.001	X				X	
Laza-revich et al., 2018 (Lazarevich et al., 2018)	N/A	CES-D	69 item FFQ	Logistic regression analysis	Sex, age, BMI	In women, the 4th quartile of depression score was positively associated with frequent consumption of fast food (1), fried food (2), and sugary food (3).	1. OR = 2.08 (95% CI 1.14 -3.82, p = 0.018) 2. OR = 1.92, (95% CI 1.17-3.15, p = 0.010) 3. OR = 2.16, 95% CI 1.37-3.43, p < 0.001)	X			X		

						There were no associations for men.							
Dalton & Hammen, 2018 (Dalton & Hammen, 2018)	N/A	BDI	Standard measures of daily eating habits	Hierarchical generalized linear modelling (Poisson)	Gender	There was no association of depression with daily maladaptive behaviours (including diet habits.)	N/A			X			
MENTAL HEALTH PARAMETER: ANXIETY													
Author, year	**Diet quality tool**	**Anxiety tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients, or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Hall et al., 2017 (Hall et al., 2017)	Macro-nutrient and micronutrient scores, based on US dietary guidelines	Anxiety: Goldberg depression and anxiety scales	24 hour dietary recall	Binary logistic regression	University, diet perception, breakfast consumption, energy intake, soda consumption, and weekly vigorous exercise	Anxiety was associated with greater risk of low macronutrient quality	OR 2.35 (95% CI 1.27, 4.38)	X			X		
Carlos et al., 2020 (Carlos et al., 2020)	KIDMED	STAI	N/A	Multiple regression analysis	Adhesion to the Mediterranean diet, alcohol consumption, level of emotional eating	Adhesion to the Mediterranean diet was not predicted by state anxiety.	N/A			X			
Keck et al., 2020 (Keck et al., 2020)	HEI	GAD-7	ASA24	Multigroup path analysis	Race, marital status, college status, GAD-7	There was a significant association of adverse GAD-7	Total caloric intake: b=−30.16, SE=10.67, p<0.01 Sugar HEI component:	X				X	

					severity, PHQ-9 severity	score with decreased total caloric intake and increased sugar intake. There was no effect on total HEI score.	b=−0.16, SE=0.05 p<0.001						
MENTAL HEALTH PARAMETER: STRESS													
Author, year	**Diet quality tool**	**Stress tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Kotecki et al., 2019 (Kotecki et al., 2019)	Online question-naire assessing diet quality	Online question-naire assessing perceived stress	N/A	Regression,A NOVA ANCOVA	N/A	Perceived stress was negatively associated with diet quality.	Mean diet quality scores were 51.32 for low perceived stress vs 50.17 for high perceived stress (p<0.05).	X					
El Ansari & Berg-Beckhoff, 2015 (El Ansari & Berg-Beckhoff, 2015)	Dietary Guideline Adher-ence Index	PSS	FFQ	Multiple linear regression models	Age, sex, living situation (accommo-dation during term time), economic situation, BMI, physical activity, faculty.	Higher perceived stress score was significantly associated with less frequent food intake of fruit and vegetables. There was no significant association between unhealthy foods and stress.	b=-0.12	X			X		
Daigle Leblanc & Villalon, 2008 (Leblanc DD	N/A	PSS	Three-day food record and a FFQ	Pearson's correlations, Student t-tests	N/A	Increased stress was associated with an increased consumption of milk and milk	1. p=0.05 2. p=0.02	X					

& Villalon L, n.d.)						products for first year students at the beginning of the first trimester (1) and of breads and cereals for fourth year students at the end of the first trimester (2).							
Nataskin & Fiocco, 2015 (Nastaskin & Fiocco, 2015)	N/A	PSS	Eating habits confidence scale, and Block fat and sodium screener	Linear regression analyses	Perceived stress, diet self-efficacy, age, race, and sex	Low levels of perceived stress were associated with the lowest levels of fat and sodium intake.	b= -1.07, (p=0.04)	X			X		
Peker & Bermek, 2011 (Peker & Bermek, 2011)	N/A	PSS	Nutrition section of HPLP II	Pearson's product moment correlation and stepwise multiple linear regression analysis	Age, place of residence, monthly family income, perceived social support, and perceived stress	Perceived stress was negatively associated with healthy diet	r=-0.36, (p<0.01)	X				X	
Cheng & Mohd Kamil, 2020 (Cheng & Mohd Kamil, 2020)	N/A	PSS	FFQ and three-day dietary record	Independent samples t-tests and Chi-square tests	N/A	There was no significant difference for all food categories between the non-stressed and stressed groups.	N/A			X			
Ahmed et al., 2014 (Ahmed et al., 2014)	N/A	DASS-21	7-day FFQ	Logistic regression analysis	Age, year of study, family income, parents' education level,	Stressed female students were more likely to eat fast foods (1) snacks and	1. OR 1.75 (95% CI: 1.02-3:00) 2. OR 2.28 (95% CI: 1.30-3.98)	X			X		

					marital status, smoking status	beverages (2) than unstressed female students. No associations were found for males.							
Almogbel et al. 2019 (Almogbel et al., 2019)	N/A	DASS-21	FFQ	Chi-square tests	N/A	Stressed participants consumed more junk foods. Non-stressed participants preferred healthier foods.	p<0.05	X					
Papier et al., 2015 (Papier et al., 2015)	N/A	DASS-21	CSIRO FFQ	Logistic regression analysis	Marital status, study status, living situation, working hours, frequency of exercise, body mass index (BMI), whether participants were trying to lose weight, smoking status.	Stress was negatively associated with consumption of meat alternatives, vegetables and fruits. Stress was positively associated with the consumption of highly processed food.	ORs 2 to 3, P<0.05	X			X		
Dalton & Hammen, 2018 (Dalton & Hammen, 2018)	N/A	LSI and Daily Stress Measure	Standard measures of daily eating habits	Poisson linear modelling	Gender	Daily stress (1) and chronic stress (2) were significantly associated with daily maladaptive behaviours (including unhealthy diet).	1. b=0.01 (p=0.02) 2. b=0.02 (p = 0.03)	X			X		
Errisuriz et al., 2016	N/A	Stress: measured by single item	FFQ	Multiple hierarchical	Gender, BMI, and race	Perceived stress was positively associated with	1. b=0.09 2. b=0.15 3. b=0.14	X			X		

(Errisuriz et al., 2016)		Stress management: measured by single item		linear regressions		past week soda (1) coffee (2) energy drink (3) salty snack (4) frozen food (5) and fast food consumption (6).	4. b=0.12 5. b=0.15 6. b=0.09 (all p<0.05)						
Kandiah et al., 2006 (Kandiah et al., 2006)	N/A	45-itemized stress-eating survey	45-itemized stress-eating survey	ANOVA	N/A	Only 33% ate healthy when stressed (compared to 80% when not stressed). When stressed, sweet foods were chosen.	N/A	X					
Oliver & Wardle, 1999 (Oliver & Wardle, 1999)	N/A	Stress-induced eating Questionnaire	Stress-induced eating Question-naire	Descriptive statistics, chi-squared test	Dieting status, gender	Intake of "snack-type" foods increased during periods of stress; females were more likely to consume sweets and chocolate (1). Intake of "meal-type" foods (fruit and vegetables, meat and fish) decreased during stressful periods.	1. Chi-squared =10.9 (p<0.01).	X					
MENTAL HEALTH PARAMETER: TEST ANXIETY													
Author, year	**Diet quality tool**	**Test anxiety tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients, or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**

Pollard et al., 1995	N/A	State anxiety scale	24 hour dietary recall	Repeated m easures anal ysis of covariance	Group (exam-stress, control, gender, time, year of study, trait anxiety, social support, dietary restraint	Students with high trait increased their consumption of total fat, saturated fat and total energy intake between baseline and exam sessions	p<0.05	X					
Trigueros et al., 2020 (Trigueros et al., 2020)	KIDMED	The Test Anxiety Inventory	N/A	Structural equation model	Exam anxiety, academic stress, emotional intelligence, resilience	Exam anxiety negatively predicted adherence to the Mediterranean diet.	co-efficient = 0.37 (p<0.001)	X			X		
MENTAL HEALTH PARAMETER: ACADEMIC STRESS													
Author, year	**Diet quality tool**	**Academic stress tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients, or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Trigueros et al., 2020 (Trigueros et al., 2020)	KIDMED	Student Stress Inventory Stress Manifestation	N/A	Structural equation model	Exam anxiety, academic stress, emotional intelligence, resilience	Academic stress negatively predicted adherence to the Mediterranean diet.	co-efficient = 0.49, (p< 0.01)	X			X		
Aljaber et al., 2019 (AlJaber et al., 2019)	CES	ASS	N/A	Authors used 12 statements to test the hypothesis that students with high stress levels would eat more	N/A	11 statements proved the hypothesis, only one statement disproved; the authors accepted the hypothesis that students who have a high stress	N/A	X					

				unhealthy foods.		level eat more unhealthy foods.							
Mansoury et al. (2015) (Mansoury et al., 2015)	N/A	PSS	24 hour recall food diary analysed using DietPlan	t-tests	N/A	Participants experiencing academic stress at T2 demonstrated significantly lower frequency of ' healthy food intake at T2 compared to T1	P = 0.001	X					
MENTAL HEALTH PARAMETER: MENSTRUAL DISTRESS													
Author, year	**Diet quality tool**	**Menstrual distress tool**	**Dietary assessment**	**Model**	**Adjustment**	**Result**	**OR, HR or RR, β coefficients, or other statistics**	**Hypothesis outcome**			**Effect size***		
								1	**2**	**3**	**Small**	**Medium**	**Large**
Bu et al. 2019 (Bu et al., 2019)	N/A	MDQ	15-item FFQ	Multiple logistic regression analyses	N/A	Negative mood was positively associated with tea, coffee, and carbonated beverage intake during the menstrual phase (1). Negative mood was positively associated with banana and dates intake during the premenstrual phase (2).	1. b=0.21, p=0.0453, OR = 1.23 2. b=0.59, p=0.0172, OR=1.81	X			X		

Note: Studies ordered according to diet quality tool; if no diet quality tool used, studies were ordered according to depression instrument.
Dietary scores: Healthy Eating Index (HEI), Automated Self-Administered 24-h recall (ASA24), Food frequency questionnaire (FFQ), Mediterranean diet (MD), Health-promoting lifestyle II (HPLP II), Commonwealth Scientific and Industrial Research Organization food frequency questionnaire (CSIRO FFQ), Test of Adherence to Mediterranean Diet (KIDMED), Compulsive eating scale (CES)

Mental health scores: Goldberg depression and anxiety scales (GDAAS), Patient Health Questionnaire 9-Item (PHQ-9), Generalised Anxiety Disorder 7-items (GAD-7), Centre for Epidemiologic Studies scale (CES-D), Beck's depression inventory (BDI), Depression, anxiety, and stress scale (DASS-21), UCLA Life Stress Interview (LSI), Academic Stress Scale (ASS), Cohen's perceived stress scale (PSS), Menstrual Distress Questionnaire (MDQ), State-Trait Anxiety Inventory (STAI)
Statistics: Odds Ratio (OR), Hazard Ratio (HR), Relative Risk (RR), M (mean), Analysis of variance/covariance (ANOVA/ANCOVA), Pearson's coefficient (r), Beta coefficient (b), Standard Error (SE)
Not applicable (N/A)
Hypothesis: Good mental health will have a beneficial effect on diet quality, and/or bad mental health will have a detrimental effect on diet quality
Hypothesis outcomes:
1. Hypothesis accepted
2. Hypothesis rejected- good mental health had an adverse effect on diet quality
3. Hypothesis rejected- no association between mental health and diet quality
*If applicable

2.3.3 Review papers:

No previous systematic reviews appraising both directions of the association of diet quality with mental health were identified.

One previous review (Saha et al., 2021) aimed to examine the influence of diet on depression and anxiety among college students. In contrast to my review, this review filtered out articles published before 2000, and only included students enrolled in at least two-year programs. Moreover, this review focused only on depression and anxiety, but no other aspects of mental health. This review assessed 16 cross-sectional studies, of which 14 fulfilled my inclusion criteria and have also been included in my review (Açik & Çakiroğlu, 2019; El Ansari et al., 2014; Hall et al., 2017; Hamazaki et al., 2015; Keck et al., 2020; Lazarevich et al., 2018; Mikolajczyk et al., 2009; Mochimasu et al., 2016; Peltzer & Pengpid, 2017b; Quehl et al., 2017; Sakai et al., 2017; Smith-Marek et al., 2016; Wattick et al., 2018). The results of this review were in line with my results, as the authors concluded that most of the cross-sectional studies found a positive influence of healthy diets on depression and anxiety, with a few studies finding inconsistent results.

One previous systematic review appraising the influence of stress on the diet of students (Lyzwinski et al., 2018) was identified. In contrast to my review, the authors reviewed the influence of stress but no other mental health disorders. The authors also included studies involving disordered eating and maladaptive weight-related behaviours, which was not the scope of my review. The stress and dietary intake section of the review identified twelve studies, all of which were considered to be of relevance and have been included in the current review (El Ansari et al., 2014, 2015b; El Ansari & Berg-Beckhoff, 2015; Errisuriz et al., 2016; Kandiah et al., 2006; C. Liu et al., 2007; Mikolajczyk et al., 2009; Nastaskin & Fiocco, 2015; Oliver & Wardle, 1999; Papier et al., 2015; Peker & Bermek, 2011; Pollard et al., 1995). The conclusions of this review were in line with my finding that there is a positive association of stress with unhealthy diet, as well as a negative association of stress with healthy diet in university students.

2.4 Discussion

2.4.1 Main findings

66 primary studies and two systematic literature reviews were reviewed in total. The majority of primary studies (n = 53) and the two reviews showed results in the expected direction, where good diet quality was associated with good mental health, and good mental health was related with good diet quality. In terms of dietary parameters, students consuming high quality foods (including fruits, vegetables, nuts, and fish) reported fewer mental health symptoms, compared with students who had a high intake of pro-inflammatory foods (such as processed meat, refined carbohydrates, desserts and sweetened beverages), who reported more mental health issues. 36 out of 45 studies supported this association. This is line with the stress-diathesis model, with the unhealthy foods acting as the stressor and being associated with the development of mental health difficulties.

From a mechanistic point of view, there are various processes that could be mediating the relationship between diet quality and mental health. These include inflammation which is a core aetiological feature of depression (Köhler et al., 2017); various components of a healthy diet may be reducing inflammation (Yahfoufi, Alsadi, Jambi, & Matar, 2018). Other candidate biological mechanisms include oxidative stress (Marx et al., 2021), maintenance of beneficial gut microbes (Burokas et al., 2017), adult hippocampal neurogenesis (Jacka, Cherbuin, Anstey, Sachdev, & Butterworth, 2015), modulation of the tryptophan-kynurenine metabolism (Agus, Planchais, & Sokol, 2018), maintenance of mitochondrial biogenesis (Sergi et al., 2019), and regulation of epigenetic processes (González-Becerra et al., 2019; Remely et al., 2015).

No studies found an adverse influence of good diet quality nor a beneficial influence of bad diet quality on mental health. These results confirm that unhealthy diets such as western diets have no benefits on the mental health of students, which is in line with findings of previous studies (Jacka et al., 2015).

The majority of studies (19 out of 23) also showed associations of mental health with diet quality, which were in the expected direction. The most compelling evidence was in favour of high levels of stress having an unhealthy influence on diet. Despite a lack of longitudinal studies, the four identified longitudinal studies that either investigated the influence of stress or academic stress on diet quality showed that stress is associated with unhealthy diets over time. These results are in line

with previous research in adults, which showed that stress was associated with unhealthy eating (Torres & Nowson, 2007), including intake of foods with high sugar content.

A potential mechanism mediating this association may be the hypothalamus-pituitary-adrenal axis (HPA-axis) being hyperactive in depression and anxiety, leading to an increase in serum cortisol. As a consequence, appetite may be increased with a preference for energy-dense foods at the expense of healthy foods (Gibson-Smith et al., 2018; Tasker, 2006). Stimulation of the appetite stimulating hormone ghrelin during stress may also be of relevance (Adams, Greenway, & Brantley, 2011).

The most common country of study origin was the USA, where characteristics of university life may be different than other developed or third world countries. However, studies in countries of lower socioeconomic status were included in the review achieving good global coverage.

In terms of interpreting findings in the context of the stress-diathesis model, some of the studies recognised the complex relationships of biopsychosocial factors on both mental health and diet. Examples of such factors affecting mental health that we identified included stressful life events, body image, physical activity, sleep, social support, use of alcohol or illicit drugs. This review also identified factors linked to diet, such as availability and access of pre-prepared meals/fast foods on campus, limited resources including money for shopping, no easy access to healthy food, and lack of companionship during meal times.

The review identified that more studies used food frequency questionnaires rather than diet quality measures. This means when only food frequency questionnaires were used, it was not always possible to obtain a clear picture in regard to the extent that diets of participants conformed to dietary recommendations. In contrast, scores of validated diet quality instruments based on dietary recommendations were easier to interpret and contributed to a better understanding of the associations between diet quality and mental health.

2.4.2 Limitations

A strength of this review is the fact that an exhaustive review of the literature was performed, including grey literature. However, it is not possible to exclude the possibility of having missed studies due to publication bias, in cases where non-significant results had not been published.

Some studies included participants that were 17 years old, which would classify as adolescents. Even though these studies were limited, the possibility of an age bias from these studies cannot be excluded.

This review largely relied on cross-sectional studies, which assessed diet and mental health at a single point of time. This means that it has not always been possible to make definite conclusions about the direction of associations, or about the changes in diet quality or mental health over time.

2.4.3 Implications for health education practice

Even though the effect sizes of the included studies were mostly small or moderate, the observed results still have implications in health education practice. Given the evidence that unhealthy dietary practices are associated with worsening mental health of students, mental health education at university should aim to raise awareness of this association. This could be done along with input from nutritionists, and could involve the introduction of relevant modules in health courses, online courses, as well as the use of leaflets and posters in campuses (Lyzwinski et al., 2018).

This review has not identified any relevant whole-diet intervention or randomised controlled studies to improve mental health of students through diet, or vice-versa. Results for an ongoing randomised controlled trial (Trottier et al., 2021) are awaited, which involves the use of a web-based wellness platform to support healthy living of students by focusing on nutrition and physical activity.

An approach involving web interventions or lectures could also be followed to educate students about the relation of stress with unhealthy dietary habits. It has been suggested that the introduction of mindfulness-based stress reduction techniques and mindful eating may be effective techniques to address this issue (Chiesa & Malinowski, 2011; Lyzwinski et al., 2018).

