Factors Affecting Mental Wellbeing among UK University Students

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Abstract

Mental wellbeing is a critical determinant of academic success and overall quality of life among university students (Storrie et al., 2010; Macaskill, 2018). Cognitive function, an integral component of mental health, has been increasingly linked to nutritional status, particularly breakfast consumption patterns (Adolphus et al., 2013; Galioto and Spitznagel, 2016). Concurrently, food insecurity has emerged as a significant concern in higher education settings, with potential ramifications for both nutritional adequacy and mental health outcomes (Bruening et al., 2017; Payne-Sturges et al., 2018). Despite the growing body of research in this field, there remains a paucity of comprehensive studies examining the complex interplay between breakfast consumption, food insecurity, and mental wellbeing among UK university students (Ansari et al., 2015; Macaskill, 2018). This thesis aims to investigate the factors affecting mental wellbeing among UK university students, with a particular focus on the role of breakfast consumption on cognitive function and the impact of food insecurity on mental wellbeing. Through a systematic review, cross-sectional studies, and an intervention study. Our systematic review established a positive association between breakfast consumption and cognitive functions. Cross-sectional studies revealed that skipping breakfast negatively impacted cognitive performance, while food insecurity was prevalent among UK university students and strongly associated with poor mental wellbeing. Financial factors emerged as significant predictors of students' mental health, with those experiencing food insecurity often demonstrating low stress-coping skills. An intervention study focused on

enhancing food literacy, financial budgeting, meal preparation, and food waste reduction skills. Results showed improvements in food security status and potential benefits for mental wellbeing, highlighting the effectiveness of educational interventions in addressing these issues. Overall, our findings suggest that multiple factors contribute to students' mental health challenges, including dietary habits, food security status, and financial management skills. This thesis contributes to the understanding of student wellbeing by establishing clear links between breakfast habits, food security, and mental health. It emphasises the need for holistic approaches in university support services, including breakfast programmes, food literacy education, and financial management training. The thesis recommends multi-level strategies involving universities, mental health services, and government regulations to create an environment that fosters both academic success and mental health. Future work will focus on developing and evaluating targeted interventions linking breakfast programmes and food education, considering longitudinal studies and investigations into socioeconomic-specific factors affecting food security and mental wellbeing among UK university students. to reduce food insecurity and potentially alleviate the increasing mental health burden among UK university students. This approach aims to address the complex interplay between nutrition, food security, and mental wellbeing in this vulnerable population.

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Declaration

The candidate confirms that the work submitted is her own and that appropriate credit has been given where reference has been made to the work of others.

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Publications

- **Paper publication**

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- **Conferences**

1. Summer Conference 2023, 3–6 July 2023, Nutrition at key stages of the lifecycle. Liverpool, UK.

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Abbreviations

WHO- World Health Organisation

FAO- Food and Agriculture Organisation

NHS- National Health Service

BNF- British Nutrition Foundation

BDA- British Dietetic Association

UN- United Nations

ONS- Office for National Statistics

BMI- Body Mass Index

RDA- Recommended Daily Allowance

GL- Glycaemic Load

GLP-1- Glucagon Like Peptide-1

CP- Concentration Performance

A- Accuracy

FI- Food Insecurity

FS- Food Security

NOS- Newcastle-Ottawa Scale

HFIAS- Household Food Insecurity Access Scale

CFS- Coping Flexibility Scale

WEMWBS- Warwick-Edinburgh Mental Wellbeing Scale

GPA- Grade Point Average

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Chapter 1- General Introduction

1.1 Mental health and wellbeing overview

The World Health Organisation (WHO) emphasises the critical importance of addressing mental health and wellbeing as a fundamental human right, asserting that "there can be no health without mental health" (WHO, 2022). Mental health is an essential component of overall health and wellbeing, underpinning our individual and collective capacity to make decisions, form connections, and shape the world in which we live. It is also critical for personal, community, and socioeconomic development (WHO, 2022). Mental health is determined by a complex interplay of individual, social, and structural factors (WHO, 2022).

The WHO (2004) defines mental health as "a state of wellbeing in which the individual realises their own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to their community." Building on this definition, mental wellbeing is characterised as a positive state of emotional, psychological, and social health defined by contentment, resilience, and the ability to cope effectively with life's challenges. It encompasses positive emotions, a sense of purpose, and the capacity to engage in meaningful relationships and activities (Gautam et al., 2024; Riches et al., 2021). As Linley et al. (2009, p. 878) state, wellbeing is "engagement with the existential challenges of life." Indeed, the concept of wellbeing has become a primary focus of the science of positive psychology, which studies ideal human functioning (Linley et al., 2009).

Cognitive functioning is a key indicator of mental health and wellbeing (Henderson et al., 2015). Healthy cognitive function is essential for general mental wellbeing (American Psychological Association, 2023), as better cognitive performance is linked to enhanced levels of mental wellbeing through improved problem-solving skills, effective decision-making, and stress management (Wyman et al., 2022). Conversely, high levels of mental health can improve cognitive function. Positive emotions and life satisfaction, for example, can enhance brain plasticity, learning, and memory. In contrast, poor mental health, such as persistent stress and depression, can impede cognitive function (Diener and Chan, 2011).

Mental wellbeing and mental health exist on a continuum rather than as binary opposites. Good mental wellbeing can coexist with a mental health condition, and poor mental wellbeing can occur without a diagnosable condition (Keyes, 2002). However, both mental wellbeing and mental health conditions have a significant impact on how individuals' function in their daily lives. While poor mental wellbeing can increase the risk of developing mental health conditions, mental health conditions can also have a substantial impact on mental wellbeing (Keyes, 2002). Interestingly, high wellbeing despite a mental health diagnosis implies that enhancing overall wellbeing can reduce mental illness prevalence (Gautam et al., 2024; Riches et al., 2021).

Globally, mental health disorders are on the rise and have a profound impact on an individual's thinking, emotional state, and behaviour, interfering with their capacity to work or participate in other activities (Keyes, 2002).

Depression, stress, and anxiety are key contributors to the global disease burden and are the most prevalent mental health disorders. They cost the world's economy approximately one trillion dollars per year (WHO, 2022). Sadness, loss of interest or satisfaction, a sense of guilt or low self-worth, disturbed sleep and/or appetite, tiredness, and lack of focus are all symptoms of depressive disorders (Pourmotabbed et al., 2020), while anxiety disorders refer to a variety of mental disorders characterised by feelings of worry, fear, and stress. These chronic health issues can have major and devastating effects on an individual's life, influencing and disrupting social relationships, academic achievement, income, and overall quality of life (Rossa-Roccor et al., 2021; Thorley, 2017). Mental disorders are associated with an increased risk of suicide, which is notably the fourth-leading global cause of death among 15–29-year-olds as of 2019 (WHO, 2023). Furthermore, these mental disorders contribute significantly to global disability, accounting for approximately 15% of years lived with disability (Rossa-Roccor et al., 2021).

In the UK, mental disorders affect many young adults, with a fivefold increase in the proportion of students with mental disorders from 2006 to 2016. Specifically, 19% of young adults experienced mental illnesses, with younger females (16–24 years old) more likely to experience mental wellbeing disorders before age 25 than males of the same age. Undergraduate students were more likely to experience poor mental wellbeing than postgraduates (Thorley, 2017). According to National Health Service (NHS) statistics, one in every six people in the UK lives with common mental health problems, such as anxiety and

depression, on a weekly basis (McManus et al., 2016). Various factors contribute to mental wellbeing, including demographic changes, financial difficulties, life pressures, relationship challenges, and chronic health conditions (WHO, 2022).

Despite the prevalence and impact of mental health disorders, the global mean for government health spending on mental health remains below 2% (WHO, 2022). In response to this concerning statistic, mental health has become a Sustainable Development Goal, reflecting the growing recognition of its critical role in achieving global development objectives (WHO, 2022). To address the insufficient progress in meeting agreed-upon 2013–2030 targets for improving mental health, the WHO recommends redefining the physical, social, and economic characteristics of environments in households, educational institutions, workplaces, and wider society. This approach recognises that mental health issues can significantly impact all aspects of life, including academic or work performance, relationships and community engagement (WHO, 2022).

1.2 The role of nutrition in mental wellbeing

Multiple factors influence brain health, including age-related changes, accidents, mental disorders, and diseases. While some of them cannot be changed, there is evidence that several lifestyle factors, such as diets and physical activity, social interaction and cognitive activity, smoking, and alcohol consumption, could be modified to stabilise or enhance mental wellbeing (Anstey et al., 2013). There are theoretical frameworks linking nutrition and

mental wellbeing (Correa-Burrows et al., 2016) with some potential mechanisms underlying this relationship. Peripheral glucose and insulin metabolism, neurotransmitter actions, cerebral oxidation, and inflammation, are all important mechanisms responsible for acute functional alterations in the brain, particularly the hippocampus (Benton, 2002; Strasser et al., 2016; Muth and Park, 2021). Extensive research indicates that the hippocampus is crucial for many aspects of mental wellbeing, including learning, memory, and mood. It is one of only two brain regions where new neurons are formed (neurogenesis) (Jacka et al., 2015; Stangl and Thuret, 2009), and it is closely associated with nutrition (Jacka et al., 2015; Shi et al., 2023). Nutrition influences the levels of brain chemicals such as serotonin and dopamine, which are important for mood regulation and cognitive function (Backman, 2023), with certain foods potentially modulating the stress response in the hippocampus (Shi et al., 2023). These neurochemicals can be influenced by caloric intake, meal frequency, meal texture, and content (Stangl and Thuret, 2009).

A balanced diet rich in whole foods, fruits, vegetables, lean proteins, and healthy fats, particularly for breakfast, is linked to improved mental wellbeing and cognitive functions (Tang et al., 2017; Wesnes et al., 2003; Arora, 2022; Mahoney et al., 2005; Sincovich et al., 2022; Yao et al., 2019). Such a diet provides vital nutrients essential for brain and cognitive activities, including glucose from lower glycaemic load foods, amino acids from proteins, and micronutrients like vitamins and minerals. These nutrients play crucial roles in

brain function and cognitive performance. Proteins supply amino acids required for neurotransmitter synthesis, which helps regulate cortisol, a stress hormone that influences stress responses throughout the day (Sincovich et al., 2022; Kim et al., 2023). Simultaneously, vitamins and minerals support the brain's many metabolic pathways (Hoyland et al., 2009), while glucose helps maintain stable blood glucose levels, supporting sustained cognitive performance throughout the morning (Mahoney et al., 2005; Smith and Foster, 2008) (Figure 1.1.).

Moreover, foods rich in antioxidants and anti-inflammatory properties, such as fruits, vegetables, nuts, whole grains, and fish, can support brain health and reduce the adverse effects of stress on the body (Kudsia, 2021; McNamara, 2015). These foods contain nutritional elements like polyphenols and polyunsaturated fats (Firth et al., 2020), which may help reduce inflammation and decrease the risk of mental disorders (Bergmans et al., 2018; Kudsia, 2021), including preventing depressive symptoms (Firth et al., 2020). This has been demonstrated in a study of 843 Australian adolescents (Bergmans et al., 2018; Kudsia, 2021) and in randomised controlled trials (Firth et al., 2020). Furthermore, dairy consumption at breakfast has also been associated with significant positive effects on children's and adolescents' development and brain function. Fortified milk can be a good source of polyunsaturated fatty acids, an essential nutrient for brain growth. Additionally, dairy products are rich in vitamins such as C, D, B6, and B12 and minerals such as calcium, zinc, and iodine, all of which are important for brain development and functioning

(Peña-Jorquera et al., 2021; O'Sullivan et al., 2009). Consequently, starting the day with these nutrients in a breakfast meal could be highly beneficial and effective for overall mental wellbeing, particularly cognitive functions (O'Sullivan et al., 2009).

In contrast, decreasing consumption of healthy foods such as those with anti-inflammatory properties or increasing consumption of high-calorie meals, particularly those high in sugar and fat (Seaquist et al., 2013; Reynolds, 2002), and/or food with a high glycaemic index and load (diets high in refined carbohydrates and sugars), leads to high blood glucose levels (>126 mg/dl) (Kirvalidze et al., 2022) and can disrupt hippocampus synaptic plasticity. This can result in low mental wellbeing such as increased anxiety, depression, low mood (Reynolds, 2002; Firth et al., 2020), poor memory, and cognitive function deficiencies (Morris et al., 2016; Reynolds, 2002; Kirvalidze et al., 2022). Additionally, it has been linked to neuropathological mechanisms seen in dementia patients (Kirvalidze et al., 2022). These effects are due to decreased hippocampus neurogenesis, impaired insulin signalling in the hippocampus, and decreased glucose transporters (Morris et al., 2016), which can result in rapid increases in blood glucose levels, stimulating the release of counter-regulatory hormones such as cortisol, adrenaline, growth hormone, and glucagon (Seaquist et al., 2013). These counter-regulatory hormones can affect anxiety, irritability, and appetite (Seaquist et al., 2013). There is also a reduction in the cofactor L-methyfolate, which can cause depressive symptoms

(Neumeister et al., 1998), increase the risk of neurological dysfunction, and decrease mental wellbeing (Gómez-Pinilla, 2008).

Similarly, hunger caused by a lack of resources, such as food insecurity (Shi et al., 2023), which often results in skipping meals, especially breakfast (Lee and Kim, 2019; Backman, 2023), has a substantial impact on brain function and cognitive health (Lin et al., 2022). For example, it may impact the developmental stages, dopamine neurobiology, and blood glucose levels, all of which influence mental wellbeing (Lin et al., 2022). This is attributed to reduced blood glucose levels and increased production of stress hormones such as cortisol (Spencer et al., 2017; Yu et al., 2023), as well as serotonin and tryptophan deficits (RM et al., 2018; Neumeister et al., 1998). These physiological changes can cause increased anxiety and stress, impairing the brain's ability to control emotions and increasing the risk of mood disorders (Spencer et al., 2017). They can also negatively impact cognitive functions such as concentration, memory, and overall mental health (Yu et al., 2023; Shi et al., 2023; Hartline-Grafton, 2017; Kim et al., 2023). This can lead to poor academic performance in students and lower productivity in adults (Hartline -Grafton, 2017). Furthermore, this chronic stress response can have long-term negative effects not only on mental health (Stachowicz and Lebiedzińska, 2016; Davison and Kaplan, 2015), but also on physical health (Stachowicz and Lebiedzińska, 2016), such as cardiovascular disease, hypertension, dyslipidaemia, type 2 diabetes, and overweight or obesity (Kubo et al., 2020).