Universities may need to review how they operate, what economic and planning decisions they make in terms of which franchises they allow onto campuses, influence what is sold in shops and raise awareness of the importance of diet quality. By helping students improve their diet quality, they may experience fewer mental health issues, as well as fewer and less severe depressive episodes. Similarly, by helping students deal with stress they may be able to experience healthier dietary habits during their university education.

2.4.4 Future recommendations

Most of the identified studies were cross-sectional, as they assessed diet and mental health at a single point of time. It is recommended that future studies use a longitudinal design when possible, enabling researchers to determine the direction of any detected associations. However, I recognise that longitudinal studies can pose challenges in terms of time and costs required.

Apart from the available cross-sectional studies establishing some associations, we also need well-powered clinical trials to further assess the associations of diet quality with the prevention, severity and relapse of depression, stress, and other mental health issues of students. The findings would inform the design of further studies, including randomised controlled trials and intervention studies. Such studies may provide more insight about the relationship between the three factors of stress, diet and emotion. However, it is recognised that designing and executing such studies may be challenging and that difficulties including randomisation may be anticipated.

I used the stress-diathesis model to interrogate the data, where the diatheses could be of biological, psychological or social nature. I noticed that studies did not always include data relevant to this model. For example, biological factors such as genetic predispositions or gut microbiota of students were not reported. Psychological factors such as perfectionism traits were also not reported. Moreover, social factors were not always reported, such as lack of ability to form group memberships, lack of culinary and basic nutritional knowledge, lack of resources and access to healthy food. Hence, the included studies only partially covered the stress-diathesis model, meaning there is scope for future studies to use the stress-diathesis model as a reference.

In terms of dietary instruments, the HEI was the most common instrument used, however it is a long instrument and students may not always engage. A previous study assessing the relationship of diet quality and mental health in adolescence has highlighted the need of a brief, validated measure of diet quality to be used in studies involving adolescents or young adults (Jacka et al., 2011). An example of such a measure might be the short-form food frequency questionnaire (SFFFQ) (Cleghorn et al., 2016), which may maximise the student engagement for future studies. In terms of mental health measures, the DASS-21 was the most commonly used measure and is a good option as it provides information about the three mental health aspects of depression, anxiety and stress. Results of studies with consistent tools for diet quality and mental health might enable the execution of a meta-analysis in the future.

2.5 Conclusions

The review results show observational evidence that a healthy diet of university students is associated with better mental health, as students that scored favourably in the diet quality instruments also scored favourably in depression, anxiety, and stress scales. The opposite applies for university students following unhealthy diets, as unhealthy diet in this group of students is associated with depression, stress, anxiety and other mental health issues. There is also observational evidence

to suggest that stress experienced by university students is associated with a deterioration in their diet quality, including a reduction in the intake of fruits and vegetables, and an increase in the consumption of sweets and fast food.

In order to establish the effectiveness of potential interventions for maintaining a healthy diet and good mental health of students, further observational studies, as well as randomised control trials would be required. This would allow the determination of whether interventions to improve diet quality at the university level could reduce mental health issues, and whether providing support to students under stress may lead to healthier dietary habits when living on campuses.

3 CHAPTER 3: Methodology

3.1 Introduction

There are several gaps in the literature in terms of understanding the associations between diet quality and mental health (and vice-versa) of students during the transition to university. Studies investigating the associations between diet quality and mental health have previously focused on the general population, but studies involving the student population are scarce. Most studies that involved the student population were performed outside the UK, and most did not focus on the critical period of transitioning to university.

This research project was designed to address the above shortfalls by investigating the associations between diet quality and mental health (and vice-versa) of students based at four UK universities. All participants were new students experiencing the transition to university at the time the study was performed. The participants were asked to complete online questionnaires, as described in the sections below.

3.2 Philosophical paradigm

3.2.1 Epistemology

The proposed study adopted the epistemological position of post-positivism, according to which knowledge of the world can be produced by testing propositions (Ritchie, Lewis, Lewis, Nicholls, & Ormston, 2013). This process involves using scientific theories to form hypotheses about associations and subsequently empirically evaluating these against observations (Ritchie et al., 2013). The proposed study followed this process to explore the associations between diet quality and mental health of students during the transition to university, as the research hypotheses were explored by collecting evidence via an online survey, and by performing analysis. Deductive logic by applying the hypothesis to observations was used to build knowledge. This means that the hypotheses (as described below) were either confirmed or rejected.

Other epistemological positions that were considered included the constructionist paradigm, according to which inductive logic is largely used to build knowledge by observing the world (Ritchie et al., 2013). However, constructionism would be more in line with a narrative design, as

constructionists believe that truths about the world can be constructed through narrative realities provided by participants that were actively and personally involved in the phenomena under investigation (De Vos, Strydom, Fouché, & Delport, 2011). In my opinion, the propositions should be tested first in the case of this study, hence why post-positivism was considered as a more appropriate epistemological position.

3.2.2 Ontology

The proposed study adopted other characteristics of the post-positivistic paradigm (Bunniss & Kelly, 2010), such as considering that facts and values are separate, and that reality is unaffected by the research process. Moreover, it was considered that it is not always possible to have full access to objective knowledge of the world, meaning that reality can only be known approximately. Hence, even though the hypotheses may be rejected or provisionally accepted, they could not be definitely proven to be true.

The ontological position of idealism was also considered, according to which reality is mind-dependent and knowable through socially constructed meanings (Ritchie et al., 2013). However, realism was considered more appropriate; this is an ontological position according to which an external reality exists independently of the researchers' beliefs or understanding (Ritchie et al., 2013). By adopting this paradigm, I recognise that it is not possible to accurately perceive reality due to imperfections of the human senses (Blaikie, 2007).

3.2.3 Quantitative methodology

The proposed study involved quantitative methodology by using online self-report questionnaires. This enabled the participants to read the questions themselves and record their own answers in the absence of the researcher (Bryman, 2016). Hence, the interviewer was not involved in the administration of the questionnaires. The absence of interviewer is in line with post-positivism and realism (Ritchie et al., 2013). Specifically, the use of self-report questionnaires overcame possible issues of bias, such as an interviewer presenting the questions in different ways to different respondents, reading the questions to the participants in the wrong order, or using different emphasis on certain items from person to person (Bryman, 2016). Moreover, it has been argued that the absence of the researcher can avoid a social desirability bias (Bryman, 2016), although there are also reports of social desirability effects in self-report dietary measures too (Hebert, Clemow, Pbert,

Ockene, & Ockene, 1995). There were also practical implications of using online self-report measures, as this meant a larger part of the eligible population could be reached within a short period of time.

3.3 Research questions

3.3.1 Primary research questions

The study considered the following primary research questions:

1. What is the association of diet quality with mental health of students during the transition to university (after controlling for confounders, such as gender, perfectionism, exercise, BMI, university of study)?
2. What is the association of mental health with diet quality of students during the transition to university (after controlling for confounders, such as gender, perfectionism, exercise, BMI, university of study)?

3.3.2 Secondary research questions

The study considered the following secondary research questions:

1. Does the transition to university moderate the relationship between diet quality and mental health of students?
2. Does the transition to university moderate the relationship between mental health and diet quality of students?

3.4 Hypotheses

3.4.1 Hypotheses for primary research questions

The hypotheses for the primary research questions were as follows:

1. Good diet quality will be associated with good mental health of students during the transition to university (after controlling for the following confounders: gender, perfectionism, exercise, BMI, university of study).

2. Good mental health will be associated with good diet quality of students during the transition to university (after controlling for the following confounders: gender, perfectionism, exercise, BMI, university of study).

The decision to control for five potential confounders was made by taking into consideration the practicalities involved in performing this study, and the number of participants that could pragmatically be recruited. Additional information, not relating to the aforementioned confounders, was collected for the purposes of performing descriptive statistics (such as information about alcohol use, recreational drug use).

3.4.2 Hypotheses for secondary research questions

The hypotheses for the secondary research questions were as follows:

1. The transition to university will significantly moderate the relationship between diet quality and mental health of students, where students with a poor transition quality will show a stronger association between bad diet quality and poor mental health compared to those with a better transition quality.
2. The transition to university will significantly moderate the relationship between diet quality and mental health of students, where students with a poor transition quality will show a stronger association between poor mental health and bad diet quality compared to those with a better transition quality.

3.5 Design

The study adopted a cross-sectional design. The study took place during the first semester of the academic year 2021-2022. Participants were first year undergraduate students at Lancaster University, University College London (UCL), Queen Mary University London (QMUL), and King's College London (KCL) living at student halls (university or private) for the first time. They were invited to participate by completing an online survey.

3.6 Participants

To respond to the primary research questions, I followed results from my systematic review (Solomou et al., 2023) which suggested that the association of diet quality with mental health, and mental health with diet quality show effect sizes ranging from small to moderate.

Hence, by setting the power of my study to 0.8, and alpha to 0.05, in a model with six predictors in total, I aimed to recruit 150 students. The minimum number of required participants was set to 150, and the maximum number to an additional 10% (i.e. 165 participants).

This number of participants was also considered suitable to conduct preliminary analyses regarding my secondary questions, with the aim of informing the development of fully powered future studies.

3.6.1 Inclusion criteria

Participants were included if they were of any gender, ethnicity or race; were at least 18 years old; were first year university students for the first time; were living at student halls (either university owned or private); were studying at Lancaster University, UCL, QMUL or KCL.

3.6.2 Exclusion criteria

Participants were excluded if they had been staying at their family home during the week prior to survey completion, and/or if they had been fasting over the week prior to survey completion.

I did not exclude participants with a diagnosis of depression, anxiety or stress, as these mental health difficulties were measured by the mental health questionnaires used. I considered including further exclusion criteria, such as mental health illnesses other than depression, anxiety and stress (such as eating disorders, schizophrenia, bipolar disorder, autism). For example, an eating disorder could potentially have an effect on diet quality where the amount of eating could be affected, such as restricted eating in anorexia nervosa and binge-eating in bulimia and binge-eating disorder. However, it would be expected that only a small proportion of the participants would fall under this category of having one of these diagnoses. For example, previous surveys (NICE, 2020) as well as a recent survey of UK students (THETAB, 2023) found that the prevalence of these disorders is much less compared to the prevalence of anxiety and depression.

In line with these statistics, I decided not to consider any mental health diagnoses as an exclusion criterion. It would be unlikely that a mental health diagnosis would be of relevance given the fact that the participants could attend university (hence indicating a good level of functioning).

Moreover, I also considered excluding participants with cardiometabolic disease; however, again the proportion of the students would have been small, and also their diagnosis would not necessarily have an effect on their diet quality. Additionally, avoiding exclusion of students having the above diagnoses may also mean that my sample was more representative of the true student population.

3.6.3 Recruitment

Participants were recruited through convenience and snowballing sampling. Communications officers, student union representatives and student societies at each participating university were contacted in order to promote the study. Recruitment involved using advertisements around the University campuses, as well as sending a press release and advertisements via emails from university communication officers. Advertisements were also sent by social media group administrators, student societies, other relevant societies, and student union representatives. Information about the study was published by using posters and flyers in teaching areas, social areas and halls of residence, as well as online via websites and social media (including Facebook, Instagram, Twitter). Permission to post in social media groups was requested from the group administrators before posts were made. A blog about the study was published at QMUL's official website. The study invitation to participate was included in the weekly recruitment circulars sent via email from KCL communication officers to KCL students, in regards to research studies available for students to participate.

3.7 Procedure

Participants were given time to settle in before starting data collection (at least two weeks after moving to university accommodation). As part of an online survey, participants were subsequently asked to complete food frequency questionnaires and mental health self-assessment questionnaires as documented below. The online survey took place through REDCap, which is a secure web application for building and managing online surveys and databases. Participants were provided with the investigator's contact details in case they wished to withdraw their data. Data were anonymous, although participants could optionally provide their email address following the end of the survey, in order to enter the voucher draw.

3.8 Measures

There were no relevant costs with the chosen questionnaires. Permission for use was obtained where appropriate; permission was specifically obtained from the creators of the College Adjustment Questionnaire (CAQ) and the short form food frequency questionnaire (SFFFQ).

3.8.1 Socioeconomic characteristics

General questions were used to obtain the socioeconomic information of the participants, including age, gender, relationship status, ethnicity, religion, employment status, and food security.

3.8.2 Lifestyle characteristics

General questions were used to obtain lifestyle information, including smoking status, alcohol use, recreational drug use, type of diet followed, knowledge/skills to cook healthily, and any recent life events (such as exams, bereavement, economic uncertainty).

3.8.3 Clinical characteristics

General questions were used to obtain information for clinical characteristics, including current weight, weight changes, and height.

3.8.4 Transition scale

The effects of the transition to university were measured by the College Adjustment Questionnaire (CAQ) (O'Donnell et al., 2018). The questionnaire consists of 14 items, with five items being relevant to educational functioning, five items to relational functioning, and four items to psychological functioning. A general index of adjustment can be computed from these subscales. Every item is scored on a scale from 1-very inaccurate to 5-very accurate, with five items being reverse-scored. The questions refer to the period since university was started. The questionnaire takes approximately 5-10 minutes to complete. The more extensive Student Adaptation to College Questionnaire (Baker & Siryk, 1984) was used to support convergent validity for the CAQ; there were large correlations between the two measures, hence suggesting good convergent validity for the CAQ (O'Donnell et al., 2018). Moreover, the CAQ subscale scores previously demonstrated good reliability, with alphas of 0.89 (Educational Functioning subscale), 0.84 (Relational Functioning subscale), and

0.79 (Psychological Functioning subscale). In order to make the questionnaire more culturally appropriate to UK students, I replaced the term “college” with “university”.

3.8.5 Mental health scale

The mental health of the participants was monitored by the 21-item depression, anxiety, and stress scale (DASS-21; (Lovibond & Lovibond, 1995). The DASS-21 is a self-report scale referring to the past week; it takes approximately ten minutes to complete. This tool has been shown to have good construct validity when it was administered to a non-clinical and broadly representative sample of the general adult UK population (n=1794) (Henry & Crawford, 2005). Additionally, good internal consistency and concurrent validity have also been shown in clinical samples, where participants had an established Diagnostic and Statistical Manual of Mental Disorders diagnosis (Antony, Bieling, Cox, Enns, & Swinson, 1998). The DASS-21 consists of three sections, each of which consists of seven items measuring depression, anxiety and stress respectively (21 items in total). Each item is rated on a 0-3 Likert scale. Good mental health is indicated by scores of 0-9 for depression, 0-7 for anxiety, and 0-14 for stress.

3.8.6 Diet quality scale

Diet quality was measured by the short-form food frequency questionnaire (SFFFQ; (Cleghorn et al., 2016). The SFFFQ refers to “a typical week over the past month”; for the purposes of this study, participants were asked to complete the questionnaire in relation to the past week.

The SFFFQ was developed by the University of Leeds and is used to provide a diet quality score (DQS). The development process of this tool involved expert knowledge about culturally specific foods, in order to tailor the tool to the UK population. The five dietary components considered as indicators of a healthy diet and used to inform the diet quality score (DQS) were fruit intake, vegetable intake, oily fish intake, fat intake and non-milk extrinsic sugar (NMES) intake. Scores of 1–3 are allocated for each of the above components of the DQS, with a score of 3 corresponding to meeting the UK dietary recommendations for that component. The minimum DQS score is 5 and the maximum score (indicating optimum dietary intake) is 15. The SFFFQ consists of 20 items (multiple choice options) and takes approximately fifteen minutes to complete. Scores of 1-5 were considered as indicating poor diet quality, scores 6-10 as moderate diet quality, and 11-15 as good diet quality.

The SFFFQ was validated (Cleghorn et al., 2016) in comparison to a previously validated and comprehensive food frequency questionnaire (FFQ)- a 217 item FFQ created for the UK Women’s

cohort study (Cade, Burley, Greenwood, & UK Women's Cohort Study Steering Group, 2004). There was significant agreement between the SFFFQ and the FFQ (κ=0.38, P<0.001). The SFFFQ is appropriate for studies that require an indication of diet quality rather than detailed nutrient intake, such as the proposed study. Moreover, the SFFFQ is less time-consuming and inexpensive compared to other measures.

A previous study assessing the relationship of diet quality and mental health in adolescence has highlighted the need for a brief, validated measure of diet quality to be used in studies involving adolescents or young adults (Jacka et al., 2011). The SFFFQ was developed after the above study by Jacka et al. was completed; to my knowledge, the SFFFQ is the only short-form diet questionnaire that has been developed for integration within population health surveys in the UK. My study was the first to use a brief diet quality questionnaire in the area of nutritional psychiatry in the UK- as has been previously suggested by Jacka et al. (Jacka et al., 2011).

3.8.7 Physical activity

Physical activity was assessed by the short version of international physical activity questionnaire (IPAQ) (Booth, 2000). The IPAQ assesses physical activity over the past week, and takes approximately five minutes to complete. The IPAQ has been shown to have good reliability and validity, with criterion validity having a median rho of about 0.30; this has been reported as being comparable to most other self-report validation studies (Craig et al., 2003).

3.8.8 Perfectionism

Perfectionism was assessed by using the Revised Almost Perfect Scale (RAPS) (Rice & Ashby, 2007). The scale consists of 23 items and takes approximately 10 minutes to complete. The scale has been shown to have good reliability and construct validity (Slaney, Rice, Mobley, Trippi, & Ashby, 2001).

3.8.9 Public involvement in survey design

As part of the survey design, we involved members of the public (including university students) and invited them to provide qualitative feedback relevant to the structure and format of the survey. Specifically, we had asked 7 individuals to provide feedback about the survey to optimise the structure and format, and to get an idea of how long it takes to complete (Appendix E). The time needed ranged

from 15 minutes to 23 minutes. The format of the survey, as well as the phrasing of questions, was adjusted according to the received feedback.

3.9 Statistical analysis

Exploratory analyses were conducted to evaluate the quality of the data, to identify any outliers, and to describe participant characteristics in terms of demographic and clinical information. To define diet quality and mental health, descriptive statistics according to the diet quality scores (DQS) of the SFFFQ, and also according to the mental health scores (DASS-21) were conducted.

To respond to the primary research questions, hierarchical regression analyses were conducted, with mental health as the dependent variable, and diet quality, gender, perfectionism, exercise, BMI, and university of study as predictors. Moreover, hierarchical regression analyses were conducted, with diet quality as the dependent variable, and mental health, gender, perfectionism, exercise, BMI, and university of study as predictors. These variables were selected as previous studies suggest they are associated with mental health and diet quality outcomes. For example, previous studies have suggested an association of poor diet quality (Firth et al., 2019), female sex (Burger & Scholz, 2018), perfectionistic traits (Levine et al., 2020), low levels of exercise (Callaghan, 2004), BMI above upper healthy limit (Brown, 2008), and rural university location (Wattick et al., 2018) with poor mental health. Moreover, studies have also suggested an association of poor mental health (Lyzwinski et al., 2018), male sex (Martinez-Lacoba, Pardo-Garcia, Amo-Saus, & Escribano-Sotos, 2018), perfectionistic traits (Prnjak, Jukic, & Korajlija, 2019), low levels of exercise (Godala, Krzyżak, Maślach, & Gaszyńska, 2022), BMI above upper healthy limit (Jia et al., 2020), and rural university location (Wattick et al., 2018) with unhealthy diets. These variables were considered as confounders rather than predictors, as they are not the focus of this thesis. Instead, they were included in the analysis in order to test the association between the main actors, which are mental health and diet quality.

In line with the stress-diathesis model, moderation analyses were performed to respond to the secondary research questions. This was done by centering the three main variables using sample means (mental health, diet quality and transition to university), including interactive effects accordingly (transition*mental health or transition*diet quality).

To run the analyses, the software SPSS (Statistical Package for the Social Sciences) was used (IBM Corp, 2021). SPSS was used to run both the regression and moderation analyses.

3.10 Ethical considerations

3.10.1 Anonymity and confidentiality

All electronic data, that were completed online, were anonymous and were stored onto university secure drives. Research results and identifiable data (email addresses) were separated. Email addresses were removed in cases where participants had provided their email address in order to enter the voucher draw. Anonymised data will be kept in Lancaster University's institutional data depository for 10 years, in line with the study's ethical approval.

3.10.2 Data management

Devices were encrypted where appropriate, however data were collected and stored online only on secure university servers. There was no audio or video collection for storage. Data will not be freely available and access may be granted only upon request. Supporting data for journal publications may be provided in an electronic format on the journal website. Access to further data (anonymised) stored in the Lancaster University's data depository may be granted only on request to genuine researchers and on case-by-case basis.

3.10.3 Informed consent

All necessary steps were taken to obtain the voluntary and informed consent from the prospective participants. When prospective participants accessed the online survey through REDCap, they were presented with an information sheet about the study. After having read the information sheet, they were presented with eligibility questions. In cases where they were not eligible for the study, a banner appeared informing them of this and that they would not be able to proceed further. If they were eligible for the study, they were directed to the consent page, where they were asked to confirm consent statements. Specifically, they were asked to confirm that they had read and understood the study information, that participation was voluntary, that their data would be anonymous, that the anonymised data would be kept by Lancaster University for 10 years following the study completion, that they consented for their data to be used for research purposes, and that they consented to taking part in the study.

After confirming the above consent statements, participants were directed to the survey. In cases where these statements were not confirmed, participants were not able to proceed further.

3.10.4 Participant distress

It was not expected that taking part in the project would cause participants undue discomfort, danger or distress. However, the researcher ensured the participants were aware they could contact their GP or attend the local A&E in case they were experiencing distress; useful resources in the event of distress (according to university of study location) were provided to all participants as part of the information sheet.

3.10.5 Risks to researcher

No specific risks to the researcher were anticipated, especially as there were no direct meetings in person with the participants. The contact details of the researcher were available to the participants, and in theory the possibility of any threatening or inappropriate behaviours towards the researcher could not be excluded. It was decided that in case of any such behaviours, these issues would be discussed with the supervisory team and escalated as appropriate. No such behaviours were observed to the point of writing this thesis.

3.10.6 Participant benefits

There were no direct benefits of taking part in this study. As a token of appreciation, participants that completed the study had the option to enter a draw for one of two £100 vouchers (by providing their email address). The email addresses were deleted from the electronic files following the draw for the vouchers, and will not be kept with the anonymous data collected by the study.

3.10.7 Dissemination of findings

The findings of the proposed study have been submitted as a PhD thesis to the University of Lancaster. The findings of the project may be used for the preparation of papers to be submitted as publications in peer reviewed journals. The findings may also form the basis of presentations and posters at relevant academic conferences.

3.11 Chapter summary

This study was designed to address questions about the association between diet quality and mental health (and vice versa) of students during their transition to university. This was one of the first studies of its kind to involve students based at UK universities. Based on principles from the philosophical paradigms of post-positivism and realism, the study recognised that knowledge of the world can be produced by testing propositions, and that the external reality exists independently of the researchers' beliefs or understanding.

By using quantitative methodology involving online self-report questionnaires, the study aimed to achieve an understanding of the impact of the transition to university on the diet quality and mental health of students. The measures used included validated questionnaires to provide information about the transition difficulties, diet quality and mental health difficulties of students.

The study was adequately powered to enable regression analyses, in order to understand the associations of diet quality and mental health (and vice versa) of students during the transition, whilst taking into consideration confounding factors.

4 CHAPTER 4: Results

4.1 Sample characteristics

The online survey was accessed 800 times from September 2021 to December 2021. The screening questions were completed by 249 participants, of which 220 were eligible to complete the survey. To answer the research question of the study, only students that provided complete responses to the mental health questionnaire (DASS21) and the diet quality questionnaire (SFFFQ) were considered. This led to 54 students being excluded, of which five had completed the DASS21 but not the SFFFQ, and 49 had completed neither. The final sample consisted of 166 students. After comparing the included participants with those that were excluded, I did not observe any significant differences in terms of age ($U(1, N = 204) = 3617.5$, $p = .49$), gender ($X^2(1, N = 204) = 0.57$, $p = .45$), university ($X^2(3, N = 205) = 3.30$, $p = .35$), or ethnicity ($X^2(1, N = 208) = 0.39$, $p = .54$).

The mean age of the included participants was 19.4 years (SD = 2.9 years). In terms of gender, 71% of the participants were female. The most common participant university was Queen Mary University of London (QMUL) (34%), followed by Lancaster University (33%). The majority of the participants (59%) were of white ethnic background. More participants were home students (69%) than overseas students (30%). The most common response to relationship status was “single” (77%). The majority were not smokers at the time of survey completion (89%), and did not self-report using any illicit drugs (93%). Most students reported no alcohol consumption (49%) or consumption of less than 14 units per week (33%). The full details of the students’ demographics are presented in Table 8.

Table 8. Demographic information

University/King's College London (UCL/KCL), Queen Mary University London (QMUL)

Variables	
Age (years)	
n (missing n)	162 (4)
Mean (sd)	19.4 (2.9)
Range	18-41
Gender, *n (%)*	
Female	118 (71)
Male	44 (27)
Other	4 (2)
University, *n (%)*	
Lancaster University	55 (33)
UCL	13 (8)
QMUL	57 (34)
KCL	37 (22)
Not known	4 (2)
University Location, *n*	
Urban (London)	107 (65)
Rural (Lancaster)	55 (31)
Not known	4 (2)
Ethnic background, n (%)	
White	98 (59)
Asian or Asian British	24 (15)
Chinese	14 (8)
Other (Black, mixed, other ethnic group)	30 (18)
Relationship status, n (%)	
Single	127 (77)
In a relationship	35 (21)
Other	4 (2)
Student status, n (%)	
Home Student	115 (69)
Overseas Student	50 (30)
Not known	1 (1)

Smoking status, n (%)	
Current smoker	19 (11)
Ex-smoker	5 (3)
Never smoked > 100 cigarettes	142 (86)
Alcohol consumption (last week), n (%)	
Rarely/no alcohol	82 (49)
<14 units	55 (33)
14-21 units	21 (13)
>21 units	8 (5)
Use of recreational drugs, n (%)	
Yes	11 (7)
No	155 (93)

4.2 Instrument reliability

Before moving to the section of responding to the main research questions, I am presenting information about the Cronbach's alpha values of the CAQ, DASS21 and APSR scales in table 10. It was found that values for reliability were good and comparable to the values reported by the original studies.

Table 9. Reliability of instruments used

College Adjustment Questionnaire (CAQ), Depression Anxiety and Stress Scale (DASS21), Almost Perfect Scale Revised (APSR).

Instrument	**Subsection**	**Cronbach's alpha**
CAQ	Educational functioning	.893
	Relational functioning	.906
	Psychological functioning	.831
DASS21	Depression score	.912
	Anxiety score	.830
	Stress score	.872
APSR	Standards score	.861
	Orders score	.772
	Discrepancy score	.950

4.3 Diet, weight and physical activity

In terms of diet (Table 9), most students (68%) reported to be omnivore (i.e. eating various types of food, including meat, vegetation and other animal products). Most students (76.5%) felt they had knowledge and skills to cook healthily. The majority (79%) did not experience any food security issues during the 12 months before survey completion. The majority (87%) did not report any weight changes since starting university. The mean BMI was 23 kg/m² (SD = 4.9 kg/m²), a result within the healthy adult BMI range of 18.5-24.9 (NIH, 2013). The mean short form food frequency questionnaire (SFFFQ) score was 9.8 (SD = 1.7) out of a maximum score of 15 (figure 2, panel A), which indicates a moderate-good diet quality. In terms of physical activity, the mean value for metabolic minutes per week was 3590 (SD = 2898) (figure 2, panel B), which indicates a high level of physical activity. Moreover, 51.8% of the students were under the category of high level of physical activity.

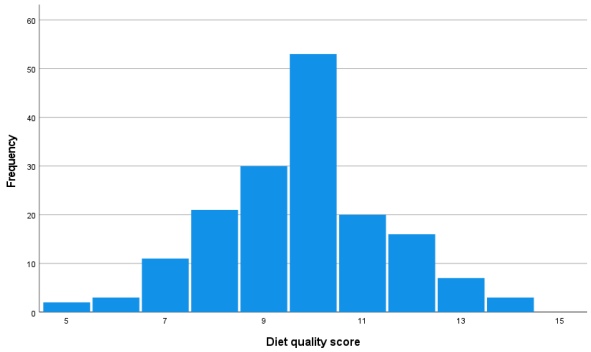
Table 10. Information about diet, weight and physical activity

Body Mass Index (BMI).

Variables	
Food insecure (last 12 months), n (%)	
Often	5 (3)
Sometimes	30 (18)
Never	131 (79)
Type of diet followed, n (%)	
Omnivore	113 (68)
Vegetarian	29 (18)
Vegan	5 (3)
Pescatarian	7 (4)
Other (Halal, Kosher)	12 (7)
Subjective knowledge/skills for healthy cooking n (%)	
Yes	127 (76.5)
No	39 (23.5)
Weight (kg)	
n (missing n)	162 (4)
Mean (sd)	65.1 (15.7)
Range	39.1-131.0

Weight change since starting university	
No change	
n (%)	87 (52)
Weight gain (kg)	
n (%)	27 (16)
mean (sd)	3.8 (3.0)
Weight loss (kg)	
n (%)	50 (30)
mean (sd)	3.4 (3.6)
Not known	
n (%)	2 (1)
BMI (kg/m²)	
n (missing n)	156 (10)
Mean (sd)	23.0 (4.9)
Range	14.7-41.0
Diet quality score (SFFFQ)	
n (missing n)	166 (0)
Mean (sd)	9.8 (1.7)
Range	5-14
Physical activity n (%)	
Low	13 (7.8)
Moderate	61 (36.7)
High	86 (51.8)
Not known	6 (3.6)
Metabolic minutes per week	
n (missing n)	160 (6)
Mean (sd)	3590 (2898)
Range	0-14238

Panel A. Distribution of the diet quality scores of the SFFFQ questionnaire



Panel B. Distribution of the metabolic minutes per week of the IPAQ questionnaire

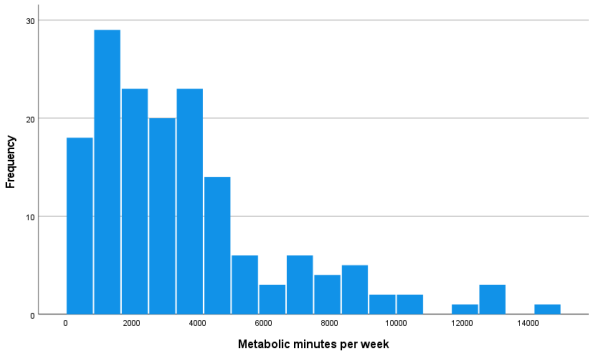


Figure 4. Diet quality and exercise score distributions

Short Form Food Frequency Questionnaire (SFFFQ), Diet quality score of the SFFFQ (DQS), International Physical Activity Questionnaire- Short Form (IPAQ).

In order to get an understanding of factors that affect diet quality (and consequently the mental health) of students during their transition to university, I performed t-tests for the various groups depending on diet type, food security, and knowledge to cook healthily.

There were statistically significant differences in the mean diet quality scores (DQS) of the SFFFQ depending on diet type ($F(4,161) = 4.131$, $p = 0.003$). Post-hoc (Games-Howell) tests demonstrated that the pescatarian (seafood-based) diet showed a statistically significant higher diet quality mean score than the omnivore diet (Mean difference = 2.283, $p = 0.016$), the vegetarian diet (Mean difference = 2.690, $p = 0.005$) and the other (Halal and Kosher) diet (Mean difference = 2.583, $p = 0.021$).

Moreover, there were statistically significant differences in the mean diet quality scores depending on food security ($F(2,163) = 5.287$, $p = 0.006$). However, post-hoc (Games-Howell) tests did not show any significant mean differences between the food security categories. In this case, the post-hoc tests should be interpreted with caution as there were only five participants in the “often true” group of the food security variable.

Students in the group reporting knowledge to cook healthily had a statistically significant higher diet quality mean score than students in the group reporting no knowledge to cook healthily ($t(164) = 4.354$, Mean difference = 1.312, $p < 0.001$).

4.4 Mental health and adjustment to university

The percentage of the participants reporting they had experienced stressful events since starting university was 43% (table 11). Financial difficulties since starting university was the most frequently reported stressful event. The group that had experienced stressful events since starting university had statistically significant lower scores for the psychological functioning subsection of the CAQ ($t(164) = 4.387, p < 0.001$) suggesting poorer psychological functioning, compared to the group that had not experienced stressful events. Moreover, the scores for the depression ($t(164) = 2.586$, $p = 0.011$), anxiety ($t(164) = 4.219$, $p < 0.001$), stress ($t(164) = 4.184$, $p < 0.001$) subsections of the DASS-21, as well as the total DASS-21 score for mental health ($t(164) = 4.115$, $p < 0.001$) were statistically significantly higher for the group that had experienced stressful events since starting university, suggesting poorer mental health in terms of depression, anxiety and stress compared to the group that had not experienced stressful events. There were no statistically significant differences between the groups that had and had not experienced stressful events for the educational functioning and relational functioning subsections of the CAQ, or for the perfectionism (APSR) score (table 11). These results suggest that experiencing stressful events did not have an impact on the educational and relational functioning of students, and that there were no differences in terms of perfectionistic traits between the students that had experienced stressful events and those that had not.

There appeared to be variability in the range of mental health scores (figure 3). Specifically, the mean depression score of 14.7 indicated moderate depression, the mean anxiety score of 13.3 indicated moderate anxiety, and the mean stress score of 15.8 indicated mild stress (table 11). This means that there was a high proportion of students with scores that would not suggest mental illness (figure 3). The distribution of the adjustment scores was also variable, with most students scoring average scores rather than scores lying on either extreme (figure 4). This was the case for all subscales of the adjustment scale (educational, relational, psychological functioning). This suggests that, overall, students had a reasonable quality of transition, with the psychological functioning scores being worse compared to the educational functioning and relational functioning scores. In terms of perfectionism, the distribution of the perfectionism scores showed that there was a variability in responses (figure 4). The mean perfectionism score of 32.0 was below the threshold for having perfectionism traits.

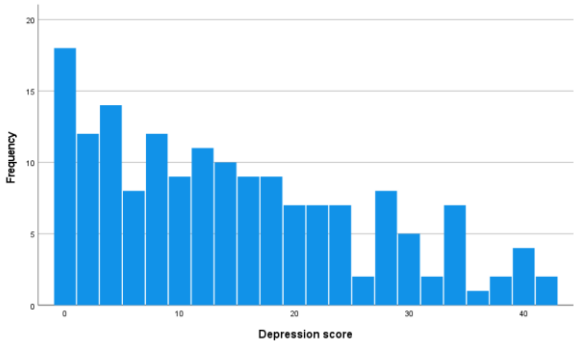
Table 11. Information about mental health and adjustment to university

College Adjustment Questionnaire (CAQ), Depression Anxiety and Stress Scale (DASS21), Almost Perfect Scale Revised (APSR).