Therefore, the relationship between nutrition and mental wellbeing is complex and multifaceted. A balanced diet, particularly one that includes a nutritious breakfast, can significantly enhance brain function and mental health (Firth et al., 2020; O'Neil et al., 2014). Conversely, poor dietary choices and food insecurity can lead to negative impacts on cognitive function, mood, and overall mental wellbeing (Kirvalidze et al., 2022; Lin et al., 2022). Regular, balanced meals are crucial for maintaining good mental health and reducing the risk of chronic stress and its associated health problems (Stachowicz and Lebiedzińska, 2016; Kubo et al., 2020). The intricate connections between nutrition, brain function, and mental wellbeing underscore the importance of dietary considerations in mental health interventions and public health strategies (Jacka et al., 2017).
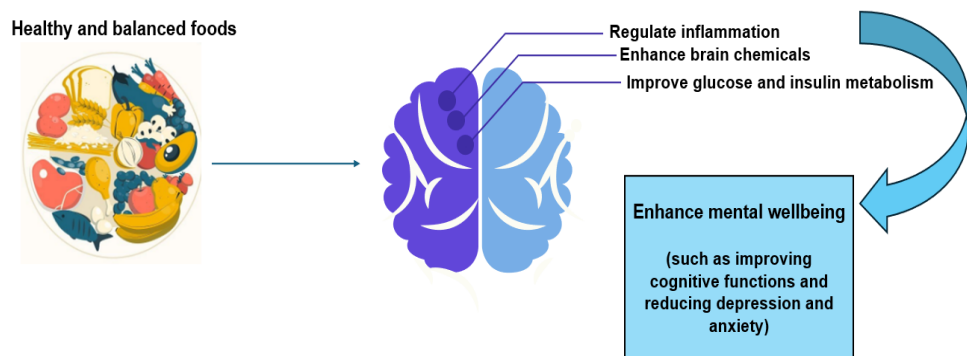
Figure 1.1: The relationship between a healthy, balanced diet and mental wellbeing.

1.3 The importance of breakfast consumption

Breakfast consumption is vital due to its significant implications for nutritional intake (Rampersaud et al., 2005), mental and physical health (Smith et al.,

2010), and academic performance (Adolphus et al., 2013). Individuals who consume breakfast regularly have healthier eating habits (Lien, 2007). They tend to consume more dietary fibre, greater levels of vitamins B12, C, and D, lower levels of total fat and sodium, and less total and added sugar (Gibney et al., 2018), as well as less consumption of unhealthy snacks, soft drinks, candies, and salty snacks, all of which are high in calories, saturated fat, and/or sugar (Deshmukh-Taskar et al., 2010; Leidy, 2013), compared to infrequent consumers or skippers (Gibney et al., 2018). Generally, breakfast consumption is linked to improved micronutrients (Gibney et al., 2018), macronutrient intake, and healthier food and beverage consumption (Giménez-Legarre et al., 2020). This reflects benefits for both physical and mental functions and makes it a crucial component of a healthy lifestyle, according to the Healthy Eating Index scores from the US Department of Agriculture (Rampersaud et al., 2005; Sincovich et al., 2022; Ackuaku-Dogbe and Abaidoo, 2014). For instance, regular breakfast consumers have lower risks of diabetes, cardiovascular disease, and obesity (Guinter et al., 2020; Mansouri et al., 2020; Rani et al., 2021).

Moreover, those who consume breakfast regularly experience improvements in mental wellbeing including lower rates of depression, stress, and emotional distress (O'Sullivan et al., 2009; Lien, 2007; Rampersaud et al., 2005; Gao et al., 2021), higher levels of life satisfaction, and engage in healthier lifestyle behaviours (Gao et al., 2021). They also report feeling more energised and having better overall mood stability (O'Sullivan et al., 2009). Additionally, they show improvements in cognitive functions (Rani et al., 2021; Hasz and Lamport, 2012), including enhancements in memory, mood, attention (Rani et al., 2021;

Rampersaud et al., 2005; Arora, 2022; Smith and Rogers 2014), concentration (Mahoney et al., 2005; Wesnes et al., 2003), and academic performance (Sincovich et al., 2022; Tarakalakshmi et al., 2017; Taha and Rashed, 2017; Arshad and Ahmed, 2014; Ackuaku-Dogbe and Abaidoo, 2014).

Furthermore, ensuring access to breakfast at school can significantly enhance cognitive function, academic performance, and overall wellbeing; therefore, the benefits of breakfast could be more effective if they were provided at schools (WEBER, 2023). A school breakfast club is one example of a programme that ensures students begin their day with a nutritious meal (Gov. UK, 2022) to meet their daily dietary needs (Gundersen et al., 2017). Breakfast clubs can provide social and emotional benefits by creating an enjoyable environment in which children can interact with peers and school staff (Hua et al., 2020). This can contribute to developing a sense of connection and belonging among students, which can improve their social skills and self-esteem (Cuervo-Cazurra and Dau, 2009; Gundersen et al., 2017), as well as boost cognitive function, attention, and concentration (Cueto and Santiago, 2012), and overall mental wellbeing (Cuervo-Cazurra and Dau, 2009; Gundersen et al., 2017). These programmes play an important role in preventing food insecurity and providing students with access to nutritional foods, particularly for households with low incomes (Garcia and Lusk, 2019).

While the benefits of breakfast are well-documented, the optimal timing and composition for maximum benefits remain subjects of debate. Some studies suggest that consuming breakfast within two hours of waking is ideal for

metabolic health (Nas et al., 2017), while others emphasize the importance of a balanced meal containing protein, complex carbohydrates, and healthy fats (Blom et al., 2006). It's important to note that despite the overwhelming evidence supporting breakfast consumption, some studies have yielded conflicting results. For instance, Betts et al. (2014) found no difference in resting metabolic rate between breakfast eaters and skippers, challenging the notion that breakfast consumption leads to increased metabolism.

The challenges of breakfast consumption are particularly pronounced among university students. Factors such as early morning classes, limited time, financial constraints, and lack of cooking skills can all contribute to breakfast skipping in this population (Pendergast et al., 2016). This is concerning given the potential impacts on cognitive function and academic performance, which are crucial for university success. From a global perspective, breakfast consumption habits and their perceived importance vary across cultures. While a hearty breakfast is considered essential in many Western countries, some cultures traditionally have lighter morning meals or even skip breakfast altogether. However, as awareness of the potential health benefits grows, there's an increasing global emphasis on the importance of a nutritious breakfast (Gibney et al., 2018).

1.3.1 Understanding breakfast

Although there appears to be widespread agreement that breakfast plays an important role in assisting consumers in achieving an optimal nutritional diet, significant challenges exist due to variations in fundamental concepts such as

defining breakfast consumption or skipping breakfast, as well as investigating breakfast components and how they may be related to overall health (Gibney et al., 2018). Considering timing in the breakfast definition is also a complex topic that can be evaluated based on the time of day, time of waking, and/or the periods that separate various eating events (de Castro, 1994). Moreover, some scientific studies have questioned breakfast habits or breakfast-eating benefits (Betts et al., 2016). The biggest factor contributing to these seemingly contradictory results in this area is the lack of a globally understood definition of breakfast (Betts et al., 2016).

Nonetheless, a breakfast meal reflects the longest daily period of fasting and represents a state of post-absorptive metabolism where the body has fully digested and absorbed nutrients from the last meal consumed (Ruge et al., 2009). This leads to the body's metabolism slowing due to the exhaustion of energy resources during a night's sleep, whereas consuming breakfast signals the body to begin the day's energy consumption processes, allowing it to process nutrients and calories more efficiently. This is crucial for maintaining a healthy weight and energy balance during the day and providing the fuel required for brain function by improving memory, focus, and problem-solving skills (Health Partners Group, 2024). Thus, breakfast is generally identified as the first meal of the day, usually consumed in the morning after a period of fasting from 8 to 12 hours the night before (Betts et al., 2016; Jakubowicz et al., 2015).

Despite the fact that foods consumed for breakfast have an important effect on health, there are few formal descriptions or examples of an appropriate

breakfast meal (Gaal et al., 2018). The majority of national nutrition societies have established recommendations that indicate which food groups should be consumed in what amount and frequency while still allowing individuals to choose their foods for each meal of the day as they prefer (Delley and Brunner, 2019). According to the British Dietetic Association (BDA), breakfast should account for 20-25% of total daily energy and nutritional intake (BDA, 2019), and foods should be selected from five main food groups, namely: starchy foods (cereals, pasta, bread), fruit and vegetables, milk and dairy, protein sources, and low-fat spreads and oils (Gaal et al., 2018).

A well-balanced macronutrient composition, including lean proteins (e.g., eggs, Greek yoghurt, tofu), low-sugar fruits (e.g., berries, apples), and complex carbohydrates (e.g., whole grains, oats), can replenish glycogen stores and provide the body with essential nutrients to support sustained energy levels and cognitive function throughout the morning (Nairn, 2022).

In Westernised countries, the most common breakfast-consuming meals are ready-to-eat cereals with milk across all age groups, followed by fruits, fruit juice, and bread (Delley and Brunner, 2019). Eating ready-to-eat cereal may be an indicator of other dietary behaviours that result in healthier food choices, better levels of physical activity, and a lower BMI (Rampersaud et al., 2005). Interestingly, this aligns with the nutritional profile of the UK Aldi Greek Yogurt Parfait option, which is the most cost-effective at about £0.85 per serving. This breakfast choice is rich in protein and provides a good balance of macronutrients, making it an excellent choice for students on a tight budget who still want a nutritious start to their day.

Research suggests that the benefits of cereals are associated with improved overall macronutrient and micronutrient intakes in both adults and children (Rampersaud et al., 2005). This includes a greater consumption of fruits, vegetables, milk, and whole grains compared to those who miss breakfast. Consequently, this results in higher intakes of important vitamins (A, C, B-6, B-12, thiamine, riboflavin, niacin, and folate), minerals (calcium, phosphorus, magnesium, iron, and potassium), and dietary fibre, while maintaining lower intakes of dietary fat and cholesterol (Rampersaud et al., 2005).

While cereals offer these benefits, other breakfast options can also provide a nutritious start to the day. For instance, the UK Tesco Avocado Toast with Egg, at approximately £1.35 per serving, offers a good mix of healthy fats, protein, and complex carbohydrates. Although slightly more expensive than the yogurt parfait, it remains a reasonably priced option for a homemade breakfast. This choice incorporates whole grains from the bread and provides a variety of vitamins and minerals from the avocado and egg.

In contrast, the Sutton Bonington Campus Cafeteria at the University of Nottingham offers a Full English Breakfast at a higher price point of £5.50 - £6.50. While this option provides a substantial meal with a variety of nutrients, it is significantly more costly than the homemade alternatives. This price difference highlights the economic considerations students must weigh when choosing their breakfast options.

1.4 The importance of food security and nutrition

Food and nutrition insecurity have been negatively associated with decreasing dietary intake in both quantity and quality (Leung et al., 2014). Food insecurity

results in insufficient intake of key nutrients, impairing brain function, raising the risk of mental health disorders such as anxiety and depression, increased stress, and lower overall mental health outcomes compared to sufficient access to healthy foods (Yu et al., 2023; Jacka et al., 2011). This might be attributed to the fact that food insecurity and poor mental health may overlap with poor dietary habits (Alegría et al., 2018; Becerra and Becerra, 2020; Shi et al., 2021); therefore, addressing the impact of food insecurity on mental wellbeing requires understanding disrupted eating habits and nutritional deficiency (Leung and Tester, 2019).

Studies undertaken in Canada, the US, and Korea have found that generally, those who were food insecure were more likely to have a lower intake of essential nutrients, including protein (Johnson et al., 2018; Castro et al., 2022; Kim and Oh, 2015), carbohydrates, vitamins (Castro et al., 2022; Johnson et al., 2018; Ranjit et al., 2020; Kim and Oh, 2015), and minerals (Davison and Kaplan, 2015; Castro et al., 2022; Kim and Oh, 2015; Johnson et al., 2018; Ranjit et al., 2020). This could be due to the lower ability to cope with financially stressful situations by using strategies such as eating less of their favourite foods, reducing meal portions, skipping meals, and borrowing money, which were the most commonly used coping strategies during food scarcity (Farzana et al., 2017; Broton and Goldrick-Rab, 2018; Hughes et al., 2011).

Indeed, those who were food insecure were more likely to have an increased intake of unhealthy food choices that are high in fat and sugar when compared to those who were food secure (Sharkey et al., 2012). Moreover, it was

discovered that having more access to unhealthy and quick-cooked frozen foods was correlated with food insecurity (Nackers and Appelhans, 2013). This change in dietary intake could be explained by the fact that, when compared to healthy foods such as fruits and vegetables, energy-dense foods or processed foods are often nutrient-poor and are frequently cheap and widely available (Leung et al., 2014). This behaviour was especially prevalent among those who are more likely to be from low-income populations (Lee and Kim, 2019; Liebe et al., 2022), such as those with limited finances (Dickinson, 2023) who lack access to adequate food (Lee and Kim, 2019). Consequently, this could be a typical period for rising mental health concerns (Drakoulidou et al., 2020; Pryor et al., 2016). Others suggested that food insecurity was linked with some, but not all, aspects of a diet (Leung et al., 2014), as no differences were found between food insecure and food secure adults in some macronutrient intake (Kim and Oh, 2015). However, the high prevalence of inadequate food intake can lead to various nutritional deficiencies, adversely affecting overall health and wellbeing.

The consequences of food insecurity extend beyond individual health. At a societal level, food insecurity can lead to increased healthcare costs, reduced productivity, and exacerbated social inequalities (Gundersen and Ziliak, 2015). In academic settings, food insecurity among students has been associated with lower grade point averages (GPA), higher dropout rates, and decreased overall academic performance (Patton-López et al., 2014). This underscores the importance of addressing food insecurity through dietary interventions and

policy changes to ensure access to nutritious foods, which are essential for improving cognitive functions and overall mental wellbeing. Strategies to combat food insecurity may include improving food assistance programs, promoting nutrition education, and addressing the root causes of poverty and inequality (Coleman-Jensen et al., 2020).

1.4.1 Understanding food insecurity

Food insecurity is not just a national issue but a global challenge. Pandemics, climate change, and wars can influence the prevalence not only in countries directly affected but also those who import their goods (Alnafissa, 2017). Many countries confront major food security challenges. Economists and experts from various disciplines have been attempting to determine and address the issue. Understanding the problem of food security would aid in developing sensible policies that, in turn, may increase food security without adversely affecting other sectors of the economy (Alnafissa, 2017).

Despite significant achievements towards increasing global food production over the last quarter century, more than 2 billion people lack consistent access to safe, adequate, and nutritious food (FAO, 2019). Almost 795 million people globally were reported to have food insecurity due to their inability to meet their nutritional requirements for a healthy and active life (Jones, 2017). In more specific terms, in 2018, 11.1% of US households were food insecure. Similarly, reports of food insecurity in the UK indicate that 10% of citizens were food insecure in 2016, while food insecurity in Canada was 12.7% in 2018 (Long et al., 2020).

People gathered millions of years ago to grow, harvest, and consume; we are not far from this idea now. Countries have become a source of power by producing food and feeding their inhabitants to keep control, as it is more than just production and feeding (Genç, 2022). Therefore, the food security term has dynamically emerged from several definitions throughout time (FAO, 2003). The comparison of these definitions demonstrates the significant rethinking and reconstruction of official food security thinking over the last three decades (FAO, 2003).

Food security developed as a term in the mid-1970s during discussions relating to the global food crisis (Maxwell and Wiebe, 1999). The first focus on food security was established by the United Nations (UN) in 1974, with a focus on the food supply and price stability of basic consumable goods. However, it just reflects the availability of enough food on a global scale, it does not guarantee that everyone has access to enough food on an individual or household level. In 1983, the Food and Agriculture Organisation (FAO) took the lead in reshaping the definition of food security to suit a new understanding of securing vulnerable people's access to adequate food supplies. It is defined as "ensuring that all people at all times have both physical and economic access to the basic food that they need." (FAO, 1983).

The FAO further refined this definition, indicating that food security is achieved "when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2015, p. 53). In contrast, food

insecurity occurs when people have restricted access to "safe and nutritious foods" and are unable to "access enough food to meet dietary energy requirements" (Pinstrup-Andersen 2009, p. 5). However, this term does not seem to accurately describe the scope of food insecurity's economic and structural roots. Thus, when addressing food insecurity, the term "food poverty" is frequently used, which is defined as "insufficient economic access to an adequate quantity and quality of food to maintain a nutritionally satisfactory and socially acceptable diet" (Long et al., 2020).

The World Bank introduced a most significant formulation of the food security concept in 1986. This concept includes a broader notion of food security as well as a clear distinction between chronic and transient food insecurity caused by natural disasters, economic crises, and conflict (Maxwell and Wiebe, 1999). The World Bank defined food security as "access of all people at all times to enough food for an active, healthy life." (World Bank, 1986:1), considering food availability and the ability to acquire it to be important and essential factors.

Following a series of global summits since the World Food Conference in 1974 and based on decades of work, the definition of food security became widely accepted in 1996 at the World Food Summit: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life," and it is still used to this day (FAO, 2015). This term includes food availability, food access, utilisation, and stability.

Food availability refers to the physical presence of food at many levels, ranging from the household to the national level, which may come from one's own production or from markets. Food access refers to the ability to obtain acceptable and healthy food and is particularly related to household resources. Utilisation refers to food use through an adequate diet, clean water, sanitation, and health care to achieve nutritional wellbeing in which all physiological needs are met. Stability can be achieved when a population, household, or individual has stable access to sufficient food and should not be at risk of losing access to food as a result of either rapid shocks (such as an economic or climatic catastrophe) or cyclical events (such as seasonal food insecurity).

It is clear from the definitions of food security that the concept of "secure access to enough food at all times" contains four key concepts (FAO, 2006), which are as follows: (a) enough food, defined as the right to produce, purchase, exchange, or receive food as a donation or gift, (b) food sufficiency, defined principally as the calories required for an active, healthy existence; (c) security, defined by the balance of vulnerability, risk, and insurance; and (d) time, where food insecurity might be chronic, transitory, or cyclical. These pillars derive from the multifaceted and multilayer character of food security and provide a more comprehensive picture for comprehension (FAO, 2006). While the concept of food security is well-defined, it's important to recognise that food insecurity, the absence of food security, exists on a spectrum. The FAO recognises different levels of food insecurity. These include mild food insecurity (people experience uncertainty about their ability to obtain food and

may compromise on food quality or variety), moderate food insecurity (people reduce the quantity of food consumed or skip meals), and severe food insecurity (people go for entire days without eating due to lack of money or other resources) (FAO, 2021).

Thus, understanding food security is crucial since developing concerns affect every aspect of food security. Although existing international relations procedures and institutions aim to eliminate new challenges such as pandemics, rising temperatures, and volatility in food prices, they are insufficient to deal with these rising threats and ensure food security (Genç, 2022).

1.5 The connection between breakfast consumption and food insecurity in universities

The relationship between breakfast consumption and food insecurity can be understood through food planning, particularly for university students facing financial constraints. Food insecurity, defined as limited or uncertain access to adequate food (Coleman-Jensen et al., 2021), often leads to compromised dietary quality and quantity. Breakfast, despite its importance for cognitive function and overall health (Adolphus et al., 2016), is frequently sacrificed when resources are scarce. For food insecure students, meal planning becomes a critical strategy. However, limited resources may force prioritization of later meals, leading to breakfast skipping (Bruening et al., 2018). This trend is concerning, as regular breakfast consumption is associated with improved nutrient intake and diet quality (Gibney et al., 2018).

Effective food planning, focusing on affordable, nutrient-dense breakfast options, can help mitigate food insecurity's impact. Gaines et al. (2014) found that food insecure students who engaged in meal planning were more likely to maintain diet quality. By incorporating cost-effective breakfast items like oats, eggs, and frozen fruits into their food plans, students can stretch their food budgets while meeting nutritional needs (Broton and Goldrick-Rab, 2018). This approach not only addresses immediate hunger, but also contributes to overall food security by ensuring consistent intake of essential nutrients. Meza et al. (2019) observed that students who planned meals, including breakfast, reported lower levels of food insecurity. Moreover, breakfast planning can reduce reliance on more expensive, less nutritious options later in the day, helping manage limited food resources more efficiently (Knol et al., 2017). Universities can play a role by providing education on budget-friendly, nutritious breakfast options and meal planning strategies. Vaterlaus et al. (2021) found that campus-based nutrition education programs improved food security status among students.

However, despite the presumed benefits of breakfast planning for food insecure students, some studies have yielded inconsistent results. Contrary to expectations, Pendergast et al. (2016) found no significant association between meal planning and reduced food insecurity among university students. Similarly, Greaney et al. (2018) observed that while students engaged in food planning reported better overall diet quality, this did not necessarily translate to lower rates of food insecurity. Interestingly, Hagedorn and Olfert (2018)

noted that some food insecure students who prioritised breakfast actually reported higher levels of stress, possibly due to the additional time and cognitive load required for meal planning. Moreover, Payne-Sturges et al. (2018) found that students who regularly planned meals, including breakfast, were not significantly less likely to experience academic difficulties compared to their non-planning peers. These findings suggest that the relationship between breakfast planning, food insecurity, and student outcomes may be more complex, potentially influenced by factors such as time constraints, cooking skills, and access to food storage and preparation facilities.

1.6 Current factors affecting mental wellbeing

1.6.1 The COVID-19 pandemic

Although even before the COVID-19 pandemic, mental health disorders among university students were increasing in the UK (Chen and Lucock, 2022), the COVID-19 pandemic spread rapidly and had a greater influence on student mental health (Campbell et al., 2022; Chen and Lucock, 2022). Young adults (ages 18–25) and females were particularly vulnerable to mental wellbeing disorders (Campbell et al., 2022; Son et al., 2020; Savage et al., 2020; Chen and Lucock, 2022). Indeed, numerous of studies have investigated the effect of the pandemic on university students' mental health. Early data showed that COVID-19 affected the mental health of university students by increasing stress, anxiety, and depression among 71% in the USA (Son et al., 2020), 64% in Canada (Statistics Canada, 2020), 25% in China (Cao et al., 2020), and 74.3% in Greece (Kaparounaki et al., 2020). This led to a high rate of reporting clinical disorder

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cases, such as a 25-to-3-fold increase in depression and an 8-fold increase in suicide, which harmfully impacted their quality of life (Kaparounaki et al., 2020) and students' academic performance (Barbayannis et al., 2022).

In the UK, a major cross-sectional survey of 53,351 adults was undertaken to measure mental health using the 12-item General Health Questionnaire, and it was discovered that mental health disorders had increased from 18.9% in 2018–2019 to 27.3% in April 2020, just one month into the COVID-19 pandemic (Hubbard et al., 2021). Also, in a survey by the National Union of Students of university students, 52% rated their mental health and wellbeing as worse than before the pandemic. In addition, another survey conducted among students by the Student Covid Insight Survey in November 2020 found that 57% of students stated that their wellbeing and mental health had deteriorated since the beginning of the autumn term, with a decrease in happiness and satisfaction in life and higher levels of anxiety when compared to the general population (Chen and Lucock 2022). Moreover, a longitudinal study found that a third of 254 university students at one UK university might have been classified as clinically depressed during lockdown, up from 15% before the pandemic (Evans et al., 2021). This increase in mental wellbeing disorders may be due to the response to COVID-19, as countries around the world took various measures in response to this pandemic. In the UK, for instance, the government implemented a lockdown throughout the country, except for vital activities. As a result, universities across the country closed their campuses and transitioned to online

teaching (Savage et al., 2020), cancelling exchange studies and graduation ceremonies (Chen and Lucock, 2022). This consequently resulted in the closure of university eating halls and cafeterias, causing many university students to purchase and prepare their own meals (Owens et al., 2020). These students might also lack food literacy and the resources necessary for appropriate meal preparation, which could increase the risk of food insecurity (Marques et al., 2022).

Furthermore, the most unfavourable changes in eating behaviour occurred more frequently among younger students, particularly first-year students who were at risk of food insecurity (Marques et al., 2022; Abbey et al., 2022). This was due to restricted financial resources, weaker purchasing power, rising housing and food costs (El Zein et al., 2019), and coping with substantial life changes for the first time, such as abandoning their term-time residences (Savage et al., 2020). Other consequences of COVID-19 restrictions include the loss of jobs and increasing uncertainty about finding alternative jobs, particularly in the hospitality sector (restaurants and bars), which was one of the most severely impacted economic sectors during the COVID-19 pandemic (Savage et al., 2020). Also, the lockdown and social isolation, government-enforced movement restrictions, and social distancing orders resulted in fewer opportunities for networking and forming relationships, as well as a higher dependence on social media and the possibility of chronic loneliness driven by social isolation (Savage et al., 2020; Chen and Lucock, 2022). These changes to students' living and studying arrangements were predicted to have a negative

influence on their mental health (Savage et al., 2020; Kakaei et al., 2022), which increased global concerns about nutritional (Kakaei et al., 2022; Savage et al., 2020; Owens et al., 2020; DeBate et al., 2021; Hagedorn et al., 2022) and mental wellbeing (Savage et al., 2020).

1.6.2 The cost of living in the UK

The cost-of-living crisis in the UK has worsened since early 2021 (Harari et al., 2022), with 9 out of 10 adults (93%) reporting that their cost of living had increased compared to the previous year (Hill et al., 2023). Similar figures were reported by the ONS in its Student Cost of Living Insights Study, which surveyed 4,201 university students in England between October and November 2022 (Lewis, 2022).
This cost-of-living crisis has led to payment resources such as salaries and welfare failing to keep up with rising costs (England et al., 2023), causing serious financial strain and difficulty in finding jobs (Andersen and Reeves, 2022). This is negatively affecting health outcomes, as 19% of adults stated it had a detrimental effect on their physical health, whereas 44% stated it harmed their mental health (Hill et al., 2023; Andersen and Reeves, 2022). These effects on health and wellbeing will probably last for generations (Hill et al., 2023). This increasing strain on budgets makes it more difficult for individuals to afford the basics, and this is commonly referred to as a "cost of living crisis" and described as a 'public health emergency' (Hill et al., 2023).

The cost of living is defined according to the think-tank Institute for Government, as "the fall in real disposable incomes (that is, adjusted for inflation and after taxes and benefits)" (Hourston, 2022). According to recent predictions by the UN Conference on Trade and Development, the global economy will grow by a percentage point less than predicted. The World Bank's recent Commodity Markets Outlook study states that the war in Ukraine has dealt a major shock to commodity markets, altering global patterns of trade, production, and consumption in ways that will keep prices at historically high levels through the end of 2024 (Keith, 2022). The crisis could also be related to policies such as subsidy cuts or the Common Agricultural Policy, as well as unresolved issues with food imports versus UK self-sufficiency (Dowler et al., 2011).

In line with the cost-of-living rise, there has been an increase in residential rent prices, with rental accommodations increasing by 3.8% in the year ending October 2022. This is the highest yearly growth rate recorded for the UK in the ONS series since January 2016, and this may affect university students (Francis-Devine et al., 2022). Also, food and energy price increases have an impact on disparities. According to the Office for National Statistics (ONS) (House of Lords Library, 2023), food and non-alcoholic beverage prices rose by 9.8% in 2022 (Harari et al., 2022) and 16.9% in 2023 (Harari et al., 2022), with the Bank of England expecting inflation to remain above 10% in the near future (Gorb, 2022). This is potentially increasing poverty and food insecurity (Andersen and Reeves, 2022).

In the academic year 2021, one in ten university students reported using a foodbank, and 47% claimed that "money worries" had a detrimental impact on their meals and food consumption. This led to 62% of students reporting spending less on food and necessities (Lewis, 2022). Resulting in students incurring more debt and relying more on credit cards. According to the ONS, one out of every four students had incurred new debt in the previous year as a result of increased borrowing and credit usage, as one in three students uses credit cards to help with daily expenses, which can harm their mental health (Lewis, 2022).