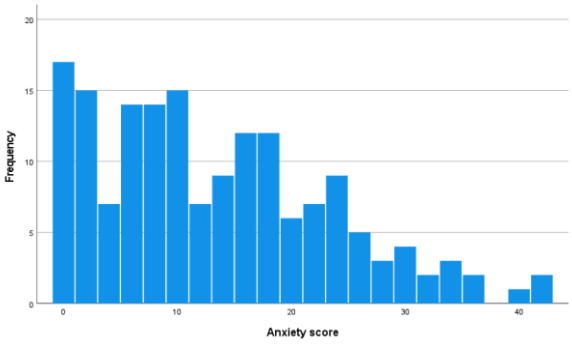
Demographics/variables	**All**	**Stressful events**	**No stressful events**	**t-test**
Stressful life events since starting university n (%)	166 (100)	72 (43)	94 (57)	N/A
Adjustment to university score (CAQ)				
Educational functioning				
Mean (sd)	17.7 (3.7)	17.4 (4.0)	18.0 (3.4)	t(164) = 1.062,
Range	5-25	5-25	9-25	p = 0.290
Relational functioning				
Mean (sd)	15.5 (5.3)	14.8 (5.3)	15.9 (5.3)	t(164) = 1.327,
Range	5-25	5-25	5-25	p = 0.186
Psychological functioning				
Mean (sd)	13.4 (4.1)	11.9 (4.0)	14.5 (3.7)	t(164) = 4.387,
Range	4-20	5-20	4-20	p < 0.001
Mental health score (DASS21)				
Depression				
Mean (sd)	14.7 (11.5)	17.3 (11.4)	12.7 (11.2)	t(164) = 2.586,
Range	0-42	0-42	0-42	p = 0.011
Anxiety				
Mean (sd)	13.3 (10.1)	16.9 (9.9)	10.5 (9.5)	t(164) = 4.219,
Range	0-42	0-42	0-42	p < 0.001
Stress				
Mean (sd)	15.8 (10.7)	19.6 (10.7)	12.9 (9.9)	t(164) = 4.184,
Range	0-42	0-42	0-40	p < 0.001
Total DASS21 score				
Mean (sd)	43.8 (28.7)	53.8 (27.8)	36.1 (27.1)	t(164) = 4.115,
Range	0-126	0-126	0-118	p < 0.001

Perfectionism score (APSR)				
n (missing n)	162 (4)	71 (1)	91 (3)	t(160) = 1.230
Mean (sd)	32.0 (7.4)	32.8 (7.7)	31.3 (7.1)	p = 0.220
Range	9-42			

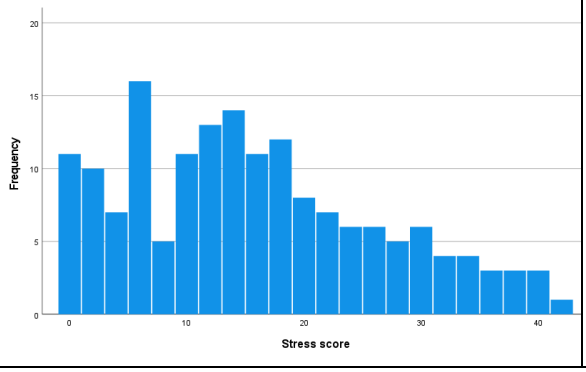
Panel A. Distribution of the depression scores of the DASS21 questionnaire



Panel B. Distribution of the anxiety scores of the DASS21 questionnaire



Panel C. Distribution of the stress scores of the DASS21 questionnaire



Panel D. Distribution of the total scores of the DASS21 questionnaire

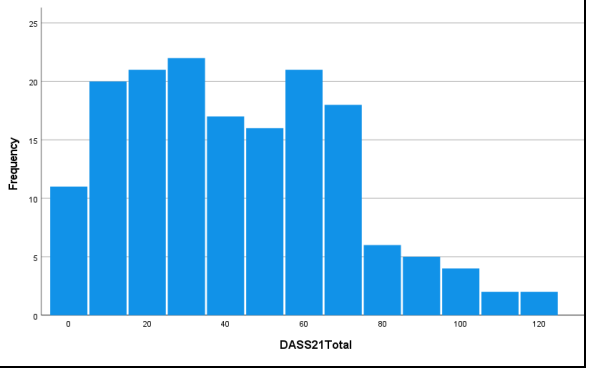
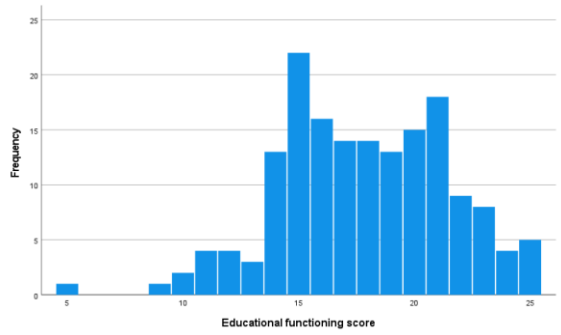
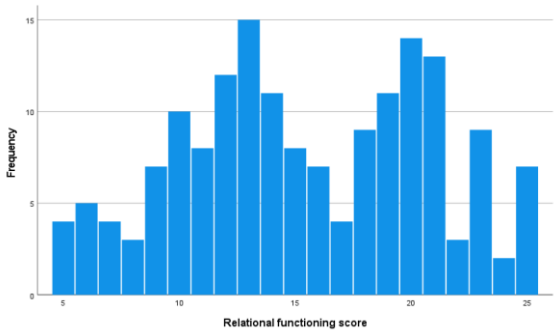


Figure 5. Distribution of the depression, anxiety, stress and total scores of the DASS21 questionnaire. Depression Anxiety and Stress Scale (DASS21)

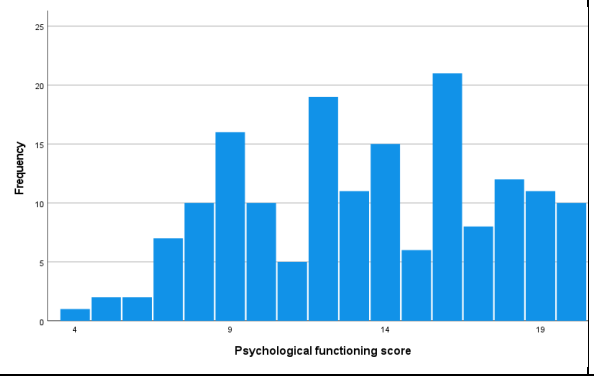
Panel A. Distribution of the educational functioning scores of the CAQ questionnaire



Panel B. Distribution of the relational functioning scores of the CAQ questionnaire



Panel C. Distribution of the psychological functioning scores of the CAQ questionnaire



Panel D. Distribution of the standards scores of the APSR questionnaire

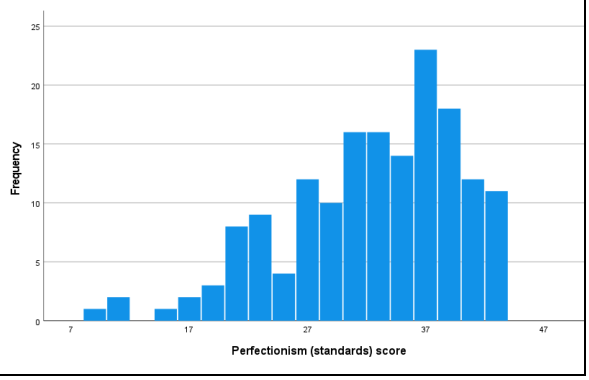


Figure 6. Distribution of the educational, relational and psychological functioning scores of the CAQ questionnaire, and of the standards scores of the APSR questionnaire. College Adjustment Questionnaire (CAQ), Almost Perfect Scale Revised (APSR)

4.5 Screening for multivariate outliers

Before running the regression analysis, I checked for the presence of multivariate outliers by using the Mahalanobis distance, as described by Tabachnik et al. (Tabachnick, Fidell, & Ullman, 2007). I did not find any multivariate outliers among the cases with the use of a $p < .001$ criterion for Mahalanobis distance. Hence, I proceeded to run the analysis without excluding any participants.

4.6 Regression analysis

As mentioned in chapter 4, I employed sequential regression to evaluate my first main question of whether diet quality predicts mental health, after controlling for confounding factors.

The sequential regression determined whether addition of information regarding gender, then perfectionism, then exercise, then BMI, then university location, and then diet quality scores (DQS) of the SFFFQ were associated with overall mental health scores (DASS-21). Table 12 presents the results of the model.

The results show that diet quality was a significant predictor of mental health. The beta (B) value was -3.46 ($p \leq .01$), meaning that for every point gained in the diet quality score, the mental health score was improved by 3.46 points. Gender was also a significant predictor ($p \leq .05$), where being male was associated with a 12.80 points reduction in the DASS-21 score compared to being female.

The sequential analysis showed that R^2 was significantly different from zero at the end of step 1, when the independent variable (IV) of gender was added to the model; $R^2 = .07$, Finc(2, 141) = 4.19, $p \leq .05$. The gender contributed to 4% of the variability in overall mental health scores (table 12). R^2 was also significantly different from zero at the end of step 6, when the IV of diet quality was added to the model; $R^2 = .11$, Finc(1, 136) = 6.53, $p \leq .01$. Diet quality contributed to 4% of the variability in overall mental health scores (table 5). After step 6, with all IVs in the equation, $R^2 = .11$, F(6, 137)= 2.40, $p \leq .05$. The adjusted R^2 value of .11 indicates that 11% of the variability in overall mental health scores was predicted by the model (table 12).

A similar strategy was followed to evaluate my second main question of whether mental health predicts diet quality, after controlling for confounding factors. Sequential regression was employed to determine if addition of information regarding gender, then perfectionism, then exercise, then BMI, then university location, and then overall mental health scores were associated with diet quality scores. Table 13 displays the results of the model.

The results show that mental health was a significant predictor of diet quality. The B value was -.01 ($p \leq .01$), meaning that for every point of improvement in mental health scores, the diet quality score was improved by .01 points. Moreover, gender was a significant predictor ($p \leq .05$), where being male was associated with a .75 points reduction in the diet quality score compared to being female. Gender contributed to 3% of the variability in diet quality scores ($p \leq .05$) (table 13). Exercise was also a significant predictor, where for every metabolic minute per week the diet quality score was improved by 0.000087 units. Exercise contributed to 4% of the variability in diet quality scores ($p \leq .05$) (table 13).

Following the final addition of the overall mental health scores in the equation, $R^2 = .11$, Finc(1, 136) = 6.53, $p \leq .01$. The mental health scores contributed to 4% of the variability in diet quality scores. Addition of the remaining IVs to the equation did not reliably improve R^2 (table 13). After the final step, with all IVs in the equation, $R^2 = .11$, $F(7, 136) = 2.46$, $p \leq .05$. The adjusted R^2 value of .11 indicates that 11% of the variability in diet quality scores was predicted by the model (table 13).

Table 12. Sequential regression of variables (including diet quality scores) on the overall mental health (DASS-21)

Variables	DASS21 score	Gender 0 (female)	Gender 1 (male)	Gender 2 (other)	Perfecti -onism	Exercise	BMI	University Location	DQS score	B	SE B	β	sr^2 (incremental)
Gender 0 (female)	.14*												
Gender 1 (male)	-.20**	-.93**								-12.80*	5.50	-.20	
Gender 2 (other)	.15*	-.26**	-.10							17.02	14.07	.10	.06*
Perfectionism (APSR)	.15*	.14*	-.20**	.13						.37	.31	.10	.01
Exercise	-.02	-.16*	.14*	.07	.05					.00	.00	.04	.00
BMI	.01	-.09	.10	-.02	-.02	-.10				.13	.48	.02	.01
University Location	.03	.23**	-.21**	-.07	.08	-.20**	-.06			.37	5.12	.01	.00
DQS score	-.19**	.15*	-.13	-.07	.01	.18*	-.07	.06		-3.46**	1.35	-.21	.04**
Intercept										64.60	20.63		
Means	44.24	.71	.26	.03	31.48	3353.69	23.06	.69	9.73				
Standard deviations	28.06	.46	.44	.16	7.46	2691.68	4.85	.47	1.74				
													R^2 = .11 Adjusted R^2 = .06 R = .33**

Depression Anxiety and Stress Scale (DASS21), Almost Perfect Scale Revised (APSR), Diet Quality Score of the Short Form Food Frequency Questionnaire (DQS)
Unstandardized beta (B), standard error for the unstandardized beta (SE B), standardized beta (β), probability value (p), correlation coefficient (R)
*p ≤ .05, **p ≤ .01

Table 13. Sequential regression of variables (including overall mental health scores) on the diet quality (DQS) score

Variables	DQS score	Gender 0 (female)	Gender 1 (male)	Gender 2 (other)	Perfecti-onism	Exercise	BMI	University Location	DASS21 score	B	SE B	β	sr^2 (incremental)
Gender 0 (female)	.15*												
Gender 1 (male)	-.13	-.93**								-.75*	.34	-.19	
Gender 2 (other)	-.07	-.26**	-.10							-.71	.87	-.07	.02
Perfectionism (APSR)	.01	.14*	-.20**	.13						-.00	.02	-.01	.00
Exercise	.18*	-.16*	.14*	.07	.05					.00**	.00	.22	.04**
BMI	-.07	-.09	.10	-.02	-.02	-.10				-.01	.03	-.02	.00
University Location	.06	.23**	-.21**	-.07	.08	-.20**	-.06			.24	.32	.06	.00
DASS21 score	-.19*	.14*	-.20**	.15*	.15*	-.02	.01	.03		-.01**	.01	-.21	.04**
Intercept										10.15	1.00		
Means	9.73	.71	.26	.03	31.48	3353.69	23.06	.69	44.24				
Standard deviations	1.74	.46	.44	.16	7.46	2691.68	4.85	.47	28.06				
													R^2 = .11 Adjusted R^2 = .07, R = .34*

Depression Anxiety and Stress Scale (DASS21), Almost Perfect Scale Revised (APSR), Diet Quality Score of the Short Form Food Frequency Questionnaire (DQS)
Unstandardized beta (B), standard error for the unstandardized beta (SE B), standardized beta (β), probability value (p), correlation coefficient (R)
*p ≤ .05, **p ≤ .01

4.7 Moderation analyses

In line with the stress-diathesis model, I performed moderation analyses to evaluate the secondary research questions. The analyses included the multiplicative effect of diet quality with the transition to university, as well as the multiplicative effect of the mental health with the transition to university.

With mental health being the dependent variable and all predictors in the model, the interaction effect of the transition and diet quality was not statistically significant ($p = .27$). Diet quality remained as a statistically significant predictor ($b = -3.13$, 95% CI [-5.33, -.93]) and contributed 4% of the total variance explained (table 14). Transition scores were also statistically significant ($b = -1.51$, 95% CI [-1.88, -1.13]) and contributed 31% of the variance. Increases on the quality of both diet and transition were associated with reductions in mental health scores.

In a model with diet quality as the dependent variable the interaction effect of the transition and mental health was not statistically significant ($p = .17$). Mental health was a significant predictor ($b = -.02$, 95% CI [-.03, -.00]), explaining 6% of the total variance (table 15).

Table 14. Sequential regression of variables (including multiplicative interactive effects of transition and diet quality) on the overall mental health (DASS-21)

Variables	**B**	**SE B**	**95% CI for B**	**β**	**sr^2 (incremental)**
Gender 0 (female)					
Gender 1 (male)	-6.73	4.55	-15.73, 2.27	-.11	
Gender 2 (other)	13.35	11.48	-9.35, 36.05	.08	.06*
Perfectionism (APSR)	.51	.26	-.00, 1.01	.13	.01
Exercise	.00	.00	.00, .00	.13	.00
BMI	-.20	.39	-.98, .57	-.04	.00
University Location	-.85	4.19	-9.14, 7.44	-.01	.00
CAQ score	-1.51**	.19	-1.88, -1.13	-.56	.31**
DQS score	-3.13**	1.11	-5.33, -.93	-.19	.04**
CAQ*DQS	.13	.12	-.10, .36	.08	.01
					R^2 = .42 Adjusted R^2 = .38 R = .65**

Depression Anxiety and Stress Scale (DASS21), Almost Perfect Scale Revised (APSR), College Adjustment Questionnaire (CAQ), Diet Quality Score of the Short Form Food Frequency Questionnaire (DQS), CAQ*DQS multiplicative effect of transition and diet quality

Unstandardized beta (B), standard error for the unstandardized beta (SE B), Confidence Intervals (CI), standardized beta (β), probability value (p), correlation coefficient (R)

*p ≤ .05, **p ≤ .01

Table 15. Sequential regression of variables (including multiplicative interactive effects of transition and mental health) on the diet quality (DQS) score

Variables	**B**	**SE B**	**95% CI for B**	**β**	**sr^2 (incremental)**
Gender 0 (female)					
Gender 1 (male)	-.64	.34	-1.31, .041	-.16	
Gender 2 (other)	-.58	.87	-2.30, 1.14	-.06	.02
Perfectionism (APSR)	.00	.02	-.04, .04	.01	.00
Exercise	.00	.00	.00, .00	.24	.04*
BMI	-.01	.03	-.07, .04	-.04	.00
University Location	.18	.32	-.45, .80	.05	.00
CAQ score	-.02	.02	-.06, .01	-.15	.00
DASS-21 score	-.02**	.01	-.03, -.00	-.30	.06**
CAQ*DASS-21	.00	.00	.00, .00	.11	.01
					R^2 = .14 Adjusted R^2 = .08 R = .37*

Depression Anxiety and Stress Scale (DASS21), Almost Perfect Scale Revised (APSR), College Adjustment Questionnaire (CAQ), Diet Quality Score of the Short Form Food Frequency Questionnaire (DQS), CAQ*DASS-21 multiplicative effect of transition and mental health

Unstandardized beta (B), standard error for the unstandardized beta (SE B), confidence intervals (CI), standardized beta (β), probability value (p), correlation coefficient (R)

*p ≤ .05, **p ≤ .01

4.8 Chapter summary

The final sample consisted of 166 students, of which 71% were female. The mean age was 19.4 years old.

There were statistically significant differences in the mean diet quality scores depending on diet type. There were statistically significant differences in the mean diet quality scores depending on food security. Students in the group reporting knowledge to cook healthily had a statistically significant higher diet quality mean score than students in the group reporting no knowledge to cook healthily.

Regression analysis showed that diet quality was a significant predictor of mental health, where better diet quality scores were associated with better mental health scores. Gender was also a significant predictor, where being male was associated with better mental health scores. Perfectionism, exercise, BMI, and university location were not found to be statistically significant predictors of mental health.

The regression analysis also showed that mental health was a significant predictor of diet quality, where better mental health scores were associated with better diet quality scores. Gender was a significant predictor, where being female was associated with better diet quality scores. Exercise was also a significant predictor, where better exercise scores were associated with better diet quality scores. Perfectionism, BMI, and university location were not found to be statistically significant predictors of diet quality.

Better transition scores were associated with better mental health scores. The interaction effect of the transition and diet quality, as well as the interaction effect of the transition and mental health were not statistically significant.

5 CHAPTER 5: Discussion

5.1 Introduction

5.1.1 The structure of this discussion

The subsequent discussion starts by returning to the beginning of the study, and revisiting the original hypotheses that had set the direction of this research. These hypotheses are reconsidered in light of the findings reported in the previous chapters. The theoretical model of stress-diathesis is reflected in the context of the study findings, and consideration is taken in regards to how this model can be considered for future research relevant to the relationships between diet quality and mental health of students.

In the discussion section, the practical and clinical implications of the findings are considered whilst taking into consideration previous literature. The discussion ends with a summary of the study's strengths and limitations, and with recommendations for relevant future research.

5.1.2 Study purpose and contributions

The purpose of this study was to investigate the associations between diet quality and mental health of students, during the transition to university.

In addition to the above, the study had two secondary aims: (1) to explore whether the transition to university moderates the relationship between diet quality and mental health of students; and (2) to explore whether the transition to university moderates the relationship between mental health and diet quality of students.

The study aimed to fill a knowledge gap in health education in UK universities. As the systematic literature review in chapter 2 has shown, the studies in the UK exploring the relationships between diet and mental health of university students are scarce. Out of the 59 studies included in the systematic literature review, only five were conducted in the UK. Of these studies, three explored the associations between diet and mental health, and two explored the associations between mental health and diet quality. Moreover, only one of these studies took into consideration the effect of the transition to university (Romijn, 2019); this was a pilot study which took place in 2019, and was the most recent of these studies. The overall conclusion from these studies is that when a healthy diet was followed the mental health scores were better in terms of depression and anxiety, compared to

when unhealthy diets were followed. Moreover, these studies suggested that students were more likely to consume junk foods when being in a state of high anxiety.

I am expanding on these findings, whilst taking into account the stress diathesis model of illness, which was a conceptual contribution of my study. It is important to take this model into consideration, as a difficult transition to university could act as a stressor for students having a vulnerability for diet quality and/or mental health issues. This is a novelty of my study, as the quality of the transition to university was not taken into consideration by most previous studies.

As part of the discussion, informed by my study findings, I explore how universities can support new students to achieve and maintain good diet quality and mental health, for example through health education and university policies. In addition, the discussion considers whether the findings could also have implications from the clinical point of view, in cases where students may have formal mental health diagnoses, for example as according to the DSM-V criteria.