This negative impact of the rising cost of living in the UK was more pronounced among younger adults, as they felt worried and unable to cope with this difficult situation (Hill et al., 2023). Longitudinal epidemiological studies show that economic crises are harmful to individuals' mental health, with those from low-income backgrounds, seeming especially at risk (England et al., 2023). This could be because those from low-income backgrounds spend a greater proportion of their income on energy and food than those from average backgrounds; consequently, rises in prices will likely have a greater impact on them and make them more vulnerable to inflationary pressures (Francis-Devine et al., 2022; England et al., 2023).

Therefore, the cost-of-living crisis is causing stress and anxiety, and as a consequence, numerous individuals are changing their behaviours to make ends meet, including cutting out essentials such as food and heating. These behavioural changes may have additional negative impacts on health and

wellbeing, such as a lack of nutrition and less capacity to interact with others. It is critical that addressing the root causes of disparities remains at the top of the health and wellbeing agenda (Hill et al., 2023).

1.7 Statement of the problem

The transition from high school to university represents a critical juncture in the lives of young adults aged 18 to 25, characterised by profound changes and multifaceted challenges (Itani et al., 2022). This period, extensively investigated and acknowledged as pivotal for student success and wellbeing (Fisher and Hood, 1987), paradoxically poses significant risks to mental wellbeing and academic achievement (Young et al., 2020).

As students embark on independent living, often in unfamiliar environments (Maillet and Grouzet 2023; Langella, 2016), they face a complex array of academic, financial, and psychosocial responsibilities. These challenges are compounded by the need to rapidly develop independence in learning and living conditions (Deliens et al., 2014; Wang et al., 2022), often while still lacking the cognitive maturity essential for adulthood (Wang et al., 2022).

The mental wellbeing implications of this transition are profound. Classified as an 'acute stressor' (Cage et al., 2021), this period can adversely affect attention, cognition, and mindfulness, factors closely linked to academic performance (Irie et al., 2019). A WHO survey across 21 countries revealed a higher prevalence of mental disorders at the onset of university studies, with 20.3% of students reporting 12-month mental disorders (Auerbach et al., 2016; Bantjes et al., 2019).

Financial pressures exacerbate these challenges. Rising tuition fees, coupled with the need to manage personal expenses (Belfield et al., 2017), create significant stress. This financial strain often leads to poor dietary habits, as students struggle with food accessibility and budgeting (Maillet and Grouzet, 2023; Deliens et al., 2014), potentially leading to food insecurity (Itani et al., 2022).

External factors have further intensified these issues. The COVID-19 pandemic has disproportionately affected vulnerable populations, including university students (Defeyter et al., 2020). Moreover, the recent surge in the UK's cost of living has particularly impacted students' mental wellbeing (Harari et al., 2022; Neves and Stephenson, 2023). These factors, combined with reduced government funding, have substantially increased the financial burden on students (Macaskill, 2013; Belfield et al., 2017), potentially jeopardising their academic persistence (Langella, 2016).

Despite the urgency of these issues, a significant knowledge gap persists regarding the specific factors affecting UK university students' mental wellbeing. While the UK Psychiatric Morbidity Survey and a 2019 National Institute for Health and Care Excellence study have revealed alarming trends in student mental health (NICE, 2020), research on specific health and wellbeing factors remains limited, particularly concerning the roles of breakfast consumption and food insecurity.

To address this issue, this thesis adopts a comprehensive, multi-faceted approach, analysing data collected from 2019 to 2023. The research specifically

investigates the impact of breakfast consumption on cognitive functions, the prevalence of food insecurity, and their relationship to mental wellbeing among UK university students. By focusing on these interconnected aspects, this study aims to provide a nuanced understanding of student wellbeing and inform evidence-based interventions and policies. This research aligns with the UN's 2030 sustainable development goals for mental wellbeing (UN, 2023) and responds to the urgent call for action to support student health and wellbeing (Defeyter et al., 2020). By elucidating the complex factors affecting student mental health during this critical transition, this thesis seeks to contribute meaningfully to the development of targeted support strategies for UK university students.

1.7.1 Aim and objectives

This thesis aimed to identify and assess factors affecting mental wellbeing among UK university students by investigating the impact of breakfast consumption on cognitive functions, the prevalence of food insecurity, and their relationship to mental wellbeing.

objectives

- A systematic review aimed to systematically evaluate published studies to determine whether skipping breakfast is detrimental to cognitive performance in university students (Chapter 2).
- A cross-sectional study aimed to examine the potential impact of breakfast consumption on cognitive functions among Nottingham first-year university students, and to explore the effects of different

breakfast compositions (carbohydrates, protein, and fat) and glycaemic load levels on cognitive functions (Chapter 3).

- A cross-sectional study aimed to examine the prevalence of food insecurity among UK university students, determine potential drivers, and assess how it affects mental wellbeing and students' ability to cope (Chapter 4).

- A pilot study aimed to determine whether a nutrition and culinary education intervention focused on preparing nutritious meals on a budget with limited cooking facilities can reduce food insecurity and subsequently improve mental wellbeing and food intake among food insecure university students (Chapter 5).

1.7.2 Research questions

In line with the above-stated objectives, the principal motivation of the present study was to investigate the following questions:

1. Is skipping breakfast detrimental to cognitive performance in university students?

2. How does breakfast consumption, including different compositions of macronutrients (carbohydrates, protein, and fat), and glycaemic load levels, impact cognitive functions among first-year university students at the University of Nottingham?

3. What is the prevalence and what are the potential drivers of food insecurity among UK university students, and how does it affect their mental wellbeing and ability to cope with stress?

4. Can a nutrition and culinary education intervention focused on preparing nutritious meals on a budget with limited cooking facilities reduce food insecurity and subsequently improve mental wellbeing among food insecure university students?

Chapter 2 - Breakfast Consumption and Cognitive Performance in University Students: A Systematic Review

2.1 Introduction

Cognition, encompassing processes such as attention, memory, problem-solving, and decision-making, is crucial for academic success in higher education. The relationship between nutrition and cognitive performance has gained significant attention, with breakfast often regarded as the most essential meal of the day (Cooper et al., 2011). However, breakfast consumption patterns among young adults, particularly university students, have raised concerns.

Research indicates that breakfast intake is less than 20% in the younger population and tends to decline as adolescents age. At the university level, approximately one-third of students skip breakfast (Sámano et al., 2019). This trend is concerning, as skipping breakfast has been associated with various negative outcomes. Studies have linked skipping breakfast for two or more days per week to poor mental health (Lee and Kim, 2019; Zahedi et al., 2022; Chang et al., 2021) and impaired cognitive functions (Masoomi et al., 2020).

The cognitive implications of breakfast skipping appear to be significant. Consistent breakfast skipping has been associated with long-lasting reductions in IQ (Stevenson and Prescott, 2014), poorer performance in intelligence quotient tests, and lower academic achievements (Bakhtiyari et al., 2020; Ze-Yu et al., 2017; Nishiyama et al., 2013; Pengpid and Peltzer, 2020). Conversely,

regular breakfast consumption has been related to optimal physiological, psychological, and social health (Sámano et al., 2019).

While the benefits of breakfast consumption have been well-documented among children (Hasz and Lamport, 2012) and adolescents (Rani et al., 2021; Gratão et al., 2022), the evidence for university students is less conclusive. Some studies suggest that breakfast consumers demonstrate improvements in cognitive functions, increased physical activity (López-Gil et al., 2022), and better academic performance (Rani et al., 2021; Gratão et al., 2022; Lytle et al., 2000). The hypothesis that difficult tasks demand more energy consumption in the brain (Sámano et al., 2019) has led to suggestions that breakfast consumption has a short-term favourable influence on core cognitive processes (Mullan and Singh, 2010; Sámano et al., 2019). However, the relationship between breakfast consumption and cognitive performance in university students remains complex, with conflicting findings reported in the literature. Given the importance of cognitive performance for academic success and the prevalence of breakfast skipping among university students, a comprehensive systematic review of existing research is necessary.

Current debates and trends in breakfast and cognition research focus on several key areas. One ongoing discussion centre on the optimal composition of breakfast for cognitive enhancement, with some researchers advocating for high-protein breakfasts (Leidy et al., 2015), while others emphasize the importance of low-glycaemic index carbohydrates (Micha et al., 2011). Another trend is the investigation of chrono-nutrition, which explores how the timing of

breakfast consumption interacts with circadian rhythms to affect cognitive performance (Chtourou et al., 2019). Additionally, there's growing interest in personalized nutrition approaches, recognizing that the cognitive effects of breakfast may vary based on individual factors such as genetic predisposition, gut microbiome composition, and habitual dietary patterns (Gibney et al., 2018).

2.1.1 Breakfast and cognition

Several studies have found that cognitive functions improve after breakfast consumption (Hasz and Lamport, 2012). Cognitive function is a comprehensive term that relates to the mental processes involved in knowledge acquisition, information manipulation, and thinking. These processes include perception, memory, learning, attention, decision-making, and linguistic abilities as examples of cognitive functioning (Kiely, 2014). More broadly 'cognition' refers to all processes linked to thinking, understanding, problem-solving, assimilating, recalling, and expressing (Arora, 2022). While cognitive functions such as memory, reasoning, and attention are key components, they are part of a complex mechanism that contributes to overall mental ability (Bellisle, 2004). Additionally, cognitive health includes thinking, learning, and remembering, as well as making and controlling movements, including balance; the emotional function of understanding and responding to emotions; and the tactile function of feeling and responding to sensations of touch (Arora, 2022).

Research has consistently indicated an association between breakfast consumption and cognitive functions (Spence, 2017), including speaking

fluency, mood (Rani et al., 2021; Wyon et al., 1997), enhanced memory and attention (Rani et al., 2021; Mahoney et al., 2005; Wesnes et al., 2003; Benton and Parker, 1998), and increased mental function (Mahoney et al., 2005). These improvements reflected better academic performance compared to those who skipped breakfast (Wesnes et al., 2003; Benton and Parker, 1998; Laird et al., 2016).

Short-term studies have demonstrated varying effects of breakfast consumption on cognitive functions, depending on the specific cognitive domains measured. For instance, breakfast eating showed improvement in cognitive function, mood, and blood glucose concentration among schoolchildren (12–15 years) through increased accuracy in the visual search test and the Stroop test (Vingerhoeds, 2015). Similarly, in adolescents (13–20 years old), accuracy in conducting a visual search test was significantly greater after breakfast consumption, and performance was better maintained throughout the morning during the Stroop test compared to those who skipped breakfast (Cooper et al., 2011).

Research suggests that the timing of breakfast consumption may play a significant role in cognitive performance. Studies have found that consuming breakfast immediately after waking led to better cognitive performance in the morning compared to delaying breakfast by several hours. This early breakfast consumption was also associated with better glucose regulation (Defeyter and Russo, 2013; Gibney et al., 2018). In the context of university students, those who consumed breakfast earlier in the morning demonstrated better GPA

compared to those who ate breakfast later or skipped it entirely (Ogata and Kayaba, 2019). These findings underscore the importance of not only consuming breakfast but also considering the timing of consumption for optimal cognitive benefits.

Long-term studies have also revealed positive effects. Lien (2007) conducted a 7-year follow-up study on adolescents and found that those who regularly consumed breakfast had better mental health outcomes in young adulthood compared to those who habitually skipped breakfast. Furthermore, Smith et al. (2010) examined the relationship between breakfast consumption and cognitive performance over a 20-year period, finding that individuals who consistently consumed breakfast throughout the study period had better cognitive function, particularly in areas of memory and executive function, compared to those who regularly skipped breakfast.

Despite the numerous studies showing positive effects, some research has found no significant impact of breakfast on cognitive functions across various age groups. This includes studies on children and adolescents (Fulford et al., 2016; Iovino et al., 2016) as well as university students (Liyanage et al., 2017; Sámano et al., 2019; Emilien et al., 2017). Several factors may contribute to these inconsistent results. Firstly, the benefits of breakfast may be more pronounced in undernourished children, suggesting that nutritional status plays a crucial role in the cognitive effects of breakfast (Iovino et al., 2016; Rogers, 2016). Secondly, the wide variety of cognitive and psychological tests

used across studies makes direct comparisons challenging and may contribute to inconsistent findings (Hoyland et al., 2009).

Moreover, age-related differences in glucose metabolism could significantly influence the cognitive effects of breakfast. Neuroanatomical research has revealed that glucose and insulin metabolism vary between younger and older individuals. Children and young teens require more glucose than those aged 16 and above (Boschloo et al., 2012), and their brains use more than 50% of the body's oxygen (Hoyland et al., 2009). This heightened glucose demand is attributed to children's larger brain-to-liver ratio compared to adults, which limits their ability to store nutrients during fasting periods (O'Sullivan et al., 2009). These physiological differences underscore the importance of considering age when evaluating the cognitive effects of breakfast. They may explain why some studies find stronger effects in younger populations and highlight the need for age-specific research and interventions regarding breakfast consumption and cognitive performance.

Overall, the impact of breakfast on cognitive function provides mixed evidence, potentially due to the lack of a clear definition for breakfast, different nutritional qualities examined, varied cognitive domains and tests used, and age differences. This inconsistency is similar to the contradictory findings in studies examining the link between breakfast skipping and obesity (Rogers, 2016). Therefore, research evidence must be assessed objectively and comprehensively to provide conclusive evidence about the value of breakfast for cognitive functions.

2.1.2 Type of breakfast and cognitive functions

The composition of breakfast plays a crucial role in cognitive performance. Different macronutrients uniquely contribute to brain function and energy metabolism, influencing cognitive function through various mechanisms. The type and quality of breakfast components, including their glycaemic characteristics, significantly impact cognitive outcomes (Sihvola et al., 2013; Deshmukh-Taskar et al., 2010). Understanding the distinct effects of carbohydrates, proteins, and fats highlights the importance of a balanced breakfast for optimal brain function.

Consuming carbohydrates for breakfast helps replace glucose levels in the brain after an overnight fast, thereby enhancing cognitive performance, attention, and memory recall (Nilsson et al., 2012). Glucose, as the primary energy source for the brain (Mergenthaler et al., 2013), significantly influences food-induced cognitive performance. However, the type and quality of carbohydrates matter. High glycaemic load (GL) carbohydrates cause rapid fluctuations in blood sugar levels, while low-GL carbohydrates provide a steadier glucose release, promoting sustained cognitive function (Smith and Foster 2008). This steadier release results in reduced volatility in plasma glucose and insulin concentrations, leading to less metabolic stress and potentially benefiting cognition (Sihvola et al., 2013).

Complementing carbohydrates, high-protein breakfast meals offer multiple benefits. They not only improve cognitive functions (Hutchison et al., 2014; Zeng et al., 2011; Mahoney et al., 2005) but also help control appetite, weight,

and energy intake (Leidy, 2013). Proteins suppress appetite-regulating hormones like ghrelin while increasing satiety hormones such as peptide YY and Glucagon-Like Peptide-1 (GLP-1) (Blom et al., 2006; Batterham et al., 2006). Moreover, protein has a higher thermic effect of food compared to carbohydrates or fats, expending more energy during digestion and metabolism (Westerterp-Plantenga et al., 2009). The cognitive benefits of protein-rich meals extend beyond energy regulation. These meals are often nutrient-dense, providing essential vitamins, minerals, and amino acids. Amino acids serve as building blocks for neurotransmitters in the brain, boosting concentration and regulating mood and cognitive function (Du et al., 2018). By encouraging the consumption of nutrient-dense foods, including protein in breakfast can improve overall diet quality (Mozaffarian et al., 2011).

In contrast, diets high in saturated and trans fats have been associated with cognitive decline and increased risk of neurodegenerative diseases (Morris et al., 2004). A breakfast high in these fats may lead to decreased cerebral blood flow and increased inflammation, potentially impairing cognitive function in the short term (Baynham et al., 2023). However, it's important to distinguish between different types of fats and their effects on brain function. While high-fat breakfasts have been associated with impaired cognitive performance, omega-3 fatty acids, particularly docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), may have beneficial effects on cognitive function. These fatty acids are crucial for brain health, supporting neuronal membrane fluidity, synaptic plasticity, and neurotransmitter function (Gómez-Pinilla, 2008). Including sources of omega-3s in breakfast, such as fatty fish, flaxseeds,

or walnuts, may contribute to improved cognitive performance and long-term brain health. Furthermore, well-balanced meals with adequate carbohydrates, proteins, and fats demonstrate better cognitive performance throughout the day (Mahoney et al., 2005).

While the specific optimal breakfast for cognitive functions remains unclear, the nutritional quality of breakfast appears crucial for students' learning ability and overall mental wellbeing (Hasz and Lamport, 2012; O'Sullivan et al., 2009). However, the inconsistent results regarding the most beneficial type of breakfast might be due to the complexity of cognitive task performance, influenced by factors such as individual skill level, motivation, arousal, prior knowledge, fatigue, and time of day (Bellisle, 2004). The challenge in drawing conclusive evidence is further compounded by the fact that most studies focus on nutritional content rather than actual food types, making it difficult to draw conclusions about specific breakfast types (Delley and Brunner, 2019). Future research should focus on understanding dietary patterns and their effects on cognitive functioning and nutritional intake (Ramsay et al., 2018), considering both quantity and quality of breakfast meals (Tang et al., 2017). This approach could help determine the value of breakfast for university students' cognitive functions, academic achievement, and overall mental wellbeing (Lee and Kim, 2019; Zahedi et al., 2022).

2.2 Aim and objectives

Indeed, the relationship between breakfast consumption or breakfast composition and cognition has been investigated, but these studies have

primarily focused on children or adolescents (Hoyland et al., 2009). In contrast, for adults, convincing data on the necessity of breakfast remains insufficient (Sihvola et al., 2013). Therefore, this systematic review aimed to systematically evaluate published studies to determine whether skipping breakfast is detrimental to cognitive performance in university students.

Objectives

- To examine the impact of breakfast types on cognitive functions.

- To explore the prevalence of skipping breakfast among university students.

2.3 Materials and methods

This review was constructed using the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) (Moher et al., 2015).

2.3.1 Search strategy and selection criteria

A computerised search of the literature was conducted using five electronic databases (PubMed, Web of Science, Scopus, Google Scholar, and Refseek) between December 2019 and April 2023. Relevant articles were obtained using defined keywords with appropriate truncations and Medical Subject Headings (Table 2.1). All database searches were refined by "Human, Adult (aged ≥ 18) and English language".

EndNote™ online was used to save identified relevant studies, and duplicates were subsequently removed. To reduce potential bias, after the initial title

screening, abstracts and full papers were reviewed by three independent researchers (AA, LC, and PJ) using strict inclusion and exclusion criteria. Furthermore, additional relevant articles were sourced from the reference lists of the included studies.

Table 2.1: Search statements used to obtain relevant articles.

Breakfast manipulation	Outcomes	Population
Breakfast, first meal, morning meal, breakfast program.	AND "cognit*" OR attent* OR academic performance OR mood, recall, speed, reaction time, memory.	University students ≥ 18 years, and any gender, academics.

2.3.2 Inclusion and exclusion criteria

In this review, searches were not refined by date, but only articles with full paper availability and in English were considered for inclusion. The searching process followed the Population (P), Intervention (I), Comparison (C), and Outcomes (O; PICO) framework.

2.3.2.1 Population

The population consisted of healthy university students (individuals who do not have chronic health conditions) aged ≥ 18 years and of either sex. Studies were excluded if participants were (i) children/adolescents under the age of 18, (ii) adults who were not undertaking university studies, and/or (iii) adults who had underlying health conditions such as diabetes, cardiovascular disease, or cancer.

2.3.2.2 Intervention

The intervention included studies that described breakfast as the first meal or food consumed in the morning, usually following a night of fasting. This could include consumption of any type of breakfast, different breakfast compositions (e.g., high-carbohydrate, high-protein, balanced), and various breakfast timing.

2.3.2.3 Comparison

The comparison component included studies that examined different types of breakfast manipulation, including comparisons between consumption and no consumption (breakfast skipping), and among various breakfast compositions (e.g., main meals, drinks, or snacks) as well as evaluation of their effects on cognitive functions.

2.3.2.4 Outcomes

Outcomes were categorised as follows:

Primary outcome:

- Any cognitive domains (including memory, attention, accuracy, mood, speed of encoding of information, mental distress, fatigue, or academic performance) in relation to consuming or skipping breakfast.

Secondary outcomes:

- Effects of any breakfast types (specifically varying amounts of protein and carbohydrates) on cognitive functioning

- The prevalence of breakfast skipping among university students

2.3.3 Data extraction, and tabulation of studies

Data extraction was completed independently. A standard data extraction form was used to obtain the data from the studies and charted using Excel (Microsoft Excel, Washington, USA). The extracted data included authors, years, country of origin, study design, populations, number of enrolled, age, details of follow-up, outcome measurements of the effect of breakfast consumption on cognitive functions, exposure measures of the association between having breakfast or not on cognitive performance in university students, and significant results. These data were extracted individually. The extraction process was guided by the research question, "How does consuming breakfast influence a university student's attention ability and cognitive performance?". Tables 2.2 and 2.3 were produced to summarise the main characteristics of the included studies.

2.3.4 Quality assessment

To assess the quality of the selected studies and mitigate the risk of bias in this review, the Newcastle-Ottawa Scale (NOS) (Wells et al., 2000) was employed. According to Luchini et al. (2017), the NOS is one of the most commonly used tools worldwide for assessing study quality. While it has some limitations, it remains a validated and reliable tool.

The scale provides up to nine points as a maximum for the risk of bias in three domains: 1) selection (four points); 2) comparability (two points); and 3) exposure and outcome assessment (three points) for case-control and cohort

studies, respectively. We used the cohort scale for observational studies and the case-control scale for interventional studies. Some adjustments were made to these elements to ensure they were validated and aligned with the included studies.

In more detail, first, the NOS for Cohort Studies consists of three main domains to score the quality of studies, which are:

1. **Selection** includes representativeness of the exposed cohort, selection of the non-exposed cohort, ascertainment of exposure, and outcomes of interest.

2. **Comparability** includes comparability of cohorts on the basis of design or analysis.

3. **Outcome** includes assessment of outcomes, length of follow-up for outcomes, and adequacy of follow-up.

Each element earns a maximum of one star for each numbered item within the Selection and Outcome categories. The Comparability category can earn up to two stars: one for the most important factor and another for a second factor. Using these stars, the quality of the studies was categorised as good, fair, or poor. We modified the total stars to align with the observational studies. A "good" quality score requires 3–4 stars in the selection, 1-2 star(s) in the comparability, and 1-2 star(s) in the outcomes. A "fair" quality score requires 2-3 stars in the selection, 1-2-star(s) in the comparability, and 0-1 star in the

outcomes. A "poor" quality score requires 1-2 star(s) in the selection, 1-2 star(s) in the comparability, and 0 stars in the outcomes.

Second, the NOS for Case-Control Studies also consists of three main domains to score the quality of studies, which are:

1. **Selection** includes case definition adequate, representativeness of the cases, selection of controls, and definition of controls.

2. **Comparability** includes comparability of cases and controls on the basis of the design or analysis.

3. **Exposure** includes ascertainment of exposure, same method of ascertainment for cases and controls, and non-response rate.

Similar rules were applied to the distribution of the stars in the case-control studies as in the cohort studies. Each element earns a maximum of one star for each numbered item within the Selection and Exposure categories. The Comparability category can earn up to two stars: one for the most important factor and another for a second factor. However, for the study quality levels (good, fair, and poor), we modified the total stars to align with the interventional studies. A "good" quality score requires 3–4 stars in the selection, 1-2 star(s) in the comparability, and 2-3 star(s) in the exposure. A "fair" quality score requires 2-3 stars in the selection, 1-2 star(s) in the comparability, and 1-2 star(s) in the exposure. A "poor" quality score requires 1-2 star(s) in the selection, 0-1 star in the comparability, and 0 stars in the exposure.

2.4 Results

The initial independent search by reviewers identified 61 articles following the inclusion criteria using the five databases. After adjusting for duplicates and reviewing the titles and abstracts, 19 articles were excluded. The remaining 40 articles were examined in more depth, and 22 studies did not meet the inclusion criteria for the reasons provided in Figure 2.1. A total of 18 articles published between 1999 and 2020 were identified as meeting our inclusion criteria. Seven of these studies were observational (Kerwani et al., 2020; Sámano et al., 2019; Abbas et al., 2017; Lipsa et al., 2017; Liyanage et al., 2017; Khanna et al., 2016; Ackuaku-Dogbe and Abaidoo, 2014), published over a six-year period (2014–2020) and eleven were interventional (Taheri et al., 2019; González-Garrido et al., 2018; Emilien et al., 2017; Hutchison et al., 2014; Zeng et al., 2011; Schroll, 2006; Nabb and Benton, 2006; Fischer et al., 2002; Benton et al., 2003; Benton et al., 2001; Smith et al., 1999) published over a twenty-year period (1999–2019).

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┌─────────────┐   ┌──────────────────────────┐
│             │   │  Records identified through │
│Identification│   │    database searching       │
│             │   │        (n= 61)              │
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│  Screening  │   └──────────────────────────┘
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│             │   │     (n = 59)       │      │   (n =19)     │
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│             │   │Full-text articles │─────▶│ 22 Excluded due to:     │
│ Eligibility │   │assessed for       │      │                         │
│             │   │eligibility        │      │(9) Full text not in English│
│             │   │   (n = 40)        │      │(3) Full-text unavailable │
└─────────────┘   └──────────────────┘      │(4) PhD/MA thesis         │
                              │              │(6) Other exposure related│
                              ▼              │to breakfast and other    │
┌─────────────┐   ┌──────────────────┐      │measurements              │
│             │   │Studies included in │      └────────────────────────┘
│  Included   │   │qualitative         │
│             │   │synthesis           │
│             │   │   (n = 18)         │
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Figure 2.1: Flow diagram for Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) for included studies (Moher et al., 2015).

2.4.1 Evaluation of studies; quality assessment

The Newcastle-Ottawa Assessment Scale (NOS) was used to assess the quality of the included studies to avoid bias. It includes two types of scales: the NOS of cohort studies for an observational study design approach and the NOS of case-control studies for an interventional study design approach. Tables 2.2 and 2.3 show that from all eighteen studies, the results of the quality analysis of the selected studies showed that nine studies (Kerwani et al., 2020; Khanna et al.,

2016; González-Garrido et al., 2018; Emilien et al., 2017; Hutchison et al., 2014; Zeng et al., 2011; Benton et al., 2003; Benton et al., 2001; Fischer et al., 2002) were considered to be good quality studies in both observational and interventional studies by achieving a high score of 5–6* and 7-9*, respectively.

The selection criteria of the scale in the observational studies showed that only one study, Khanna et al. (2016), obtained 4 stars due to recruiting students across different universities, followed by Kerwani et al. (2020), with 3 stars, while the remaining studies obtained 2 stars due to insufficient group representation. In the interventional studies, most of the studies met the selection criteria, except Nabb and Benton (2006), Schroll (2006), and Smith et al. (1999), as they did not provide sufficient descriptions in the selection criteria.

The four studies (Taheri et al., 2019; Nabb and Benton, 2006; Schroll, 2006; Smith et al., 1999) were deemed fair studies by receiving a score of 5 or 6* (Table 2.3). This is due to not providing adequate definitions for the samples according to the selection criteria of the scale with different response rates in the exposure. The remaining studies, Abbas et al. (2017), Ackuaku-Dogbe and Abaidoo (2014), Lipsa et al. (2017), Liyanage et al. (2017), and Sámano et al. (2019), were all rated as low-quality and received only 3 or 4* (Table 2.2).

In the comparability criteria, most of the studies obtained one star, except Hutchison et al. (2014), Benton et al. (2003), and Fischer et al. (2002), which obtained two stars as they examined two factors.

In the outcome criteria of the observational studies, Abbas et al. (2017), Ackuaku-Dogbe and Abaidoo (2014), Liyanage et al. (2017), Lipsa et al. (2017), and Sámano et al. (2019) used self-reported questionnaires, while Kerwani et al. (2020) and Khanna et al. (2016) used both structured interviews and self-reported questionnaires. None of the studies conducted follow-up studies, or they were outside the scope. In the exposure criteria for the interventional studies, most of the studies obtained three stars, except for five studies (Taheri et al., 2019; González-Garrido et al., 2018; Emilien et al., 2017; Nabb and Benton, 2006; Schroll, 2006), due to a lack of data in the ascertainment of exposure or response rate.

Table 2.2: Risk of bias assessment (Newcastle-Ottawa Quality Assessment Scale criteria) for observational studies.