5.2 Hypotheses

This study specified two primary and two secondary hypotheses for the relationships between diet quality and mental health of students during their transition to university. Following the data analysis, these hypotheses have either been accepted or rejected (Table 16). Both primary hypotheses were confirmed, as there were significant associations between diet quality and mental health, and vice versa. None of the secondary hypotheses were accepted.

The acceptance or rejection of hypotheses took place in line with the epistemological position of post-positivism, according to which knowledge of the world can be produced by testing propositions. Deductive logic by applying the hypothesis to observations was used to build knowledge, which is discussed in this section. Results are discussed whilst following the ontological position of realism, and recognising that an external reality exists independently of my beliefs or understanding of the findings.

Table 16. Study hypotheses outcomes (accepted or rejected) following data analysis

Hypothesis	Type of hypothesis	Accepted
Good diet quality will be associated with good mental health of students during the transition to university	Primary	Yes
Good mental health will be associated with good diet quality of students during the transition to university	Primary	Yes
The transition to university will significantly moderate the relationship between diet quality and mental health of students, where students with a poor transition quality will show a stronger association between bad diet quality and poor mental health compared to those with a better transition quality.	Secondary	No
The transition to university will significantly moderate the relationship between diet quality and mental health of students, where students with a poor transition quality will show a stronger association between poor mental health and bad diet quality compared to those with a better transition quality.	Secondary	No

5.3 Discussion of key findings

The study results showed that having a good diet quality during the transition to university was associated with better mental health. These results are in line with the findings of my systematic literature review, which showed that the majority of the included studies (36 out of 45) found that good diet quality of students was associated with better mental health in terms of depression, anxiety, stress and overall general mental well-being. The review found that the effect sizes were small-moderate, which are in line with my study findings too. My results are in agreement with a previous study of students transitioning to a UK-based university, which found that the group with the worst diet quality had higher levels of depression and anxiety compared to groups with better diet quality (Romijn, 2019). The results are also in agreement with previous studies involving the general population (Sánchez-Villegas et al., 2015), that also found that good quality diets were associated with good mental health.

5.3.1 Association of diet quality with mental health during the transition to university: potential mechanisms

My study investigated the relationship of diet quality with mental health of students during the transition to university. The statistical analysis showed that diet quality was a significant predictor of mental health of students, where better diet quality was associated with better mental health.

It has previously been shown in the general population that the risk of developing depression is less when healthy diets, such as the Mediterranean diet, are followed (Sánchez-Villegas et al., 2009). These diets reduce inflammation, which has been found to be implicated in psychiatric disorders (Bauer & Teixeira, 2019; Osimo, Cardinal, Jones, & Khandaker, 2018). The Mediterranean diet is a diet rich in fruits and vegetables, whole grains, nuts and legumes, and olive oil, but also seafood. In line with the fact that the seafood is a core component of the Mediterranean diet, I found statistically significant differences in the mean diet quality scores depending on diet type, with the pescatarian diet being associated with a statistically significant higher diet quality mean score than the omnivore, vegetarian diet and other (Halal and Kosher) diets. However, results should be interpreted with caution in view of the small number of participants that were under the vegan, pescatarian, and other categories.

The mechanism of the association may also be relevant to vulnerabilities that students may be experiencing during their transition. For example, the lack of regularity and the loss of home rituals may mean that regular home-made food is replaced by irregular and unhealthy fast-food. In addition, when transitioning to university, students may face financial difficulties. In fact, financial difficulties since starting university was the most frequent stressful event reported by my study participants. Financial difficulties can lead to food insecurity, and when being food insecure students may rely more on cheaper unhealthy food- a negative change compared to the food they used to have at home. The effects of these changes could be contributing towards a deterioration of mental health, as students are perceiving a worsening of their diet and a loss of their usual home dietary routines.

Moreover, the fact that students now have to rely on their own cooking means that the quality of the foods they prepare may not be of the same high standard as the food they used to have at home- in cases where they lack the knowledge to cook healthily. My findings showed that students reporting good knowledge of cooking healthily had better quality of diets than those that had no knowledge. There can also be an impact on mental health, as when being unable to cook to the same standard as home food students may experience negative feelings, such as inadequacy and inability to cope by themselves (Hyytinen, Tuononen, Nevgi, & Toom, 2022).

A factor that may be particularly relevant to international students studying in the UK is that foods that used to be accessible in their own countries may no longer be available. In view of this, they could be relying more on non-traditional ready-made meals which could be of worse diet quality compared to their home foods. The loss of having access to traditional foods, in combination with the feeling that their new foods are of worse quality, could be negatively impacting on their mental health.

5.3.2 Association of mental health with diet quality during the transition to university: potential mechanisms

My study investigated the relationship of mental health with diet quality during the transition to university. The results showed that there was a statistically significant association where good mental health was related to good diet quality, however the association was weaker compared to the association of diet quality with mental health. It might be the case that certain mental health difficulties may be more associated with diet quality than others. For example, the results of my systematic literature review (chapter 2) showed that even though there was some evidence that worse scores for anxiety and stress might be associated with poorer diets, the evidence from studies was inconsistent in regards to other mental health difficulties, such as symptoms of depression as measured by depression scales.

The association of mental health with diet quality found by my study might make sense when considering this in the context of the stress-diathesis model. Students with a predisposition to mental health difficulties may develop anxiety and/or depression when the transition to university acts as a stressor. It has been previously established that the hypothalamus–pituitary–adrenal axis becomes hyperactive when experiencing depression and anxiety, leading to an increase in appetite-stimulating hormones such as cortisol and ghrelin (Chuang & Zigman, 2010; Pariante & Lightman, 2008; Vreeburg et al., 2010). As a consequence, appetite may be increased with a preference for energy-dense foods at the expense of healthy foods, hence leading to poor diet quality of students experiencing mental health difficulties.

Once students develop anxiety and depression, it might also be the case that they may lack the motivation to spend time and efforts to buy healthy ingredients and prepare healthy meals themselves. Instead, it might be easier to rely on unhealthy ready-made meals and take-aways (Veale, 2008). Hence, this could also be having a negative impact on their diet quality.

5.3.3 Predictors of the associations between diet quality and mental health of students

In order to explore the relationships between the diet quality and mental health of students, I considered various factors that could act as predictors of diet quality, or predictors of the mental health of students. This section discusses the predictors that were found to be statistically significant, as well as those that were not. All predictors discussed in this section were part of the same model, and were all included in the regression analyses.

5.3.3.1 Gender

My study results showed that gender was a significant predictor of the overall mental health scores of the participants, as gender contributed to 4% of the variability in overall mental health scores. I found that being female was associated with worse mental health scores compared to being male. My results are in agreement with previous literature. For example, a study of medical students at a German university found that female students scored unfavourably for depression and quality of life scores compared to male students (Burger & Scholz, 2018).

As well as being a predictor of mental health scores, I found that gender was also a statistically significant predictor of diet quality, where males had worse diet quality scores compared to females. These results are in agreement with a previous study of Spanish university students, which found that being male was associated with following unhealthy diets (Martinez-Lacoba et al., 2018).

5.3.3.2 Weight gain and high BMI

An increase in weight during the transition to university might be relevant to the association of diet with mental health, especially as weight gain and high body mass index (BMI) is associated with inflammation. In line with the stress-diathesis model, students vulnerable to gaining weight might be experiencing weight gain when the transition to university acts as a stressor. Previous studies have shown that the diet changes when students start university can lead to a phenomenon called “Freshman 15”, which refers to gaining 15 lb (6.8 kg) of weight during the first year of university (Brown, 2008).

In contrast to these findings, my results did not support the notion that students gain weight when they start university, as only 16% of the participants reported a weight gain. When asked whether they had gained, lost or maintained the same weight, more students (30%) reported a weight loss rather than weight gain, and more than half of the students did not report any changes in their weight. A previous study that examined weight changes of students while transitioning to a UK-based

university found that 30% of the participants had gained weight (Romijn, 2019); this is in contrast to my results.

As part of my regression analysis, BMI was tested as a potential predictor for diet quality and mental health of students. The results showed that BMI was not a statistically significant predictor of diet quality, nor of mental health. These results are in contrast with studies which have previously reported that obese and overweight students are more likely to have mental health difficulties, such as depression, compared to students with normal BMI (Akinyemi et al., 2022).

An explanation for not observing a weight gain in my sample could be that students with a personal interest in food and nutrition may have been more willing to participate in my study. This is also supported by the fact the participants had a relatively high average diet quality score, as well as an average BMI that fell within the healthy range for adults. Hence, the BMI may not have been high enough to reach statistical significance as a predictor of diet quality and mental health of students.

Another explanation could be that I relied on students self-reporting their weight/BMI and weight changes, rather than objectively measuring weights over a period of time. Hence, there might have been discrepancies in the reported weights, as students may have reported inaccurate weights, or they may have not been aware of changes in their weight. For example, it has previously been shown that that individuals underreport their weight in self-reports, and that Individuals with higher body mass index (BMI) underestimate their weight more than those with lower BMI (Kkeli & Michaelides, 2023).

5.3.3.3 University location

The participant sample included students from four UK universities, of which three were considered to be situated in a setting considered as urban (London), and one in a setting considered as rural (Lancaster). The participant sample was skewed towards studying at urban universities (65%). It has previously been argued that students at rural areas may have poorer diets and mental health. For example, a study of students at an Appalachian university in the USA suggested that students may experience poor mental health due to the rural region being characterised by low socioeconomic status, poor access to health services, and poor physical health (Wattick et al., 2018).

In contrast to the above study, I did not find any associations between university location and mental health scores, nor between university location and diet quality scores. This could be explained by the fact that previous studies, such as the study by Wattick et al., took place in other parts of the world, hence the study settings may have been different than the UK settings. To my knowledge, there are no previous relevant studies in the UK to act as comparison to my study results. An alternative explanation may be that students could be arriving from an urban area to a rural university setting,

and vice-versa, hence any associations may not be obvious in such a short period of time; the environment before starting university may still be more relevant than the current environment at university.

5.3.3.4 Perfectionism

Perfectionism is prevalent in university students that are highly motivated (Curran & Hill, 2019), and may increase the risk of developing mental health difficulties. Self-critical perfectionism is related to poor mental-health outcomes during the transition to university (Levine et al., 2020), and it has been suggested that perfectionism leads to experiencing stress and depression in an additive manner, with outcomes becoming sustained over time (Levine et al., 2020).

In view of this, I considered perfectionism as being potentially a predictor of diet quality, as well as a predictor of mental health of students, during the transition to university. I considered that, in line with the stress diathesis model, perfectionistic traits may make students vulnerable to developing mental health problems when the transition to university acts as a stressor. However, the regression analyses of my data demonstrated that perfectionism did not show a statistically significant effect neither in relation to mental health nor in relation to diet quality of students during the transition to university.

Even though perfectionism has previously been shown to be associated with the development of mental health issues, it might have been less relevant to my sample as the perfectionism scores have overall been low and few participants reached the threshold for being considered as perfectionists.

In terms of perfectionism and diet, maladaptive perfectionism may lead to disordered eating (Prnjak et al., 2019) where the obsession with following a healthy diet becomes maladaptive and leads to an eating disorder. However, this is a separate topic which my study did not aim to address.

The low overall perfectionism scores may have been the reason why perfectionism was not associated with diet quality of my participants, although it may also be the case that even though perfectionism is relevant to disordered eating (Prnjak et al., 2019), it may not be as relevant to the quality of the diets.

5.3.3.5 Exercise

My results did not show any associations of exercise with mental health. This is an unexpected finding, as previous studies have reported that exercise improves mental health by reducing anxiety, depression, and negative mood, as well as by improving self-esteem and cognitive function (Callaghan, 2004). My study may have failed to detect these associations as the majority of the participants reported moderate or high physical activity, whereas the associations may be more relevant for individuals with low physical activity, who then experience an improvement in their mental health when higher levels of physical activity are introduced (Parker et al., 2019).

I found significant associations between exercise and diet quality, where higher levels of physical activity were associated with better diet quality. This observation could be relevant to the health attitudes of students, as participants engaging in healthy overall lifestyles may demonstrate both high exercise levels and healthy diets, whereas those not engaging in exercise may follow unhealthy lifestyles that involve eating unhealthy foods.

Although not being an aim of my study, I found that there were statistically significant differences in terms of exercise levels according to university location, with students at Lancaster reporting a higher level of physical activity compared to students in London. These results are in line with a previous research study involving female university students in India, which found that rural students were superior in terms of physical fitness components- including strength, endurance, speed and agility (Gill, Deol, & Kaur, 2010); it was argued that these differences may be due to students in urban settings having more sedentary lifestyles. It might also be the case that students in Lancaster might be walking or cycling more often as a means of transportation compared to students in London.

5.3.4 The impact of the transition to university on diet quality and mental health of students

In order to describe the difficulties during the transition to university, I used the college adjustment questionnaire (CAQ) which produces separate scores in both social aspects of the adjustment (educational and relational functioning scores), as well as psychological aspects of the adjustment (as measured by the psychological functioning score). I also asked the students whether they had experienced any stressful events since starting university, as this would indicate a difficult transition. As expected, the students that had experienced stressful events had significantly worse psychological adaptation scores of the CAQ questionnaire, compared to students that had not self-reported stressful events. Similarly, the mental health scores of the DASS-21 questionnaire were worse for the students that had experienced stressful events. These results suggest that a difficult transition to university can have a detrimental effect on the mental health of students, even though

we cannot exclude the possibility that some students may already have had poor mental health before transitioning.

Interestingly, I did not observe any statistically significant differences in terms of the educational and relational functioning subscale scores of the CAQ, between the groups that had and had not experienced stressful events since starting university. It may be the case that students that participated in my study were able to maintain a reasonable level of functioning in terms of educational and relational activities even when having experienced stressful events. However, the extra effort and processes needed to achieve this may have added to the distress experienced by students; this may have contributed to the statistically significant differences in the psychological functioning subscale scores of the CAQ, observed between the students that had and had not experienced stressful events.

Contrary to expectations based on the stress-diathesis model, my study did not find any statistically significant moderational effects. This could be attributed to the participants' generally good diet quality and mental health scores, which may have limited variability, making it difficult to detect such effects. Moreover, the effect sizes are generally small or moderate, meaning the study might have lacked the statistical power necessary to identify small effect sizes. Future studies with larger samples are needed to replicate these findings. Another explanation of the null findings could be that factors, such as perfectionism and exercise, may be predictors of mental health rather than confounders.

5.3.5 Impact of the transition to university on diet and mental health of students: potential mechanisms

Issues at the time of the study included lockdowns and restrictions relevant to COVID-19, as well as a cost of living crisis. Financial anxiety is a known issue during university studies (Archuleta et al., 2013), and financial problems were the most common stressful events mentioned by my participants during their transition to university. We cannot exclude the possibility that these factors may have made the transition for students more difficult than expected. However, apart from these additional stressors there may be various other ways through which the period of transitioning to university can be difficult.

During this transition period, there are various vulnerabilities of students that can lead to diet quality and/or mental health issues. For example, a vulnerability of students when they move to university may be a lack of regularity and a disruption of circadian rhythms. Students may experience a loss of their regular routines and may face the challenge of adapting to new routines that involve an

unstable schedule that fluctuates from day to day. They are faced with the challenge of establishing their own schedules and social rhythms, whilst at the same time having to deal with academic demands and their own personal tasks (Fischer et al., 2020). This means that their routines relevant to food may also be affected, which can impact their diet quality. Moreover, the stress of losing a regular routine or having to adapt to new and unfamiliar routine could also potentially have a negative impact on the students' mental health. For example, it has been shown that irregular event schedules are associated with poorer mental well-being of university students (Fischer et al., 2020).

Another vulnerability may be a loss of the home practical and social rituals involved in preparing food. These disruptions may be linked with considerable changes in daily routines, which in turn may impair the body's capacity to maintain biological rhythms- such as appetite rhythms (Frank et al., 2007). Moreover, a meal is not just about food, but also about the human interchanges and interactions that evolve around food. There is a meaning in the sequence of cooking something, serving it and sharing it with others, which may be lost when living alone at a university campus (Harris et al., 2005). This could potentially lead to a variety of issues. For example, students may now be faced with the challenge to prepare food by themselves whilst not having the knowledge to cook foods of similar quality to those they were used to have at home.

Students that have knowledge to cook healthily may indeed rely more on their own cooking rather than on take away foods, and similarly may shop healthier raw materials than students lacking this knowledge. I found that students in the group reporting knowledge to cook healthily had a statistically significant higher diet quality mean score than students in the group reporting no knowledge to cook healthily. Hence, students that lack the knowledge to cook may be more vulnerable to following low quality diets during the transition to university. My results are in agreement with a previous study of students transitioning to a UK-based university, which showed that knowledge to cook before attending university was predictive of better diet quality at university (Romijn, 2019). Previous findings of a study at a large Australian university showed that students reporting self-perceived excellent cooking skills and higher cooking frequency had better diet quality scores (Shi, Grech, & Allman-Farinelli, 2022). Moreover, it has been reported that lower frequency of takeaway and convenience meal consumption is associated with better diet quality (Thorpe, Kestin, Riddell, Keast, & McNaughton, 2014).

The loss of the home practical and social rituals relevant to food preparation may also be relevant to food security, as students may no longer have access to food at university in the same way they did at home. It has previously been shown that food insecurity of university students can compromise their diet quality, hence food insecure students may be vulnerable to following low

quality diets during their transition to university. For example, a study at an Australian university found that food-insecure students had a poorer diet quality than their food-secure peers (Shi et al., 2022).

Moreover, a systematic review has also reported an association of food insecurity with poorer dietary outcomes in university students (Shi, Davies, & Allman-Farinelli, 2021). My results showed that there were statistically significant differences in the mean diet quality scores depending on food security categories, which included often, sometimes and never experiencing food insecurity. However, post-hoc (Games-Howell) tests did not show any significant mean differences between the food security categories. The post-hoc tests should be interpreted with caution as there were only five participants in the "often" group. The diet quality scores were approximately two points lower in this group compared to both the "never" and "sometimes" groups, with p values marginally failing to reach significance ($p = 0.079$ and $p = 0.108$ respectively). It is possible that significance would have been reached had there been more participants in the "often" group.

Another relevant factor when considering the impact of the transition on students is that a relatively large percentage of students at UK universities are international. The overall percentage of international students that took part in my study was 30%, which is in line with the UK university demographics (Rogers, 2022). When international students move to university campuses, this transition could mean they lose the "tastes of home". These tastes may develop as early as birth, as via breastfeeding we are born to the flavours and preferences of our mother and our mother's culture (Harris et al., 2005). These tastes remain powerful emotional triggers throughout lifetime, a phenomenon sometimes called the "Proust Effect" (Green, Reid, Kneuer, & Hedgebeth, 2023). The food of childhood is the food of home, and if this is lost when transitioning away from home then the sense of home may also be lost, thus affecting mental health and mental well-being.

This is also supported by evidence in the literature of psychology relevant to immigrants, who attempt to alleviate their depression with foods familiar of their upbringing (Harris et al., 2005). It may be argued that this phenomenon may be relevant for international students transitioning away from their home abroad to university, and that international students may be more vulnerable to developing this kind of difficulties. Previous literature suggested that additional transitions faced by international students may include dietary acculturation (Shi, Lukomskyj, et al., 2021). However, it remains unclear as to whether these transitions can lead to differences between the diet quality of international and home students. For example, a study done at a large Australian university did not find any differences between the diet quality scores of home compared to international students (Shi et al., 2022).

5.4 Implications for policy and practice at universities

The findings draw attention for the need to consider strategies at the university level to raise awareness of the associations between diet and mental health. The findings also highlight the need for universities to review how they operate in order to promote better diet quality and mental health of students during their university experience, and especially during the transition to university.

Considering the fact that food insecurity may be a factor affecting the diet quality of students, food assistance services may be helpful for food insecure students (Shi et al., 2022). The quality of food offered as part of food assistance would also be relevant, as diet quality may only improve if fresh and healthy options are offered as part of the food assistance, rather than options that may be low in terms of nutritional quality (Efrati Philip, Baransi, Shahar, & Troen, 2018).

The study findings suggest that good knowledge to cook healthily is associated with a better diet quality of students. This means that there may be scope to target and improve the food literacy of university students; this may increase the confidence of students to cook healthily by themselves rather than relying on take away foods of low nutritional value, thus leading to a better diet quality. Food literacy would not just include cooking skills, but also education relevant to planning, managing, budgeting, selecting and preparing food (Shi et al., 2022; Vidgen & Gallegos, 2014). Nutrition programmes that can either be delivered in person or online may be needed as part of university education, in order to improve food literacy of students. For example, a four-session nutrition programme delivered to low-to-middle income Western Australian adults was effective in improving food literacy, as well as dietary behaviours (Begley, Paynter, Butcher, & Dhaliwal, 2019). Similar programmes tailored to the needs of the university students could be developed, and for example could involve online game-based quizzes to improve nutrition outcomes (Belogianni, Ooms, Lykou, Nikoletou, & Jayne Moir, 2023).

My literature review has not identified any relevant whole-diet intervention or randomised controlled studies to improve mental health of students through diet, or vice-versa. However, there have been published studies that involved dietary interventions in the general population. Future studies could follow the design of a study by Jacka et al. (2017), which was a two-arm randomised controlled cross-over trial that compared the Mediterranean diet to social support for 12 weeks (Jacka et al., 2017). Students can, similarly, be split into two groups, with the intervention group receiving a personalised nutrition intervention delivered by a dietitian, motivational interviewing, and goal setting.

Other dietary interventions that could also be considered by future studies involving the student population include:

1. Group sessions, including nutrition education lectures, cooking demonstrations, and discussion (Agarwal et al., 2015). At the end of the sessions, quizzes could be used to assess the knowledge of the participants following the presented materials (Scheier et al., 2005).
2. Individualised dietary counselling meetings with a clinical nutritionist, aiming to increase the use of vegetable oils, fruits, vegetables, and fish, as well as decrease the use of meat and animal fats (Einvik et al., 2010).
3. Use of a supermarket home delivery service that would deliver food directly to participants. (Forster et al., 2012). The food delivered could include at least five portions of fruits and vegetables per day, whole grain bread, fish twice per week, and nuts at least once a week.
4. Dietary advice via newsletters, followed by maintenance of a food dietary that can be reviewed monthly by a nutritionist (Jenkinson et al., 2009).
5. Educational sessions focusing on shopping. These could include help with weekly menus, shopping lists, food coupons, as well as discussions about the access and cost of cultural-specific foods and counselling about the correct preparation of shopping lists (Kasckow et al., 2014).
6. Encouraging participants to follow a Mediterranean-based diet by providing relevant healthy foods for free (Wardle et al., 1997).

My study did not collect information about the food environment and food purchasing at the university campuses. However, previous studies have reported that a higher frequency of food and beverage purchasing on campuses was associated with the consumption of energy-dense and nutrient-poor foods (Roy et al., 2017; Whatnall, Soo, Patterson, & Hutchesson, 2021). This means that an unhealthy food environment may predispose students to adapting diets of low quality, which in turn could have an unfavourable impact on their mental health.

There may be scope for relevant university policies to be developed. For example, universities may need to review what economic and planning decisions they make in terms of which franchises they allow onto campuses, and influence what is sold in the university shops. Additionally, there could be consideration for exclusion zones around the university campuses for franchises and shops that offer unhealthy foods.

Development of such policies would allow monitoring the types of food stores allowed on campuses, as well as around campuses; this may limit the availability of fast foods and maximise the

availability of healthy options at cheaper prices (Shi, Wang, Norman, Allman-Farinelli, & Colagiuri, 2018).

Future studies could consider the implementation of a "Healthy Food and Beverage policy" as used by the University of California Berkeley, USA (Rickrode-Fernandez, Kao, Lesser, & Guess, 2021), in order to ensure availability of healthy options on campus. Components of this policy that could be considered include:

- Vendors to offer meals that include options with fresh vegetables and fruit, whole grains, plant-based protein, and lean meats.
- Healthier cooking techniques to be used by the vendors, such as baking, roasting, stir-fry, grilling, and poaching.
- At least half of all snacks, entrees, and meals sold in vending machines to meet the pre-specified per-package standards.
- Healthier beverages to occupy at least 70% of shelf space in retail settings
- Restrictions to be implemented around the caffeine content of energy drinks, and around the size of sweetened beverages.
- Healthy foods and beverages to be placed in more prominent positions by vendors.
- Vendors to display the energy and sugar contents of foods, as well as use healthier beverage menus.

In terms of mental health, universities have developed policies over the years to manage the mental health of students. The services that are normally offered by universities include either individual or group counselling (Worsley, Pennington, & Corcoran, 2020). However, universities are faced with the challenge of an increased demand for support services (Broglia, Millings, & Barkham, 2017), whilst at the same time experiencing a reduction in government funding which has led to closures of student counselling services (Worsley et al., 2020). An additional challenge for universities is that only a third of UK university students with mental health problems seek support from counselling services (Macaskill, 2013). This may be due to barriers such as experiencing the stigma of mental illness, or due to not being aware of the availability of services (Hunt & Eisenberg, 2010).

The above issues mean that in addition to traditional counselling, universities also need to move beyond traditional forms of support (Worsley et al., 2020). Alternative interventions could be explored by future studies with a view of also improving the students' diet quality, in the context of maintaining well-being and good mental health. Examples of interventions that future studies may consider include the following:

1. Mindfulness-based interventions (Bamber & Kraenzle Schneider, 2016), to target control of attention, awareness of the present moment, acceptance, and non-judgemental thoughts (Kabat-Zinn, 2006).
2. Technology-delivered psychological interventions, including online cognitive behavioural therapy (CBT) (Farrer et al., 2013), or online acceptance and commitment therapy (Howell & Passmore, 2018).
3. Psychoeducation interventions, in order to provide information to individuals on topics such as stress, coping, and ways to relax (Conley, Durlak, & Dickson, 2013).
4. Educational/personalised mail feedback interventions to provide students with feedback about their symptoms, as well as to suggest appropriate coping methods- including self-help and help-seeking (Reavley & Jorm, 2010).
5. Recreation programmes, such as meditation, yoga, Tai Chi (meditative martial arts), exercise, and animal therapy (Worsley et al., 2020).

5.5 Strengths and limitations of the study

There are a number of strengths to this study. For example, the study had a strong theoretical foundation in regards to models; it did not adopt a narrow biomedical approach, and instead used a stress diathesis model of biopsychosocial factors to investigate and analyse exposure and outcomes, taking into consideration relevant confounding variables.

Even though the study had strengths, there were also some limitations. For example, the study was cross-sectional meaning that the students could not be followed up over a period of time, and the direction of the cause and effect could not be determined. The study consisted of more participants (166) than were estimated to be necessary (150), meaning it was adequately powered to answer the primary aims. However, the data for diet and mental health were self-reported, which may have led to underestimating associations (Murakami, Sasaki, Takahashi, Uenishi, & Japan Dietetic Students' Study for Nutrition and Biomarkers Group, 2009).

Moreover, students with a personal interest in food and nutrition may have been more willing to participate in the study. This may explain the relatively high average diet quality score of the participants. It may be the case that the associations found could potentially be even more relevant for the general student population that may have lower diet quality scores. The study sample was otherwise representative in terms of sociodemographic composition, as this was comparable with that of the overall undergraduate student population in the UK.

The sample was also balanced in terms of geographical location, in terms of rural vs urban settings. The study sample included participants of various ethnic backgrounds (White, Asian or Asian British, Chinese, Black, Mixed, other), but the majority of the participants were of White ethnic background (59%). This is in line with the demographics for UK universities, as in academic year 2020-2021 students of White ethnicity accounted for a majority of 74% of all UK domiciled enrolments (HESA, 2022). The sample was also in line with the ratio of home to international students at UK universities. Of the four universities involved in the study, UCL is known to have the highest percentage of international students (54.3%), followed by King's College London (41.4%), Lancaster University (29.8%), and Queen Mary University of London (22.8%) (Rogers, 2022). The overall percentage of international students of the study participants was 30%, which is in line with university demographics described above.

An issue that was not addressed by my study is that relationships between diet quality and mental health during the transition to university could also be partly explained by biological mechanisms, such as inflammation and dysregulated hypothalamic pituitary adrenal (HPA) axis. For practical reasons, I did not measure or study biological parameters. Hence, a limitation of my study is that it did not involve the use of blood markers, such as inflammatory markers, cortisol levels and ghrelin levels. This would have been a costly approach for a PhD project, and I instead used self-reported data for diet which are considered to provide a more complete information on the composition of the overall diet compared to non-self reported measures, such as biomarkers (Murakami et al., 2009). Use of blood markers could be considered by future studies that may have access to relevant funding.

In terms of methodology, my study had some strengths. For example, all the measures used involved self-reported questionnaires in the absence of the researcher, hence reducing the chances of a social desirability bias (Bryman, 2016). Moreover, all different measures in this study were previously validated. These measures also assessed variables with similar time frames. However, even though measures for depression, stress and anxiety were included, I did not include measures for other mental health difficulties. There are other mental health issues such as eating disorders that often develop around the age of moving to university, hence we cannot rule out the possibility that some students with eating disorders may have taken part in my study.

5.6 Recommendations for further research

5.6.1 General recommendations

My study used the stress–diathesis model to interrogate the data, where the diatheses could be of biological, psychological, or social nature. This model can be used when designing and reporting further studies relevant to the field of diet and mental health during the transition to university.

Future studies could consider both a general student population sample, as well as a clinical student sample with established mental health diagnoses. My study sample only included a general student population group, and did not include a clinical group of students with established mental health diagnoses. The students taking part may have been "healthier" than the general student population, having good average diet quality and mental health scores. This means that the findings may not necessarily be applicable to students with major depressive disorder, who may experience reduced appetite and reduced dietary intake as a consequence. It is possible that the relationship between diet quality and mental health may be stronger in this group of students. Hence, further research involving clinical student samples is needed. Such studies may contribute knowledge as to whether diet interventions may be used clinically as an adjunct treatment for mental health issues of university students, especially during the transition to university.

Moderational studies would be needed to investigate the various factors that could moderate the relationships between diet and mental health (and vice-versa) of students during the transition to university. This may include food security, lack of regularity, loss of home rituals, knowledge to cook healthily, access to traditional foods, and other relevant factors (table 17).

Table 17. Factors identified as potential moderators of the relationships between diet and mental health during the transition to university, which could be investigated by further moderational studies

Food security	Coping with homesickness	Financial distress
Diet type	Home vs International students	Motivation to eat healthily
Knowledge to cook healthily	Lack of regularity	Loss of home rituals
Knowledge to shop healthily	Access to traditional food	Alcohol and recreational drugs

Future research could involve well-powered clinical trials to further assess the associations of diet quality with the prevention, severity and relapse of depression, stress and other mental health issues of students. This would inform the design of randomised controlled trials (RCT), or quasi-

experimental trials in cases where the RCT design would not be feasible- such as when randomisation is not possible. The use of consistent and validated measures of diet quality and mental health may also allow executing a meta-analysis of relevant studies in the future.

There is also a need for mediational studies in order to better understand the mechanisms that mediate the associations of diet and mental health of students during their transition to university. Studies of longitudinal design would be the most appropriate to explore these mechanisms, although I recognise that there can be challenges in terms of time and costs required. Candidate mechanisms could include weight changes, body mass index (BMI), perfectionism, gender. Future studies may also consider the exploration of biological mechanisms that may be mediating the associations between diet and mental health. These could include:

1. *Inflammation:*

An inflammatory response leads to the release of mediators, such as prostaglandins, chemokines, and cytokines, which induce changes in functional brain activity, neurotransmitter metabolism, and neuroendocrine function (Marx et al., 2021). Future studies may explore the degree of inflammation by using blood testing to measure markers of inflammation, such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR).

2. *Oxidative stress:*

Depressed individuals have elevated oxidative stress markers and lower antioxidant markers when compared to controls (T. Liu et al., 2015). Future studies may consider the use of blood markers to measure antioxidant levels (such as vitamin C, E, selemium, zinc) and oxidative stress markers (such as peroxides, superoxide, hydroxyl radicals, singlet oxygen, and alpha-oxygen).

3. *Gut microbiota:*

Research over the recent years has implicated the microbiota–gut–brain axis in the development of mental health disorders (Cryan et al., 2019). Future studies may consider the use of gut microbiome testing and characterisation by collecting stool samples. As an extension of this, intervention studies using faecal transplants could also be considered.

4. *Hypothalamic–pituitary–adrenal (HPA) axis:*

Altered HPA axis has been linked to mental health disorders; for example, depressed individuals may experience excess production of cortisol, and abnormal responses to adrenocorticotropic hormone

(Naughton, Dinan, & Scott, 2014). Future studies could consider the use of blood markers in order to measure levels of hormones such as cortisol, adrenocorticotropic hormone, and ghrelin.

5. *Adult hippocampal neurogenesis:*

The hippocampus is an area of the brain involved in formation of memories and regulation of mood (Fanselow & Dong, 2010), and also expresses the brain-derived neurotrophic factor (BDNF). It has been reported that patients with major depression demonstrate lowered levels of serum BDNF (Karege et al., 2002). Moreover, it has been shown that individuals following healthier diets have larger hippocampal volumes (Jacka et al., 2015). Future studies could consider the use of blood markers in order to measure levels of growth factors, such as BDNF. The use of imaging, such as magnetic resonance imaging (MRI) could also be used to measure the effects of diet on parts of the brain, such as the hippocampus.

6. *Tryptophan-kynurenine metabolism:*

The kynurerine pathway involves the metabolism of tryptophan to the neurotoxic quinolinic acid, and the neuroprotective kynurenic acid (Cervenka, Agudelo, & Ruas, 2017). It has been shown that the balance of metabolites produced through this pathway may play a role in mental health disorders, such as depression (O'Farrell & Harkin, 2017). Diet could play a role in modulating this pathway. Future studies could consider the use of blood markers to measure the levels of tryptophan metabolites, such as quinolinic acid and kynurenic acid.

7. *Epigenetics:*

Epigenetics can affect the methylation age of DNA, which has been related to the development of depression (M. Li et al., 2019). A poor quality diet may lead to the methylation processes being impaired (Rucklidge, Johnstone, & Kaplan, 2021). Future studies could involve the use of epigenetic analysis techniques, such as DNA methylation analysis, DNA-protein interaction analysis, and chromatin accessibility analysis.

Finally, another issue to consider is the fact that my systematic literature review did not identify any qualitative studies in relation to the diet quality and mental health of students during their transition to university. In line with the realist paradigm that I adopt, I feel it is necessary for qualitative studies to take place in addition to quantitative studies, in order to better understand the associations between diet and mental health of students. Hence, future studies could also include a qualitative component, with a focus of exploring the students' experiences relevant to transitioning to university,

and relevant to their diet and mental health during this transition period. The information obtained from qualitative studies may also inform the design of future relevant quantitative studies. In order to inform future university policies, the studies collecting information about food environment and food purchasing at the university campuses could also involve a qualitative component.

5.7 Chapter summary

This chapter has discussed the findings of a thesis exploring the associations of diet quality with the mental health of students during their transition to university. In line with the results of my systematic literature review and literature involving the general population, I found that better diet quality of students during their transition is associated with better mental health, and vice versa. These associations could be explained by considering various factors, such as the lack of regularity during the transition, the loss of home rituals and home food, lack of knowledge to cook healthy, lack of motivation to cook healthily and biological mechanisms such as inflammation and effects on the HPA axis.

In practical terms, the findings draw attention for the need to consider strategies at the university level to raise awareness of the associations between diet and mental health. They also draw attention for the need for universities to re-assess their policies, in order to improve the food environment on campuses, and effectively promote health education of students to achieve better health of students in terms of diet and mental health.

Further studies, including moderational and mediational studies, are needed to test the influence of the various factors that could moderate the relationships between diet and mental health. These could include longitudinal studies, qualitative studies and quasi-experimental studies.

6 CHAPTER 6: Conclusion

A basic underpinning of this study was that both the diet quality and mental health of students can deteriorate when students transition to university. By exploring this underpinning, the study aimed to improve our understanding of the associations between diet quality and mental health, during their transition period to university.

Both the empirical study, as well as the systematic literature review, found evidence that a good diet quality of students is associated with good mental health of students. There was also evidence that good mental health of students is associated with good diet quality. The empirical study found that a good quality of the transition to university is associated with good mental health of students. Whereas the results did not show any associations between the quality of transition and diet quality, this needs to be explored further.

There are various potential moderators of diet quality and mental health of students during their transition to university, which can be explored by future studies. These include knowledge to cook and shop healthily, food security, weight changes, access to traditional food, as well as biological mechanisms. I recommend that future studies use a longitudinal design when possible, enabling researchers to determine the direction of any detected associations. Qualitative studies are also warranted.

This thesis has filled a research gap and contributed to our knowledge of the associations between the diet quality and mental health of students during their transition to universities in the UK. The findings of the thesis inform the design of relevant studies in the future; these may also involve participants with a clinically established mental health diagnosis. The findings of this thesis also act as a reference for policy makers in terms of designing future university policies relevant to the mental health of students, the diet quality of students, the health education of students, the food security of students and the university food environment.