Study ID	Selection				Comparability (**)		Outcome			Total (*)	Quality score
	Representativeness of exposed cohort (*)	Selection of non-exposed cohort (*)	Ascertainment of Exposure (*)	outcome of interest (*)	(**)	Assessment of outcome (*)	Outcome long (*)	Adequacy of follow up (*)			
Kerwani et al., 2020	Randomly selected group of medical undergraduate students in Odisha, India.	Yes (*)	Structured interview (*) (self-administered questionnaire+ an interviewer-administered for cognitive scales)	Yes (*)	The prevalence of skipping breakfast and it related to cognitive functions (*)	Self-report+ interview (*)	No follow up	No statement	5(*)	Good	
Abbas et al., 2017	Randomly a selected group 649 university students from the first, second, third, and fourth year in medical colleges at the University of Andalusia in Tartous, Syria.	Yes (*)	Questionnaires+ the fatigue scale. Students answered questionnaires in school during the day of a public lecture (Self-report) with the authors' assistance if needed.	Yes (*)	The impact of having breakfast on attention and concentration (*)	Self-report	No follow up	No statement	3(*)	Poor	
Lipsa et al., 2017	Selected group in the campus of Sambalpur University. 46 females.	Yes (*)	No description of the way of data collection from the questionnaire.	Yes (*)	The impact of skipping breakfast on memory and concentration (*)	Self-report	No follow up	No statement	3(*)	Poor	
Liyanage et al., 2017	Selected group. 150 final year medical students in 6 major specialties (Pediatrics, Medicine, Gynecology and Obstetrics, Surgery, Psychiatry and Family Medicine)	Yes (*)	Self-report questionnaire. & trail making test to assess cognitive aspects.	Yes (*)	The impact of breakfast habits on cognitive aspects (*).	Self-report	No follow up	No statement	3(*)	Poor	
Sámano et al., 2019	Selected group from Mexico City. 422 bachelor university students. Most students were from middle-income level.	Yes (*)	Questionnaire+ Stroop Test to assess cognition (No description of the data collection	Yes (*)	The relationship between nutritional quality of breakfast and cognitive interference (*)	Self-report.	No follow up	No statement	3(*)	Poor	

Study ID	Selection				Comparability (**)	Outcome			Total (*)	Quality score
	Representativeness of exposed cohort (*)	Selection of non-exposed cohort (*)	Ascertainment of Exposure (*)	outcome of interest (*)	(**)	Assessment of outcome (*)	Outcome long (*)	Adequacy of follow up (*)		
			from the questionnaires)							
Khanna et al., 2016	Somewhat representative of the average in the student's community. 206 random sample from 3 different universities across Pune. (*)	Yes (*)	Structured Interview (*) and self-administered questionnaires. Using two scales; Hopkins symptoms checklist-10 and mindful attention awareness scales.	Yes (*)	The impact of breakfast habits on mental distress and mindful attention awareness (*)	Self-report + interview (*)	No follow up	No statement	6(*)	Good
Ackuaku-Dogbe and Abaidoo, 2014	Selected group of 317 second-year medical students (pre-clinical studying basic sciences and clinical students in ophthalmology.	Yes (*)	Self-report	Yes (*)	The level of skipping a morning meal and its impact on attention and fatigue (*)	Self-report	No follow up	No statement	3(*)	Poor

Table 2.3: Risk of bias assessment (Newcastle-Ottawa Quality Assessment Scale criteria) for interventional studies.

Study ID	Selection				Comparability (**)	Exposure			Total (*)	Quality score
	Is the case definition adequate? (*)	Representativeness of the cases (*)	Selection of Controls (*)	Definition of Controls (*)	(**)	Ascertainment of exposure (*)	Same method of ascertainment for cases and controls (*)	Non-Response rate (*)		
Taheri et al., 2019	Yes *	Potential for selection biases or not stated	Community controls *	No history of disease *	The impact of breakfast consumption on inhibitory cognitive control *	No description	Yes*	Same rate of response *	6*	Fair
González-Garrido et al., 2018	Yes *	Healthy samples from the same area *	Community controls *	No history of disease *	The effect of having breakfast or not on cognitive processing *	No description	Yes*	Same rate of response *	7 *	Good
Emilien et al., 2017	Yes *	Healthy samples from the same area *	Community controls *	No history of disease *	The impact of different macronutrient breakfast contents on mood and cognitive performance *	Blind structured to case/control status *	Yes*	The rate of recruited participants was not the same for cases and controls	7*	Good
Hutchison et al., 2014	Yes*	Healthy samples from the same area *	Community controls *	No history of disease *	The impact of breakfast in cognitive performance * The possibility of linking it to glucose levels *	Blind structured to case/control status *	Yes*	Same rate of response *	9*	Good
Zeng et al., 2011	Yes *	Healthy samples from the same area *	Community controls *	No history of disease *	The impacts of HP breakfast on cognition including mood, alertness and attention *	Blind structured to case/control status *	Yes*	Same rate of response *	8*	Good
Nabb and Benton, 2006	No description	Healthy samples from the same area *	Community controls *	No description	The effect of glucose levels and changes in fibre and carbohydrate content in breakfast meals on mood and cognition *	Blind structured to case/control status *	Yes*	Rate different and no designation	5 *	Fair
Schroll, 2006	No description	Healthy samples from the same area *	Community controls *	No description	The impact of breakfast on short-term memory *	No description	Yes*	Same rate of response *	5 *	Fair

Study ID	Selection				Comparability (**)		Exposure			Total (*)	Quality score
	Is the case definition adequate? (*)	Representativeness of the cases (*)	Selection of Controls (*)	Definition of Controls (*)	(**)	Ascertainment of exposure (*)	Same method of ascertainment for cases and controls (*)	Non-Response rate (*)			
Benton et al., 2003	Yes *	Healthy samples from the same area *	Community controls *	No history of disease *	To assess the benefit of a low versus high GI breakfast on cognition in both humans and rats**	Blind structured to case/control status *	Yes*	Same rate of response *	9*	Good
Fischer et al., 2002	Yes *	Healthy samples from the same area *	Community controls *	No history of disease *	The influence of different ratios of carbohydrate to protein on cognitive functions and the relationship between postprandial metabolic and cognitive changes **	Blind structured to case/control status *	Yes*	Same rate of response *	9 *	Good
Benton et al., 2001	Yes *	Healthy samples from the same area *	Community controls *	No history of disease *	The effect of breakfast, and it interacts with a subsequent snack, on mood and memory in the morning *	Blind structured to case/control status *	Yes*	Same rate of response *	8 *	Good
Smith et al., 1999	No description	Healthy samples from the same area *	Community controls *	No description	The impacts of breakfast cereal and caffeinated coffee on working memory, attention, and mood *	Blind structured to case/control status *	Yes*	Same rate of response*	6*	Fair

2.4.2 Study characteristics

2.4.2.1 Geographical locations of the studies

Tables 2.4 and 2.5 provide a summary of all the study characteristics, both for the observational and interventional studies. The studies were conducted in various countries including China (Zeng et al., 2011), Ghana (Ackuaku-Dogbe and Abaidoo, 2014), India (Kerwani et al., 2020; Lipsa et al., 2017; Khanna et al., 2016), Iran (Taheri et al., 2019), Mexico (Sámano et al., 2019, González-Garrido et al., 2018), Sri Lanka (Liyanage et al., 2017), Syria (Abbas et al., 2017), UK (Nabb and Benton, 2006; Benton et al., 2003; Benton et al., 2001; and Smith et al., 1999), USA (Emilien et al., 2017; Hutchison et al., 2014; and Schroll, 2006) and Switzerland (Fischer et al., 2002).

2.4.2.2 Population of studies

The studies included a total of 2687 participants, with sample sizes ranging from 13 and 649. The mean age across all studies ranged from 20.0 ± 2.0 to 26.3 ± 3.6 years old. Of the 18 studies, 10 recruited both genders (Kerwani et al., 2020; Abbas et al., 2017; Liyanage et al., 2017; Sámano et al., 2019; Khanna et al., 2016; Ackuaku-Dogbe and Abaidoo, 2014; González-Garrido et al., 2018; Emilien et al., 2017; Hutchison et al., 2014; Smith et al., 1999); 4 others included females only (Lipsa et al., 2017, Nabb and Benton, 2006; Benton et al., 2003; Benton et al., 2001); 3 others included male students only (Taheri et al., 2019; Zeng et al., 2011; Fischer et al., 2002); and one didn't mention any gender (Schroll, 2006). Furthermore, 12 articles recruited only undergraduate students

(Kerwani et al. (2020); Abbas et al. (2017); Liyanage et al. (2017); Sámano et al. (2019); Ackuaku-Dogbe and Abaidoo (2014); González-Garrido et al. (2018); Emilien et al. (2017); Hutchison et al. (2014); Zeng et al. (2011); Nabb and Benton (2006); Benton et al. (2003); Benton et al. (2001); one recruited both undergraduate and postgraduate students (Khanna et al. (2016)); while one recruited only postgraduate students (Lipsa et al. (2017). The rest did not report the stage of study (Taheri et al. (2019), Schroll (2006), Fischer et al. (2002), and Smith et al. (1999)) (Tables 2.4 and 2.5).

2.4.2.3 Breakfast definition

We identified breakfast from each study in this review as a breakfast, snack, light meal, morning meal, or main meal. There was no reported definition of breakfast consumption or skipping in any of the included studies, but they described breakfast as the most essential meal of the day and one that comes after the longest period of fasting (Liyanage et al., 2017), with the requirement to contain 20–25% of the recommended daily total for energy and nutrients (Hasz and Lamport, 2012). It should include the following three components: (1) protein, (2) carbohydrates, and (3) vitamins (Aranceta-Bartrina et al., 2019). In contrast, skipping breakfast was interpreted as missing at least one morning meal from Monday to Saturday in a week (Liyanage et al., 2017).

2.4.2.4 Types of breakfast in studies

Many different types of breakfasts were used in the included studies, such as high protein/low carbohydrate, low protein/high carbohydrate, and

carbohydrate/no animal protein; breakfast meals with equal energy content but different ratios of carbohydrates and protein; breakfast cereal and caffeine; regular breakfasts; and various breakfast treatments with different amounts of protein and carbohydrate levels (Tables 2.4 and 2.5).

2.4.2.5 Measurement of cognitive functions

The studies in this review utilised various measurements of cognitive functions. These included questionnaires and a variety of scales, such as the Forward Digit Span to measure short-term memory, the Backward Digit Span to assess working memory, and the Mini-Mental Scale Examination to evaluate global cognitive function (Kerwani et al., 2020); the Hopkins Symptoms Checklist-10 to assess mental distress; the Mindful Attention Awareness Scale to assess mindful attention (Khanna et al., 2016); the Trail Making Test to measure attention (Liyanage et al., 2017); the Stroop Test to measure cognitive interference (Taheri et al., 2019; Sámano et al., 2019); and the Fatigue Scale to measure levels of fatigue (Abbas et al., 2017) (Tables 2.4 and 2.5).

2.4.3 Outcomes

2.4.3.1 Prevalence of skipping breakfast among university students

The prevalence of breakfast consumption among university students was only measured in six observational studies (Kerwani et al., 2020; Abbas et al., 2017; Ackuaku-Dogbe and Abaidoo, 2014; Khanna et al., 2016; Lipsa et al., 2017; and Liyanage et al., 2017). The findings of these studies showed that skipping breakfast was common and ranged from 33.3% to 71.92% (Table 2.4). These

studies found that not having enough time, waking up late, and financial issues were the most frequent reasons for skipping breakfast. Only four studies took gender into account when determining the prevalence of breakfast consumption. Ackuaku-Dogbe and Abaidoo (2014) and Khanna et al. (2016) found that female students were more likely than male students to skip breakfast, while Kerwani et al. (2020) and Abbas et al. (2017) found that male students tended to skip breakfast more frequently than female students.

2.4.3.2 Breakfast and cognition among university students

Out of the eighteen studies, fifteen (Kerwani et al., 2020; Abbas et al., 2017; Lipsa et al., 2017; Khanna et al., 2016; Ackuaku-Dogbe and Abaidoo, 2014; Taheri et al., 2019; González-Garrido et al., 2018; Hutchison et al., 2014; Zeng et al., 2011; Schroll 2006; Nabb and Benton, 2006; Fischer et al., 2002; Benton et al., 2003; Benton et al., 2001; Smith et al., 1999) showed that habitual breakfast consumption had beneficial effects on cognitive functions among university students. Despite these studies showing a positive effect of breakfast consumption on cognitive functions, there were differences in how they reported their results. This could be due to the different methodologies used, the different breakfast types examined, and the cognitive domains measured. However, the three remaining studies (Liyanage et al., 2017; Sámano et al., 2019; Emilien et al., 2017) revealed no connection between breakfast consumption and cognitive functions. Nevertheless, Sámano et al. (2019) linked the benefit of eating breakfast with a decrease in the time spent answering the

cognitive tasks but not with cognitive interference, attributing that finding to the nutritional quality of the breakfast (Table 2.6).

2.4.3.3 The impact of breakfast types on cognitive performance

Tables 2.4 and 2.5 show a summary of the methods and results of the studies on breakfast and cognitive functions. No breakfast types were measured in observational studies because all of them were cross-sectional and relied on administered questionnaires. Only one study, Sámano et al. (2019), measured how the nutritional quality of breakfast affected cognitive functions and found that the nutritional quality of breakfast was correlated with time spent answering the Stroop test but not with cognitive interference.