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APPENDICES

Appendix A: Review protocol as published at PROSPERO

The association of diet quality with mood and mental health of university students: a systematic review of observational studies

Citation

Solomis Solomou, Guillermo Perez Algorta, Siobhan Reilly, Jennifer Logue. The association of diet quality with mood and mental health of university students: a systematic review of observational studies. PROSPERO 2020

CRD42020196336 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42020196336

Review question

What is the association of diet quality with mood and mental health of university students?

Searches

The search strategy will involve the databases PubMed, CINAHL, EMBASE, PsycINFO and The Cochrane Library and Web of Science. The search strategy will use the following terms:

Student* AND (Diet* OR Nutrition OR Eat* OR Food OR Weight gain) AND (Mood OR Depress* OR Anxiety OR Stress OR Mental health)

The actual search strategies will incorporate both medical subject headings (MeSH) and free-text terms which will be adapted according to the database searched.

Google Scholar, OpenGrey and ResearchGate will also be searched in order to identify any relevant grey literature.

The databases will be searched from inception to the date of search conduction. The reference lists of the identified papers and reviews will also be hand searched in order to identify any additional papers of relevance.

Authors of papers may be contacted to obtain further information regarding the retrieved studies, as well as to identify any papers that may have been missed.

Search strategy

https://www.crd.york.ac.uk/PROSPEROFILES/196336_STRATEGY_20200630.pdf

Types of study to be included

Included studies will be observational studies published in peer reviewed *journals, including* cr*oss*-sectional and longitudinal studies, as well as review studies of observational evidence. Observational data may also be obtained from other kinds of studies (such as randomised controlled trials) where available.

Sources of observational evidence will also include grey literature (such as conference abstracts, protocols, theses, letters).

Publication languages will include English, Greek, and Spanish (as these are the authors' languages). There will be no publication period restrictions.

Condition or domain being studied

The transition to university life may affect diet quality, as well as mood and mental health of students. Manifestations of these changes can take the form of an unhealthy diet and weight gain. Concurrently, university students show a high incidence of onset of mental health problems, in particular issues related with depression and anxiety. We will review the current literature for the association of diet quality with mood and mental health of university students. We will also review evidence for potential moderators of this association (such as gender, ethnicity).

Participants/population

The participants of the included studies will be university students of any ethnic origin, gender and age, studying in any country, with or without a mental health diagnosis (such as depression and/or anxiety).

Intervention(s), exposure(s) [1 change]

No interventions applicable.

The exposure of interest is diet quality. Various methods can be used to measure diet quality, including the use of a priori defined diet quality score. For the narrative review, we will include studies using any kind of diet quality measure. For the meta-analysis, we will include studies using a priory diet quality score only (such as the Healthy Eating Index (HEI), the alternate Healthy Eating Index (AHEI), the Dietary Approaches to Stop Hypertension (DASH) score, the Mediterranean Diet Score (MDS), the Diet Quality Index (DQI) score, the Dietary Inflammatory Index (DII) or other published scores.

Comparator(s)/control [1 change]

For the meta-analysis, we will compare the highest diet quality score category to the lowest.

Context

Studies evaluating university students, of any country.

Main outcome(s) [1 change]

Depression or anxiety or depressive/anxiety symptoms or other mental health symptoms (assessed by relevant scales, or as experienced subjectively by participants, or as diagnosed by health professionals).

Measures of effect

For the narrative review, we will include studies using any kind of diet quality measure. For the meta-analysis, we will include studies using a priory diet quality score only (such as the Healthy Eating Index (HEI), the alternate Healthy Eating Index (AHEI), the Dietary Approaches to Stop Hypertension (DASH) score, the Mediterranean Diet Score (MDS), the Diet Quality Index (DQI) score, the Dietary Inflammatory Index (DII) or other published scores.

Additional outcome(s)

None

Measures of effect

Not applicable

Data extraction (selection and coding)

We will screen titles for inclusion, followed by screening of abstract and then content. We will obtain full texts in cases where abstract eligibility is considered uncertain, or if title eligibility is considered uncertain and abstracts are not available. We will contact authors of studies in case there is not enough information to decide whether a study meets the inclusion criteria. Reasons for excluding studies will be recorded and a PRISMA (Preferred Reporting Items Systematic Reviews and Meta-Analysis) diagram will be used for every reference.

Data extraction will involve use of the relevant sections of the Cochrane good practice data extraction form. Data extraction from reviews will involve using a modified version of the NICE extraction form. The data will be extracted in an electronic format in order to achieve effective time management and reduce any errors during data entry.

Extracted data will include the following:

Authors, year of publication, setting, study design, sample size, geographical location, follow-up time (if applicable).

Demographic and clinical characteristics of participants.

Measures used (where applicable) and main findings (dietary assessment tool used and score used, assessment of depression and/or anxiety, depressive and anxiety symptoms scale and threshold

used, confounders used, main findings including odds ratios or hazard/risk ratios and standard errors/confidence intervals).

Risk of bias (quality) assessment

We will assess the quality and risk of bias of observational studies by using the Mixed Methods tool for Appraisal (MMAT) (Hong et al., 2019). We will resolve discrepancies by discussion with the supervisory team.

We will categorize risk of bias as follows:

Low risk: plausible bias that is unlikely to seriously alter the results

High risk: plausible bias that seriously weakens confidence in the results

Unclear risk: inadequate information for making a decision

In order to appraise published review papers of observational studies, we will use the guidance of the Centre for Reviews and Dissemination.

Strategy for data synthesis

We will perform a narrative synthesis review (Popay et al., 2006) of observational studies (and of reviews of observational studies) reporting associations of diet quality with mood and mental health of university student populations (with or without an established mental health diagnosis). If possible, we will perform a meta-analysis of observational studies that used predefined healthy dietary indices.

Analysis of subgroups or subsets

f possible, random-effects meta-analyses will be conducted to determine effect sizes for eligible observational studies that have used predefined healthy dietary indices. As it is expected that study results will be heterogeneous, it is anticipated that a random effects meta-analysis will be performed rather than a fixed effects meta-analysis. For eligible cross-sectional studies, a meta-analysis of the linear association between dietary patterns (healthy dietary indices) and depressive symptoms will be performed. If feasible, a random effects meta-analysis will also be performed for longitudinal data. All analyses will be performed using the Metafor package for R program (Viechtbauer, 2010).

Contact details for further information

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Organisational affiliation of the review

Lancaster University https://www.lancaster.ac.uk/

Review team members and their organisational affiliations [1 change]

Dr Solomis Solomou. Lancaster University

Dr Guillermo Perez Algorta. Lancaster University

Dr Siobhan Reilly. Lancaster University

Dr Jennifer Logue. Lancaster University

Type and method of review [1 change]

Epidemiologic, Meta-analysis, Narrative synthesis, Systematic review

Anticipated or actual start date

01 July 2020

Anticipated completion date

31 December 2020

Funding sources/sponsors

None

Conflicts of interest

Language

English

Country

England

Stage of review [1 change]

Review Completed published

Details of final report/publication(s) or preprints if available [2 changes]

https://doi.org/10.1093/her/cyac035

Subject index terms status

Subject indexing assigned by CRD

Subject index terms

Affect; Diet; Humans; Mental Health; Students; Universities

Date of registration in PROSPERO

19 August 2020

Date of first submission

30 June 2020

8 Stage of review at time of this submission [2 changes]

Stage	Started	Completed
Preliminary searches	Yes	Yes
Piloting of the study selection process	Yes	Yes
Formal screening of search results against eligibility criteria	Yes	Yes
Data extraction	Yes	Yes
Risk of bias (quality) assessment	Yes	Yes
Data analysis	Yes	Yes

9 Revision note

Publication link has now been updated.

The record owner confirms that the information they have supplied for this submission is accurate and complete and they understand that deliberate provision of inaccurate information or omission of data may be construed as scientific misconduct.

The record owner confirms that they will update the status of the review when it is completed and will add publication details in due course.

10 Versions

19 August 2020

28 January 2021

28 November 2022

28 November 2022

Appendix B: Quality assessment of studies included in the systematic literature review (chapter 2)

Table A. 1: Quality assessment (diet effects on mental health), based on Newcastle-Ottawa quality assessment scale

Study	Selection score (max 5)	Comparability score (max 2)	Outcome score (max 3)	Total score (max 10)	Quality category
Abramson 2017 (Abramson, 2017)	3	1	2	6	Medium
Aceijas et al 2017 (Aceijas et al., 2017)	5	2	2	9	High
Açik et al 2019 (Açik & Çakiroğlu, 2019)	3	2	2	7	Medium
Breiholz 2010 (Breiholz, 2010)	1	1	1	3	Low
Chacon-Cuberos et al. 2019 (Chacón-Cuberos et al., 2019)	5	1	1	7	Medium
Chacon-Cuberos et al. 2018 (Chacón-Cuberos et al., 2018)	5	2	2	9	High
El Ansari et al 2014 (El Ansari et al., 2014)	3	1	2	6	Medium
El Ansari et al 2015a (El Ansari et al., 2015b)	4	2	2	8	High
El Ansari et al 2015b (El Ansari et al., 2015a)	3	2	2	7	Medium
Fabian et al. 2013 (Fabián et al., 2013)	3	2	2	7	Medium
Faghih et al 2020 (Faghih et al., 2020)	4	2	2	8	High
Hamazaki et al. 2015 (Hamazaki et al., 2015)	4	2	2	8	High
Hendy, 2012 (Hendy, 2012)	1	2	2	5	Medium

Jaalouk et al 2019 (Jaalouk et al., 2019)	2	2	2	6	Medium
Jeffers et al. 2019 (Jeffers et al., 2019)	2	2	2	6	Medium
Knowlden et al. 2016 (Knowlden et al., 2016)	3	2	2	7	Medium
Lesani et al., 2016 (Lesani et al., 2016)	3	2	2	7	Medium
Liu et al. 2007 (C. Liu et al., 2007)	4	2	2	8	High
Lockhart, 2017 (Lockhart, 2017)	3	2	2	7	Medium
Lopez-Olivares et al. 2020 (López-Olivares et al., 2020)	4	2	2	8	High
Lutz et al., 2017 (Lutz et al., 2017)	4	2	2	8	High
Mikolajczyk et al., 2009 (Mikolajczyk et al., 2009)	3	2	2	7	Medium
Mochimasu et al., 2016 (Mochimasu et al., 2016)	2	2	2	6	Medium
Oleszko et al., 2019 (Oleszko et al., 2019)	3	1	1	5	Medium
Peltzer & Pengpid, 2017a (Peltzer & Pengpid, 2017a)	3	2	1	6	Medium
Peltzer & Pengpid, 2017b (Peltzer & Pengpid, 2017b)	4	2	2	8	High
Piqueras et al., 2011 (Piqueras et al., 2011)	3	2	2	7	Medium
Quehl et al 2017 (Quehl et al., 2017)	3	1	2	6	Medium

Ramon Arbues et al 2019 (Ramón-Arbués et al., 2019)	5	2	2	9	High
Romijn 2020 (Romijn, 2019)	3	2	2	7	Medium
Rossa-Roccor 2019 (Rossa-Roccor, 2019)	3	2	2	7	Medium
Sakai et al 2017 (Sakai et al., 2017)	4	2	2	8	High
Schnettler et al., 2015 (Schnettler et al., 2015)	3	2	2	7	Medium
Smith-Marek et al., 2016 (Smith-Marek et al., 2016)	3	2	2	7	Medium
Tran et al., 2017 (Tran et al., 2017)	3	2	2	7	Medium
Wattick et al., 2018 (Wattick et al., 2018)	3	2	2	7	Medium
Zurita-Ortegal et al., 2018 (Zurita-Ortega et al., 2018)	3	2	2	7	Medium
Rossa-Rocor et al., 2021 (Rossa-Roccor et al., 2021)	4	2	2	8	High
Stanton et al., 2021 (Stanton et al., 2021)	4	2	2	8	High
Attlee et al., 2022 (Attlee et al., 2022)	4	2	2	8	High
Lo Moro et al., 2021(Lo Moro et al., 2021)	3	1	2	6	Medium
Lee et al., 2022 (Lee et al., 2022)	3	2	2	7	Medium
Alfreeh et al., 2020 (Alfreeh et al., 2020)	4	2	2	8	High
Saharkhiz et al., 2021 (Saharkhiz et al., 2021)	3	2	2	7	Medium

Table A. 2: Quality assessment (mental health effects on diet), based on Newcastle-Ottawa quality assessment scale

Study	Selection score (max 5)	Comparability score (max 2)	Outcome score (max 3)	Total score (max 10)	Quality category
Ahmed et al. 2014 (Ahmed et al., 2014)	2	2	2	6	Medium
Aljaber et al. 2019 (AlJaber et al., 2019)	1	1	1	3	Low
Almogbel et al. 2019 (Almogbel et al., 2019)	2	1	2	5	Medium
Bu et al. 2019 (Bu et al., 2019)	2	1	2	5	Medium
Cheng & Mohd Kamil, 2020 (Cheng & Mohd Kamil, 2020)	3	1	1	5	Medium
Leblanc & Villalon 2008 (Leblanc DD & Villalon L, n.d.)	2	1	1	4	Medium
Dalton & Hammen 2018 (Dalton & Hammen, 2018)	3	1	2	6	Medium
El Ansari et al. 2015 (El Ansari & Berg-Beckhoff, 2015)	4	2	2	8	High
Errisuriz et al., 2016 (Errisuriz et al., 2016)	3	2	2	7	Medium
Hall et al., 2017 (Hall et al., 2017)	3	2	2	7	Medium
Kandiah et al., 2006 (Kandiah et al., 2006)	3	2	1	6	Medium
Keck et al., 2020 (Keck et al., 2020)	4	2	2	8	High
Kotecki et al. 2019 (Kotecki et al., 2019)	2	1	1	4	Medium
Lazarevich et al. 2018 (Lazarevich et al., 2018)	4	2	2	8	High

Mansoury et al. 2015 (Mansoury et al., 2015)	2	1	1	4	Medium
Nataskin & Fiocco, 2015 (Nastaskin & Fiocco, 2015)	3	2	2	7	Medium
Oliver & Wardle, 1999 (Oliver & Wardle, 1999)	3	2	1	6	Medium
Papier et al., 2015 (Papier et al., 2015)	3	2	2	7	Medium
Peker & Bermek, 2011 (Peker & Bermek, 2011)	3	2	2	7	Medium
Pollard et al., 1995 (Pollard et al., 1995)	3	2	2	7	Medium
Trigueros et al., 2020 (Trigueros et al., 2020)	3	2	2	7	Medium
Carlos et al., 2020 (Carlos et al., 2020)	3	1	2	6	Medium

Table A. 3: Quality assessment of review papers based on the guidance of the Centre for Reviews and Dissemination

Study	**Type of review**	**Aims**	**Population**	**Quality appraisal**
Saha et al., 2021 (Saha et al., 2021)	Systematic review	To gather research evidence on the association between diet and depression and anxiety among college students.	University students (international)	Medium quality
Lyzwinski et al., 2018 (Lyzwinski et al., 2018)	Systematic review	To examine the patterns of dietary intake among university students experiencing stress, and to explore these relationships with weight.	University students (international)	Medium quality

Appendix C: Poster used for participant recruitment

Health & Medicine | Lancaster University

STUDY ABOUT DIET AND MENTAL HEALTH

- We are investigating the association of diet with the mental health of university students.
- We are looking for first year university students living at student halls (university or private accommodation).
- You will be asked to complete a 30-minute online survey about your diet and mental health.
- If you complete the survey you will enter a draw for two £100 vouchers.
- To join the study, access the online survey at: https://redcap.link/dietmood

- For more information, you can contact the study team at s.solomou@lancaster.ac.uk

Appendix D: Online survey

Confidential

Page 1

Participant Information Sheet

Project Title:

The association between diet quality and mental health of University students

My name is Solomis Solomou and I am conducting this research as a student in the Mental Health PhD programme (blended learning) at Lancaster University, Lancaster, United Kingdom. Thank you for your interest to take part in this project.

What is the study about?

The purpose of this study is to investigate the association between diet and mental health. This will be one of the first studies in the UK to investigate this association in first year university students.

Why have I been approached?

You have been approached because the study requires information from first year university students living at student halls (on campus or private accommodation) and are at least 18 years old.

Are there any exclusion criteria? You should not participate if:

- you are not a first year university student living at student halls,
- you are under the age of 18,
- you are not studying at Lancaster University, UCL, QMUL, or KCL
- you have been staying at your family home over the last week,- you have been fasting over the last week.

Do I have to take part?

No. It's completely up to you to decide whether or not you take part. There will be no negative consequences if you decide not to participate.

What will I be asked to do if I take part?

If you decide you would like to take part, you will be asked to complete the online questionnaire. This will last approximately 30 minutes and can be done from home at a time that is suitable for you.

Will my data be Identifiable?

The information you provide is anonymous. No identifiable information (e.g. any names, date of birth and other information that might identify you) will be reported in the final report.

The data collected for this study will be stored securely and only the researchers conducting this study will have access to these data.

The files on the computer will be encrypted (that is no-one other than the researcher and the university supervisors will be able to access them) and the computer itself password protected. All your personal data will be confidential and will be kept separately from your questionnaire responses.

You may stop the study at any point, but this DOES NOT mean your data will be withdrawn. Your data will be saved and may be used even if you do not complete all of the survey.

If you would also like to withdraw your data from the study, please email the main researcher, Solomis Solomou, at

s.solomou@lancaster.ac.uk with your ID number and request to remove your data. In case you would like to do this, your ID number is [record_id]. Please write this number down now, just in case you choose to stop with the study and withdraw your data.

It may not be possible to withdraw your data if they have already been incorporated into the overall data analysis.

What will happen to the results?

The results will be summarised and reported in a final report for my PhD thesis, which will be submitted for examination as part of my final PhD evaluation. This may also be submitted for publication in an academic or professional journal. The findings may also form the basis of presentations and posters at relevant academic conferences.

For further information about how Lancaster University processes personal data for research purposes and your data rights please visit our webpage: www.lancaster.ac.uk/research/data-protection

Are there any risks?

There are no risks anticipated with participating in this study. However, if you experience any distress following participation you are encouraged to contact the resources provided at the end of this sheet.

Are there any benefits to taking part?

Although you may find participating interesting, there are no direct benefits in taking part. As a token of appreciation, you will have the option to enter a random prize draw for one of two £100 vouchers if you complete the study.

Who has reviewed the project?

This study has been reviewed by the Faculty of Health and Medicine Research Ethics Committee, and approved by the University Research Ethics Committee at Lancaster University.

Where can I obtain further information about the study if I need it?