In the interventional studies, breakfasts and cognitive domains were measured in a variety of ways by providing breakfast meals to identify the differences in cognitive performance between students who consumed breakfast and those who did not, as well as the types of breakfast that were more beneficial for cognitive performance. Hutchison et al. (2014) investigated different types of breakfasts, including high protein/low carbohydrate, low protein/high carbohydrate, and carbohydrate/no animal protein. Their findings indicated that a low-carbohydrate, high-protein breakfast improved cognitive functions, particularly memory and verbal fluency. Zeng et al. (2011) examined breakfast meals equal in energy but with different contents of carbohydrates and protein and also found that a high-protein breakfast enhanced mood, alertness, and attention. Fischer et al. (2002) tested different ratios of carbohydrates and

protein (protein-rich, carbohydrate-rich, and a balanced breakfast) and discovered that memory was improved after consuming a protein-rich breakfast and reaction times were faster after the balanced meal. While attention and decision times improved within the first hour of consuming a carbohydrate-rich breakfast. Based on these results, protein-rich breakfasts improve performance, potentially due to less variation in glucose metabolism. Smith et al. (1999) examined the effects of breakfast cereal and caffeine and found that breakfast positively affected mood and memory, while caffeine improved the encoding of new information and counteracted fatigue. Similar findings were found by Taheri et al. (2019) when they examined the effects of breakfast cereal on cognition and found that it improved cognitive performance for inhibitory control. Benton et al. (2001), Nabb and Benton (2006), and Benton et al.'s (2003) studies examined the effects of different amounts of carbohydrates and changes in fibre and found that different amounts of carbohydrates affected mood and memory positively in those with better glucose tolerance. Schroll (2006) and González-Garrido et al. (2018) investigated regular breakfasts and found that regular breakfast consumption, regardless of the type of breakfast, was demonstrated to increase cognitive functions such as memory. However, Emilien et al. (2017) examined many breakfast treatments in terms of different amounts of protein and carbohydrate levels and found no significant difference in their effects on cognitive functions.

The majority of these studies were conducted as one-day experiments (Emilien et al., 2017; Hutchison, 2014; Zeng et al., 2011; Nabb and Benton, 2006; Benton

et al., 2001; Benton et al., 2003; Smith et al., 1999); two days (González-Garrido et al., 2018; Schroll, 2006); and the longest was one week (Taheri et al., 2019; Fischer et al., 2002).

2.4.3.4 Glucose and cognitive functions

Most of the included studies measured blood glucose levels to provide accurate results regarding cognitive functions, except for Taheri et al., 2019; Schroll, 2006; and Smith et al., 1999. In these studies, González-Garrido et al. (2018) found that increased glucose levels correlated with better cognitive performance after breakfast treatments. This could be due to the high glycaemic index of foods consumed, as Taheri et al. (2019) found similar results with a high glycaemic index breakfast on cognitive performance through cognitive inhibitory control. However, Nabb and Benton (2006) and Benton et al. (2001) revealed that the benefits of breakfast consumption and glucose levels on memory and mood were only observed in individuals with better glucose tolerance. Similar results were found by Fischer et al. (2002), Benton et al. (2003), and Hutchison et al. (2014), who found that a low glycaemic index breakfast such as low carbohydrate/high protein breakfasts improved cognitive functions through low blood glucose levels in those who had better glucose tolerance, considering time after breakfast consumption. As described by Benton et al. (2001), the advantages of breakfast on memory could be obtained just 20 minutes after consuming breakfast. In contrast, Benton et al. (2003) discovered that cognitive functions were associated with breakfast consumed later, between 150 and 210 minutes, similar results were discovered in rats, as

learning ability improved after 180 minutes with a low glycaemic index diet. Thus, even though these short-term favourable influences on cognition were inconsistent, this might relate to the different timing of glucose measurements and the type of breakfast consumed. Also, it seems that those with better glucose tolerance appear to be more receptive to breakfast's potential benefits for cognitive functions. See Tables 2.4 and 2.5.

Table 2.4: Summary of data extraction from observational studies.

Author, year & country of origin	Study Design	Population	N (number) enrolled	Analyzed and age at follow-up	Loss to follow up (any differences between groups?)	Outcome measures	Exposure measures	Effects and significances
Kerwani et al., 2020 India	A cross-sectional study, self-administered questionnaire + structured interview for cognitive scales: Forward Digit Span for short-term memory; Backward Digit Span for working memory; and Mini Mental Scale Examination for global cognitive function.	Medical undergraduate university students.	184 undergraduate students. Females comprised 57.1% of participants, more than males.	*Mean age of the participants 20.7 ± 1.4. *SPSS V20 was used for analysis.	No follow-up.	Prevalence of skipping breakfast +cognitive functions.	The prevalence of skipping breakfast and its association with different domains of cognitive functions.	The prevalence of skipping breakfast was 55.9%. All three cognitive scores (FDS, BDS and MMSE) were improved among those who consumed breakfast.
Sámano et al., 2019 Mexico City	A cross-sectional study, questionnaire + cognitive interference (Stroop Test).	Undergraduate university students.	422 students, 238 females, 184 males.	The mean age of the participants is 22 years old.	No follow-up.	Nutritional quality of breakfast and cognitive interference.	The relationship between nutritional quality of breakfast and cognitive interference.	The nutritional quality of breakfast was correlated with time spent answering the Stroop test, but not with cognitive interference.
Abbas et al., 2017 Syria.	A questionnaire + fatigue scale	Medical undergraduate university students.	649 undergraduate students. 380 males and 269 females.	*The study did not mention the participants' age *SPSS V22 was used for analysis.	No follow-up.	Breakfast prevalence+ Fatigue and academic performance.	The association between skipping breakfast and fatigue, concentration during lectures and academic performance.	The prevalence of skipping breakfast was 33.3%. 78% were tired when they did not eat breakfast compared to 90% who were active after consuming breakfast. 58.7% were unable to concentrate in lectures when they did not have breakfast, compared to 90.6% who were more concentrated after consuming their breakfast.

Author, year & country of origin	Study Design	Population	N (number) enrolled	Analyzed and age at follow-up	Loss to follow up (any differences between groups?)	Outcome measures	Exposure measures	Effects and significances
Lipsa et al., 2017 India	A cross-sectional study, questionnaire.	Postgraduate university students.	46 female post graduate university students.	The study did not mention the participants' age. Also, it did not mention statistical methods that have used.	No follow-up.	Eating breakfast and cognitive functions including memory attention.	The effect of skipping breakfast on memory and attention.	60.8% of the students reported that skipping breakfast has a negative effect on memory and 82.6 % agreed that they had difficulty focusing and working when they did not eat breakfast.
Liyanage et al., 2017 Sri Lanka	A cross-sectional study, self-administered questionnaire+ attention, task switching, speed of processing.	Medical undergraduate university students	121 university students, both genders.	*The mean age of the participants 25.5 years old. *SPSS V16 had used for analysis.	No follow-up.	Prevalence of breakfast consumption and its relation to cognitive functions.	The impact of breakfast habits and their association with cognitive aspects.	The prevalence of skipping breakfast was 55.4%. There were no significant differences in cognitive performance between students who consumed or did not consume breakfast.
Khanna et al., 2016 Pune, India	A cross-sectional study in 3 universities, (interviews, and a self-administered questionnaire) using Hopkins's Symptoms Checklist-10 (HSCL-10), and a mindful attention awareness scale.	Undergraduate and postgraduate university students.	206 university students 138 males and 68 females.	*The mean age of the participants 20.0 ± 2.0. *SPSS V22 was used for analysis.	No follow-up.	Influencing breakfast consumption on mental distress and mindful attention awareness.	The impact of breakfast eating habits on mental distress and mindful attention awareness.	The prevalence of skipping breakfast was 42.2%. A significant relationship between habitual breakfast consumption, mental distress, and mindful attention awareness. Consuming milk was linked with lower mental distress and improved attention.
Ackuaku-Dogbe and Abaidoo 2014 Ghana	A cross-sectional study, self-administered questionnaire.	Medical undergraduate university students.	317 undergraduate students. 203 males and 114 females.	*The mean age of the participants 22.1 ± 2.1. *SPSS V17 was used for analysis.	No follow-up.	Prevalence of skipping breakfast+ attention and fatigue.	The frequency of skipping breakfast and its impact on attention and fatigue levels during clinical sessions.	The prevalence of skipping breakfast was 71.9%. It was significantly related to fatigue and poor attention during clinical sessions.

Table 2.5: Summary of data extraction from interventional studies.

Author	Sample characteristics "Gender"	Mean age	Study design	Method measurements	Breakfast conditions	Outcome measurements	Results	Conclusion
Taheri et al., 2019 Iran	40 male university students (Not mention degree level).	21.3 years old.	Experimental study.	Breakfast manipulation, Stroop Interference Test.	A ready-to-eat breakfast cereal or no breakfast cereal in two experimental and control conditions. The breakfast meal contained a high glycemic index ready-to-eat breakfast (cereals and 125 ml skim milk: 200 kcal, 36 g carbohydrate, 5 g protein, 1.5 g fat, 1 g fiber, 22 g sugars).	Inhibitory cognitive control.	Breakfast consumption improved cognitive aspects.	Breakfast consumption has a positive effect in cognitive performance for inhibitory control.
González-Garrido et al., 2018 Mexico	20 undergraduates students (10 males, 10 females).	25.4 ± 2.8 years old.	Experimental study.	Blood glucose levels, 3 working memory tasks with varying cognitive load: 0-back, 1-back, and 2-back. Recording electrophysiological.	The performance assessed at three n-back working memory tasks in two morning sessions on both normal (after breakfast) and 12-hour fasting conditions.	Cognitive processing.	Skipping breakfast disturbed earlier cognitive processing steps, particularly attention allocation, early decoding in working memory, and stimulus evaluation. This effect increases with task difficulty.	Skipping breakfast affects earlier cognitive processing steps negatively.
Emilien et al., 2017 USA	33 undergraduate students, 19 males and 14 females.	22.0 ± 2.0 years old.	Randomized, counterbalanced crossover design.	Blood samples, questionnaire, food intake, cognitive functions.	No breakfast (NB), low protein/high carbohydrate—no animal protein (LP/HC-NAP), low protein/high carbohydrate—with animal protein (LP/HC-AP) or high protein/low carbohydrate—with animal protein (HP/LC).	Cognitive performance.	No statistically significant effected of breakfast on cognitive performance.	Changing the macronutrient content of breakfast influences the glycaemic response but has no effect on cognitive performance.
Hutchison et al., 2014 USA	33 undergraduate students. 19 males and 14 females.	22±2 years old.	Cross-over study design.	Cognitive performance test, blood samples, and food log.	Four conditions with three breakfast treatments: no breakfast meal, high protein/low CHO, low protein/high CHO, CHO/no animal protein.	Cognitive performance.	Memory was sensitive to the low CHO/high protein treatment. Verbal fluency was sensitive to overall treatment and reflected a stronger effect of the low CHO/high protein breakfast over time.	Low carbohydrate/ high protein breakfast showed benefits for cognitive performance.

Author	Sample characteristics "Gender"	Mean age	Study design	Method measurements	Breakfast conditions	Outcome measurements	Results	Conclusion
							Verbal fluency was marginally sensitive to the treatment, with the two protein treatments leading to continued improvement over time.	
Zeng et al., 2011 China	13 male undergraduate university students.	21.5 ± 2.8 years old.	Randomized crossover design.	Blood samples, mood and Continuous Performance Test (CPT) two breakfasts treatments.	The meals were two types of breakfast equal in energy, but different contents of carbohydrates and protein. HP meal with a PRO/CHO/FAT ratio of 5:3:2; the AP breakfast with a PRO/CHO/FAT ratio of 1:7:2.	Mood, alertness and attention.	Better mood and high performance in attention tests after consuming a high-protein breakfast.	High protein breakfast had a significant enhancement on cognitive functions.
Nabb and Benton 2006 UK	168 females Undergraduate students.	20.4 ± 1.99 years old.	Randomized crossover study.	Blood glucose levels, mood questionnaire, testing meals, cognitive test battery including immediate recall of a word list, vigilance, reaction times and delayed recall of the word list.	8 meals were constructed in changes in fiber and carbohydrate contents.	Cognitive measurements including immediate recall of a word list, vigilance, reaction times and delayed recall of word list.	Those who had poorer glucose tolerance and consumed a high amount of carbohydrates had a tired feeling. The carbohydrate amounts did not impact memory in those with better glucose tolerance. Reaction times had different responses as the high carbohydrate showed a faster response later in the morning.	Poor glucose tolerance causes poor memory and mood. Consumption of higher carbohydrate had faster reaction times response in the late morning.
Schroll 2006 USA	20 university students (No mention of their genders and the degree).	Over 18 years old.	Experimental study.	Using memory tests, breakfast testing.	Two groups: G\group A was given breakfast on day 1 of the testing series, while G/ B did not receive breakfast on that day. G/A did not receive breakfast on day 2, while G/B was given breakfast on day 2,	Cognitive functions including memory.	Consuming breakfast had a significant improvement in short-term memory.	Breakfast consumption has a positive effect on short-term memory.

Author	Sample characteristics "Gender"	Mean age	Study design	Method measurements	Breakfast conditions	Outcome measurements	Results	Conclusion
Fischer et al., 2002 Switzerland	15 Male university students (Not mention the degree level).	26.3±3.6 years old.	Repeated-measures counterbalanced cross-over design.	Cognitive tests, blood samplings, questionnaires, and testing meals.	Test meals consisted of isoenergetic CHO and PRO suspension mixed at three different ratios: The CHO-rich meal with a CHO/ PRO ratio of 4:1 (CHO [4:1]), the balanced meal with a CHO/PRO ratio of 1:1 (BAL [1:1]), and the PRO-rich meal with a CHO/PRO ratio of 1:4 (PRO [1:4]).	Cognitive functions including attention, accuracy and efficiency of cognitive tasks.	Accuracy in short-term memory was best after the PRO. Attention and decision times were transiently improved within the first hour after the CHO meal, whereas after the first hour the BAL and PRO meal resulted in improved performance. Reaction times of a central task were fastest after the BAL..	A protein-rich or balanced meal resulted in better overall cognitive performance.
Benton et al., 2003 UK	106 female undergraduates + 48 rats.	21 years old.	Experimental study.	Cognitive functions including memory, as well blood glucose level.	Four different cereal-based diets. The main difference between these diets was the type of carbohydrates (SAG Vs RAG).	Measuring the benefit of a low Vs high GI breakfast on cognitive performances.	A low GI diet improved memory, as well as rats performed better learning performance than a high GI diet.	Low GI breakfast improved cognitive performance.
Benton et al., 2001 UK	150 female undergraduate students.	21 years old.	Experimental study.	Blood glucose levels, tests of memory and mood, breakfast meals and snacks.	Six conditions randomly allocated between the students: 1. Fasted throughout. 2. No breakfast + snack at 1130 h. 3. 10 g corn flakes at 1000 h + nothing at 1130 h. 4. 10 g corn flakes at 1000 h + snack at 1130 h. 5. 50 g corn flakes at 1000 h + nothing at 1130 h. 6. 50 g corn flakes at 1000 h + snack at 1130 h.	Cognitive functions including mood and memory.	Consuming a snack showed a better mood. Eating a larger breakfast was associated with a poorer mood later in the morning. Memory for the word lists was not influenced by eating breakfast, but 20 min after a midmorning snack, more words were recalled.	Breakfast consumption was correlated with better motivation, and better memory was associated with lower blood glucose levels.