If you have any questions about the study, please contact the main researcher:

Solomis Solomou

Email: s.solomou@lancaster.ac.uk

Department of Health Research

Lancaster University

Lancaster

LA1 4YG

Complaints

If you wish to make a complaint or raise concerns about any aspect of this study and do not want to speak to the researcher, you can contact:

Professor Bruce Hollingsworth

Tel: +44 (0)1524594154

Email: b.hollingsworth@lancaster.ac.uk

Department of Health Research

Lancaster University

Lancaster

LA1 4YG

If you wish to speak to someone outside of project team, you may also contact:

Dr Laura Machin

Tel: +44 (0)1524 594973

Chair of FHM REC

Email: l.machin@lancaster.ac.uk

Faculty of Health and Medicine

(Lancaster Medical School)

Lancaster University

LA1 4YG

Resources in the event of distress:

We are not expecting this study to cause you any distress.

However, if you do experience distress following your participation in the study, we advise you to contact your GP and/or your mental healthcare provider, who can offer guidance and advice to best manage this.

Here are also some useful resources you can access in case of distress:

What to do during a mental health crisis:

If you are on campus - Dial 999 for the Emergency Services, then afterwards contact the Security Reception on 01524 594541 (staffed 24 hours a day, 365 days a year) to let them know, so they can direct the Emergency Services appropriately on arrival.

If you are off campus - Dial 999 to connect straight to the Emergency Services or go to your local Accident and Emergency Department.

Lancashire and South Cumbria Foundation Trust Wellbeing and Mental Health Crisis Line - Call on 0800 953 0110 (open all year round).

Useful non-emergency contacts:

NHS 111 - This is the NHS non-emergency number. It's fast, easy and free. Call 111 and speak to a highly trained advisor, supported by Healthcare Professionals, to find out where help is available. NHS 111 is available 24 hours a day.

Lancashire and South Cumbria Foundation Trust Wellbeing and Mental Health Helpline and Texting Service - Call on 0800 915 4640 (open weekdays 7pm-11pm, and weekends 12 noon-12 midnight) or text HELLO to 07860022846.

The Samaritans - If you need someone to talk to, you can call The Samaritans on 116 123. This is a freephone number, and they are available 24 hours a day, 365 days a year.

Papyrus - HOPELineUK, run by Papyrus, is a confidential helpline, staffed by trained professionals who give support and advice to young people under the age of 35 feeling suicidal or anyone concerned about a young person. Call them on 0800 0684141 (Monday to Friday 10am-10pm, Saturday to Sunday 2pm-5pm).

UCL:

If you're in immediate danger of hurting yourself or others:

Go directly to the Accident & Emergency (A&E) department of your local hospital to get help UCLH is the nearest A&E department to UCL’s main campus Call 999 to request an ambulance if you are unable to reach the hospital yourself If you're feeling distressed and need urgent support:

Contact your GP surgery to request an emergency appointment If your GP surgery isn't open, call the free NHS out-of-hours medical line on 111 for help accessing the right services You can call the Samaritans on 116 123 to talk to someone at any time, day or night Nightline are a listening service for students, by students - they're available overnight on +44 (0)207 631 0101 Other available services:

Camden and Islington Crisis team, tel. 02033176333 (24 hours) Mind, tel. 03001233393 iCOPE, tel. 02033176670 (Camden), tel. 02033177252 (Islington)

QMUL: If you are in immediate danger of harming yourself or others, call 999. An ambulance may be called if appropriate, and they will advise whether you should go to A&E.

Otherwise, you can access urgent mental health support by:

Requesting an urgent appointment with your GP (GPs are offering video/phone consultations) Contacting your local

NHS Mental Health Crisis Number – enter the borough, county or town where you are currently living and 'Mental

Health Crisis Line' into your search engine. Example: City & Hackney Mental Health Crisis Line, tel. 0800 073 0006

(24 hours) Calling Samaritans on 116 123 (24 hours, 365 days a year)

Other available services:

Mind, tel. 03001233393

KCL:

If you feel like you cannot keep yourself safe and you are in immediate danger of harming yourself or attempting to take your life:

Go to the closest Accident and Emergency (A&E Department). Call 999 to request an ambulance if you cannot go to the hospital yourself Call South London and Maudsley Crisis line, tel. 0800 731 2864 (24 hours)

If you need urgent mental health support:

Contact your GP surgery to request an emergency appointment (some GP surgeries are currently offering phone appointments only) If your GP surgery is not open, call the free NHS medical line on 111 for help accessing the right services, but again be aware they are at capacity at present so only call in crisis You can call the Samaritans on 116 123 to talk to someone at any time, day or night, 24/7 You can text Shout on 85258 You can download Stay Alive app, an app for those at risk of suicide and those worried about someone You can contact the Listening Place for face to face support and online and telephone support You can call Mind, tel. 03001233393

Thank you for taking the time to read this information sheet!

Consent

By proceeding to the next page you confirm that:

1) You have read the information sheet and fully understand what is expected of you withinthis study;

2) That your participation is voluntary;

3) You confirm that you understand that any information you give will remain anonymous;

4) You consent for the data to be discussed with my supervisors at Lancaster University;

5) You consent to Lancaster University keeping the anonymised data for a period of 10 yearsafter the study has finished, which may be used by researchers during this period;

6) You consent to the data being pooled, published and used for these research purposesunless you take the necessary steps to withdraw your data from the study. As stated, you may stop the study at any point, but this does not mean your data will be withdrawn. If you would also like to withdraw your data from the study, please email the main researcher, Solomis Solomou, at s.solomou@lancaster.ac.uk with your ID number and request to remove your data.

In case you would like to do this, your ID number is [record_id];

7) You consent to taking part in the current study.

I have read the above and consent

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Please answer the questions below to determine whether you may be eligible for the study

We are sorry but your answers indicate you would not be eligible for the study. Please do not proceed further. Thank you for your time and interest to participate.

We are pleased to inform you that your answers indicate you are eligible for the study. Please click "submit" to continue.

Please answer the questions below about demographic information

Thank you very much for consenting to participate in this study.

The following set of questions will ask about demographic and clinical information.

Please remember that if you need to take a break you can save your progress by clicking the appropriate button below and writing down your code. It is important that you remember the code that is given to you as otherwise your progress may be lost.

If you reopen the study from the original link, you should be able to enter your code and continue where you left off.

Age (years)

Please specify:

Progress: 5%

.

Please answer the questions below about your lifestyle

Progress: 10% .

Page 1

Please answer the following questions about your clinical background

What is your weight? (in kilograms)

_____

(e.g. 2.5)

How much weight (in kilograms) have you lost?

_____

(e.g. 2.5)

What is your height? (in metres)

_____

(e.g. 1.65)

The next section of the study will contain the first questionnaire.

If you need a break, please remember that it is possible to save and continue later. If you are ok continuing with the study, then please proceed to the next section.

Thank you.

Progress: 15% .

THE COLLEGE ADJUSTMENT QUESTIONNAIRE (CAQ)

Listed below are some statements that describe how university students might be feeling about their experience with university.

Please use the rating scale below to indicate how accurately each statement describes you at this point in time.

Please read each statement carefully, and then choose the number that corresponds to how accurately the statement describes you.

Response Options:

1: Very Inaccurate

2: Moderately Inaccurate

3: Neither Inaccurate nor Accurate

4: Moderately Accurate 5: Very Accurate

2)

3)

4)

5)

6)

7)

8)

9)

Progress: 30% .

THE DEPRESSION, ANXIETY AND STRESS SCALE (DASS-21)

The following section is in relation to your mental health.

Please read each statement and click a number 0, 1, 2 or 3 which indicates how much the statement applied to you over the past week.

There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all

1 Applied to me to some degree, or some of the time

2 Applied to me to a considerable degree, or a good part of time3 Applied to me very much, or most of the time

6)

7)

8)

9)

THE SHORT FORM FOOD FREQUENCY QUESTIONNAIRE (SFFFQ)

The following section is about your diet.

Do not be concerned if some things you eat or drink are not mentioned.

Please choose how often you ate at least ONE portion of the following foods & drinks over the last week (a portion includes: a handful of grapes, an orange, a serving of carrots, a side salad, a slice of bread, a glass of pop).

Please only make one choice, but answer every line.

Rarely or never Less than 1 a week Once a week 2-3 times a week 4-6 times a week 1-2 times a day 3-4 times a day 5+ a day

Fruit (tinned / fresh)

Fruit juice (not cordial or squash)

Salad (not garnish added to sandwiches)

Vegetables (tinned / frozen / fresh but not potatoes)

Chips / fried potatoes

Beans or pulses like baked beans, chick peas, dahl

Fibre-rich breakfast cereal, like

Weetabix, Fruit 'n Fibre,

Porridge, Muesli

Wholemeal bread or chapattis

Cheese / yoghurt

Crisps / savoury snacks

Sweet biscuits, cakes, chocolate, sweets

Ice cream / cream

Non alcoholic fizzy drinks/pop

(not sugar free or diet)

Sausages, bacon, corned beef, meat pies/pasties, burgers

Chicken/turkey nuggets/twizzlers, turkey burgers, chicken pies, or in batter or breadcrumbs

White fish in batter or breadcrumbs - like 'fish 'n chips'

White fish not in batter or breadcrumbs

Oily fish - like herrings, sardines, salmon, trout, mackerel, fresh tuna (not tinned tuna)

Progress: 60% .

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (IPAQ)

The following section is about exercise.

Think about all the vigorous activities that you did in the last 7 days.

Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal.

Think only about those physical activities that you did for at least 10 minutes at a time.

How much time did you usually spend doing vigorous physical activities on one of those days?

hours per day

_____

minutes per day

_____

Progress: 65% .

Think about all the moderate activities that you did in the last 7 days.

Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

Think only about those physical activities that you did for at least 10 minutes at a time.

How much time did you usually spend doing moderate physical activities on one of those days?

hours per day

_____

minutes per day

_____

Progress: 70% .

Think about the time you spent walking in the last 7 days.

This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

How much time did you usually spend walking on one of those days?

hours per day

_____

minutes per day

_____

Progress: 75% .

Think about the time you spent sitting on weekdays during the last 7 days.

Include time spent at work, at home, while doing course work and during leisure time.

This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

During the last 7 days, how much time did you spend sitting on a week day?

hours per day

_____

minutes per day

_____

Progress: 80% .

REVISED ALMOST PERFECT SCALE (RAPS)

The following items are designed to measure attitudes people have toward themselves, their performance, and toward others.

There are no right or wrong answers.

Please respond to all of the items. Use your first impression and do not spend too much time on individual items in responding.

Respond to each of the items to describe your degree of agreement with each item.

	1- Strongly Disagree	2- Disagree	3- Slightly Disagree	4- Neutral	5- Slightly Agree	6- Agree	7- Strongly Agree
1)	I have high standards for my performance at work or at school.						
2)	I am an orderly person.						
3)	I often feel frustrated because I can't meet my goals.						
4)	Neatness is important to me.						
5)	If you don't expect much out of yourself, you will never succeed.						
6)	My best just never seems to be good enough for me.						
7)	I think things should be put away in their place.						
8)	I have high expectations for myself.						

9) I rarely live up to my high standards.

10) I like to always be organized and disciplined.

11) Doing my best never seems to be enough.

12) I set very high standards for myself.

13) I am never satisfied with my accomplishments.

14) I expect the best from myself.

15) I often worry about not measuring up to my own expectations.

16) My performance rarely measures up to my standards.

17)

I am not satisfied even when I know I have done my best.

18) I try to do my best at everything I do.

19) I am seldom able to meet my own high standards of performance.

20) I am hardly ever satisfied with my performance.

21) I hardly ever feel that what I've done is good enough.

22) I have a strong need to strive for excellence.

23) I often feel disappointment after completing a task because I know I could have done better.

Progress: 95% .

Thank you for completing this survey

There will be a random prize draw for one of two £100

vouchers for participants that have completed the study. If you would like to take part, please enter your email address. The winners will be notified by email after the end of the study.

_____

In case of experiencing any distress, we advise you to contact your GP and/or your mental healthcare provider. Please find some useful resources below, according to your university.

Lancaster University

University College London (UCL)

Queen Mary University of London (QMUL)

King's College London (KCL)

Lancaster University:

What to do during a mental health crisis:

If you are on campus - Dial 999 for the Emergency Services, then afterwards contact the Security Reception on 01524 594541 (staffed 24 hours a day, 365 days a year) to let them know, so they can direct the Emergency Services appropriately on arrival.

If you are off campus - Dial 999 to connect straight to the Emergency Services or go to your local Accident and Emergency Department.

Lancashire and South Cumbria Foundation Trust Wellbeing and Mental Health Crisis Line - Call on 0800 953 0110 (open all year round).

Useful non-emergency contacts:

NHS 111 - This is the NHS non-emergency number. It's fast, easy and free. Call 111 and speak to a highly trained advisor, supported by Healthcare Professionals, to find out where help is available. NHS 111 is available 24 hours a day.

Lancashire and South Cumbria Foundation Trust Wellbeing and Mental Health Helpline and Texting Service - Call on 0800 915 4640 (open weekdays 7pm-11pm, and weekends 12 noon-12 midnight) or text HELLO to 07860022846.

The Samaritans - If you need someone to talk to, you can call The Samaritans on 116 123. This is a freephone number, and they are available 24 hours a day, 365 days a year.

Papyrus - HOPELineUK, run by Papyrus, is a confidential helpline, staffed by trained professionals who give support and advice to young people under the age of 35 feeling suicidal or anyone concerned about a young person. Call them on 0800 0684141 (Monday to Friday 10am-10pm, Saturday to Sunday 2pm-5pm).

UCL:

If you're in immediate danger of hurting yourself or others:

Go directly to the Accident & Emergency (A&E) department of your local hospital to get help UCLH is the nearest A&E department to UCL’s main campus Call 999 to request an ambulance if you are unable to reach the hospital yourself If you're feeling distressed and need urgent support:

Contact your GP surgery to request an emergency appointment If your GP surgery isn't open, call the free NHS out-of-hours medical line on 111 for help accessing the right services You can call the Samaritans on 116 123 to talk to someone at any time, day or night Nightline are a listening service for students, by students - they're available overnight on +44 (0)207 631 0101 Other available services:

Camden and Islington Crisis team, tel. 02033176333 (24 hours) Mind, tel. 03001233393 iCOPE, tel. 02033176670 (Camden), tel. 02033177252 (Islington)

QMUL: If you are in immediate danger of harming yourself or others, call 999. An ambulance may be called if appropriate, and they will advise whether you should go to A&E.

Otherwise, you can access urgent mental health support by:

Requesting an urgent appointment with your GP (GPs are offering video/phone consultations) Contacting your local

NHS Mental Health Crisis Number – enter the borough, county or town where you are currently living and 'Mental

Health Crisis Line' into your search engine. Example: City & Hackney Mental Health Crisis Line, tel. 0800 073 0006 (24 hours) Calling Samaritans on 116 123 (24 hours, 365 days a year)

Other available services:

Mind, tel. 03001233393

KCL:

If you feel like you cannot keep yourself safe and you are in immediate danger of harming yourself or attempting to take your life:

Go to the closest Accident and Emergency (A&E Department). Call 999 to request an ambulance if you cannot go to the hospital yourself Call South London and Maudsley Crisis line, tel. 0800 731 2864 (24 hours)

If you need urgent mental health support:

Contact your GP surgery to request an emergency appointment (some GP surgeries are currently offering phone appointments only) If your GP surgery is not open, call the free NHS medical line on 111 for help accessing the right services, but again be aware they are at capacity at present so only call in crisis You can call the Samaritans on 116 123 to talk to someone at any time, day or night, 24/7 You can text Shout on 85258 You can download Stay Alive app, an app for those at risk of suicide and those worried about someone You can contact the Listening Place for face to face support and online and telephone support You can call Mind, tel. 03001233393

This is the end of the survey. Thank you for your participation!

Appendix E: Patient and Public Involvement (PPI)

Test participant 1:

- Text in information sheet not exactly in centre
- There was no option to specify other ethnic white background etc
- I suggest to ask for religion as this may affect food choices
- I suggest to make question for exercise duration clearer
- Progress bar is useful as it helps to know how much of the survey is left
- Time taken: 16 minutes

Test participant 2:

- Format good overall
- Length ok
- Consider using additional units as some people may not be familiar with kilograms or metres
- Some questions in RAPS appear similar
- Progress bar helpful, good to know how much is left
- Time taken: 20 minutes

Test participant 3:

- Format good
- Length is fine
- Accidentally entered height in cm rather than m, got relevant message when pressed submit but was not sure how to correct this as the survey progressed to next stage
- Some questions in RAPS are similar
- Progress bar helpful, as I like to know how much is left when doing surveys
- Time taken: 15 minutes

Test participant 4:

- It was a very straightforward survey
- Easy to understand questions
- Simple scoring system
- And the introduction of it was very good, to highlight eligibility criteria

- I don’t think it requires any significant improvements
- I did the survey in about 15 minutes

Test participant 5:

- I found it smooth and easy to use. Particularly liked the progress bar at the bottom. I also liked the use of examples (such as what a portion means) to help with making estimates about things.
- Some thoughts:

- Will you be excluding students working from home due to Covid? Because I wonder if this would be a commonly asked question for your target group completing the survey

- When you mentioned questions about Mental health - one of the first questions is about aware of dryness of my mouth. It could be confusing for students as they might not see the link between the mental health and the question (dryness of mouth could be dehydration but in the context of the rest of the questions it sounded like it was relating to anxiety), so might need signposting that you are including physical symptoms relating to mental health

- The progress bar reaches 100% after the penultimate question rather than the last set of questions, so I wasn't expecting the last set of questions

- In the last set of questions, I couldn't tell the difference between these two statements- not sure if this is intentional though

“My best just never seems to be good enough for me”.

“Doing my best never seems to be enough”.

- A couple of places where you used American English

What will happen to the results? The results will be summarized should be 'summarised'

You consent to Lancaster University keeping the anonymized should be 'anonymised'

- Grammar (Sorry I do a lot of proof-reading that's why I'm commenting on the spelling & grammar!)

Will my data be Identifiable?

The files on the computer will be encrypted (that is ADD A COMMA no-one other than the researcher and the university supervisors will be able to access them)

- Hope this is helpful. Really interesting work you're doing
- In total, it took me 15 minutes to complete.

Test participant 6:

- Lengthy introduction, but I recognise that the information has to be included
- Overall survey length is ok, structure is clear

- Looks long at the start, but towards the end the questions can be answered faster
- Progress bar was helpful as I knew how much of the survey was left
- Diet questionnaire has good detail, although some questions were hard to answer accurately due to not remembering
- For weight and height questions, maybe use bold font for units of weight and height, as did not notice them initially
- On the phone the diet questionnaire frequencies appear a bit strange, but are ok on computer
- Took 15 minutes to do

Test participant 7:

- Well structured
- Instructions are clear
- Length of survey is reasonable
- I found the progress bar helpful
- I did the survey on the phone, survey displayed better on landscape rather than portrait mode
- Took 23 minutes to do