Author	Sample characteristics "Gender"	Mean age	Study design	Method measurements	Breakfast conditions	Outcome measurements	Results	Conclusion
Smith et al., 1999 UK	144 university students, 72 males and 72 females (No mention of the degree level).	21.0-year-old.	Experimental study.	Performance tasks included categoric search task, categoric search task with masked target, serial recall task, memory task, spatial memory task, assessment of mood, and background questionnaires.	Breakfast cereal and a cup of coffee. Although no limit was placed on how much the subject could have. Allowing to add sugar and semi-skimmed milk if they wanted.	Cognitive functions including working memory, attention, mood.	Consuming breakfast cereals had a more positive mood at the start of the test sessions, performed better on a spatial memory task, and felt calmer at the end of the test session than those in the no breakfast condition. No effect of caffeine on mood or working memory, but it did improve the encoding of new information and counteract the fatigue that developed over the test session.	Breakfast cereal was associated with greater positive mood and short-term improvement in spatial memory; however, breakfast did not affect the speed of encoding of information.

Table 2.6: Summary of significant findings on the effects of breakfast consumption on cognitive domains in university students from the eighteen selected studies.

Study design	Study ID	Cognitive measurements	Critical finding of breakfast consumption on cognitive domains in the selected studies	
			Advantages	No advantages
Observational Studies	Kerwani et al., 2020	The effect of skipping breakfast on different domains of cognitive functions.	There is a positive association between consuming breakfast and improving short-term memory (p = 0.537), working memory (p = 0.103), and cognitive functions (p = 0.658).	
	Abbas et al., 2017	The impact of breakfast consumption on attention and concentration.	Breakfast consumption was associated with increased concentration and attention in the morning lectures for 90.6% of students.	
	Lipsa et al., 2017	The influence of skipping breakfast on memory and concentration.	Breakfast consumption enhanced concentration in 82.6% of students and memory in 60.8% of students.	
	Liyanage et al., 2017	The effect of breakfast habits on cognitive functions.		No effect on cognitive functions.
	Sámano et al., 2019	The relationship between nutritional quality of breakfast and cognitive functions.	Breakfast quality was associated with time spent answering a cognitive test (p < 0.050), but not with cognitive interference.	No effect on cognitive functions.
	Khanna et al., 2016	The impact of breakfast consumption on mental distress and mindful attention awareness.	A positive effect was found on mental distress and mindful attention awareness (p<0.001) post-consuming breakfast.	
	Ackuaku-Dogbe and Abaidoo 2014	The effect of breakfast consumption on attention and level of fatigue.	The students reported that 82% were not tired and 86.2% were more concentrated after they had breakfast.	

Study design	Study ID	Cognitive measurements	Critical finding of breakfast consumption on cognitive domains in the selected studies	
			Advantages	**No advantages**
Interventional Studies	*Taheri et al., 2019*	The impact of breakfast cereal consumption on inhibitory cognitive control.	Breakfast consumption improve cognitive performance for inhibitory control (p ≤ 0.05).	
	González-Garrido et al., 2018	The impact of omitting breakfast on cognitive processing.	Positive effects on working memory, reaction time, attention, and stimulus evaluation.	
	Emilien et al., 2017	The influence of breakfast consumption on cognitive functions.		No effect on cognitive functions.
	Hutchison et al., 2014	The impact of high protein breakfast on cognitive functions.	Positive effects on memory and verbal fluency post consumed high protein breakfast (p = 0.068).	
	Zeng et al., 2011	The effect of high protein breakfast on mood and attention.	Positive effects on mood and attention test performance post consumed high protein breakfast (p < 0.05).	
	Schroll 2006	The impact of breakfast in short-term memory.	A positive impact on short-term memory (p=0.003).	
	Nabb and Benton 2006	The interaction between glucose tolerance and breakfast of carbohydrates on cognition.	Better glucose tolerance was associated with better cognitive performance including memory (p < 0.03).	
	Fischer et al., 2002	The effect of carbohydrate/ protein rates on cognition.	A positive impact in short-term memory, attention, decision time, and reaction time.	
	Benton et al., 2003	The impact of a low Vs high GI breakfast on cognitive performances within the following 4 h.	Low glycaemic index improve memory in humans and learning ability in rats in the late morning.	No effect on cognitive functions through high glycemic index diet.
	Benton et al., 2001	The impact of breakfast and snack on memory and mood.	Better mood and memory were associated with lower blood glucose levels (p<.001).	
	Smith et al., 1999	The influences of breakfast cereal and caffeinated coffee on working memory, attention, and mood.	Breakfast cereal was associated with greater positive short-term improvement in memory (p < 0.05), mood (p < 001) while caffeine was associated with encoding new information (p < 0.01) and attention (p < 0.05).	

2.5 Discussion

To our knowledge, this review is the first recent collection of evidence on the role of breakfast consumption in cognitive performance. The primary aim was to systematically review published literature and determine whether skipping breakfast is detrimental to cognitive performance in university students. Furthermore, it aimed to examine the impact of breakfast types on cognitive functions and explore the prevalence of skipping breakfast among university students. The prevalence of skipping breakfast among university students ranged from 33.3 to 71.92%, higher than the 10 to 30% found in children's studies (Monzani et al., 2019) and higher than the 31% found in adults in the UK (Gaal et al., 2018). The present review indicates that breakfast can improve short-term cognitive functions including attention, memory, concentration, reaction time, mood, and performance compared to those who omitted breakfast, but it is difficult to determine which type of breakfast is more beneficial.

We found that some breakfast types worked better than others within cognitive domains. This is similarly found in children's studies (Sihvola et al., 2013; Deshmukh-Taskar et al., 2010). In this review, breakfast composition was found to significantly impact cognitive function and mood. A protein-rich breakfast demonstrated benefits for memory, verbal fluency, alertness, and attention (Hutchison et al., 2014; Zeng et al., 2011; Fischer et al., 2002), outperforming low-protein or varied-carbohydrate breakfasts in most aspects. However, reaction times were notably faster following a balanced meal. Carbohydrate-rich breakfasts also showed specific advantages, enhancing

attention, decision-making speed (Fisher et al., 2002), mood, and memory (Smith et al., 1999). These findings suggest that both protein and carbohydrate content play crucial, albeit different, roles in breakfast's cognitive benefits. However, the studies by Benton et al. (2001), Nabb and Benton (2006), and Benton et al. (2003) found that carbohydrate breakfast impacted cognitive functions positively, even though this was obtained from different levels of carbohydrates measured. The different results of cognitive functions with types of breakfast consumption reported could be due to the glucose tolerance levels (Benton et al., 2001; Nabb and Benton, 2006), as most of the studies in this review showed benefits of consuming breakfast in those who had low blood glucose levels and better glucose tolerance compared to those with poorer glucose tolerance. This is consistent with the evidence suggesting that the effects of breakfast consumption on cognition may be related to blood glucose levels in the bloodstream (Mahoney et al., 2005), as the blood glucose response that occurs after a meal most likely helps to enhance cognition. Even smaller increases in blood glucose may improve memory and learning by producing more acetylcholine (Mahoney et al., 2005). Although it has been demonstrated that glucose improves cognitive ability in people of all ages (Korol, 2002), younger children showed a greater impact than older children when comparing previous research findings with this review. These disparities in the benefit of breakfast consumption on performance could be attributed to differences in metabolic rates between older and younger children or to differences in the degree of physical stress experienced following an overnight fast (Mahoney et al., 2005), as schoolchildren have a faster brain glucose metabolism than adults,

and the longer overnight fasting phase caused by increased sleep needs during childhood and adolescence might deplete glycogen stores overnight (Adolphus et al., 2016).

Moreover, in research including children, the data generally supported the idea that lower-GI breakfasts might promote cognition compared to higher-GI breakfasts. This shows that breakfast meals that cause a glycaemic response, which is characterised by blood glucose levels that are sustained above fasting levels, may help with cognitive performance (Adolphus et al., 2016). Within the limited data in this review, this is consistent with Benton et al.'s (2003), Nabb and Benton's (2006), and Benton et al.'s (2001) findings.

There is also a further explanation of the mechanism that could play an important role in cognitive functions, which was examined experimentally in rats. Given the liver's importance in maintaining blood glucose levels, researchers have investigated the idea that this organ may govern glucose's memory-enhancing capacity. The celiac ganglion transmits the majority of autonomic nervous system messages from the liver to the brain. It appears that the liver recognises blood glucose increases and sends information to the brain, which could indicate glucose levels that may improve memory by at least two routes, one peripheral and one central (Benton and Parker, 1998).

Positive effects were observed in some of the included studies that tracked the breakfast effect at a variety of times across the morning, from 20 minutes to late morning 240 minutes. The impacts of breakfast consumption compared to fasting were more frequently seen at 240 minutes (Hutchison et al., 2014; Zeng

et al., 2011), followed by 75 minutes (Fischer et al., 2002) and 20 minutes (Benton et al., 2001). When comparing these studies, which tracked students' performance throughout the morning, it was found that breakfast consumption improved cognitive performance in the mid-late morning. This finding is consistent with children's studies that found the influence of breakfast eating compared to fasting occurred most frequently post-breakfast in the late morning (3–4 hours) (Adolphus et al., 2016; Family Action, 2019). This could also be related to blood glucose concentrations; cognitive performance changes were observed as postprandial blood glucose concentrations returned to baseline in some trials that tracked performance throughout the morning with multiple testing sessions.

2.5.1 Limitation

Despite the fact that this review found that breakfast can improve short-term cognitive functions including attention, memory, concentration, reaction time, mood, and performance compared to those who skipped breakfast, it has some limitations. Only nine out of eighteen studies were graded as good in both observational and interventional studies according to the quality assessment scale for cohort studies (Tables 2.2 and 2.3), as the poor studies did not present a fair average of the populations, used a weak methodology to assess cognition, did not provide adequate definitions for the student samples, had less comparability, and lacked data in the ascertainment of exposure or response rate. This heterogeneity prevented us from conducting a meta-analysis to obtain accurate results from these studies. Therefore, most of these studies

draw different conclusions about the role of breakfast in cognitive performance among university students.

It is possible that breakfast consumption affects cognitive functions when considering glucose tolerance level, types and amounts of macronutrients, gender, age, cognitive task types used, and the duration between consuming breakfast and cognitive performance. Also, even though the findings imply that breakfast consumption has domain-specific effects on cognition when compared to fasting, it is important to note that cognitive functions are not separate; they overlap, hence the assignment of individual cognitive tasks to a particular cognitive domain is inconsistent (Adolphus et al., 2016).

Thus, future research should generally promote caution in the methodology of studies by considering numbers and groups of participants, standardising tests of cognitive functions, conducting studies over adequate durations, and carefully designing breakfast treatments. There was insufficient evidence to reach robust conclusions from the results presented in this review to prove which type of breakfast is more effective for cognitive domains. This may encourage researchers in the future to investigate more about the role of breakfast components in cognitive domains among university students.

2.6 Conclusion

Overall, this review indicates that breakfast can improve short-term cognitive functions including attention, memory, concentration, reaction time, mood, and performance compared to those who omitted breakfast, but it is difficult

to determine which type of breakfast is more beneficial. Although certain components of cognition appear to be particularly vulnerable to morning fasting, the demands imposed on the brain, the types of cognition tests, the time after breakfast consumption, and glucose levels are all crucial variables that deserve additional investigation.

However, because of a lack of evidence in this area and a variety of methods used, it is unclear how breakfast types and cognitive functions interact. Considering glucose tolerance, those with better glucose tolerance appear to be more receptive to breakfast's potential benefits for cognitive functions, although this is not the only mechanism for this interaction.

Future research is needed to explore how breakfast consumption affects cognitive functions among university students, whether an increase in blood glucose caused by breakfast intake improves cognitive performance, and what types of breakfast are more beneficial for cognitive functions.

Chapter 3- The Relationship between Breakfast Consumption and Cognitive Functions among Nottingham First-Year University Students

3.1 Introduction

The transition from school to university marks a significant period of change, characterized by various physiological, psychological, and social adjustments (Evans et al., 2018). This transition substantially affects first-year university students' lifestyle habits, including their eating patterns, physical activity levels, and mental wellbeing (Rampersaud et al., 2005; Patton-López et al., 2014). Of particular concern is the dramatic change in breakfast consumption habits, a trend that has prompted significant debate among researchers, health professionals, and educators (Pendergast et al., 2016). While breakfast has traditionally been touted as 'the most important meal of the day', recent research has called this assertion into question, particularly for university students. Our systematic review in Chapter 2 revealed that the prevalence of breakfast skipping among university students ranges from 33.3% to 71.92%. This finding aligns with other research indicating that 48% of university students, or nearly two out of every five, skip breakfast (Pengpid and Peltzer, 2020). First-year students are particularly vulnerable to this trend as they navigate new schedules, increased autonomy, and the challenges of balancing academic demands with self-care (Deliens et al., 2014).

Several factors contribute to the high prevalence of breakfast skipping among first-year students. These include lack of time, altered sleep patterns, financial constraints, limited cooking skills, and limited knowledge about the importance

of breakfast (Gaal et al., 2018; Baghurst and Baghurst, 2007). The transition to university can increase consumption of comfort foods, which are often unhealthy, due to emotional challenges (Mikolajczyk et al., 2009). Additionally, increased alcohol consumption can affect overall diet and nutrition patterns (Nelson et al., 2009). These dietary changes can potentially impair cognitive functions and academic performance (Adolphus et al., 2013). Moreover, the relationship between breakfast consumption and mental wellbeing is increasingly recognized. Skipping breakfast has been linked to higher levels of stress, anxiety, and depressive symptoms among university students (Lee and Kim, 2019). The nutritional content of breakfast, particularly its role in stabilizing blood glucose levels, may play a key role in mood regulation and stress management throughout the day (Benton and Parker, 1998).

The relationship between breakfast consumption and cognitive function in university students, especially first-year students, remains controversial. While some studies have demonstrated associations between regular breakfast consumption and improved cognitive performance in areas such as attention, memory, and problem-solving (Adolphus et al., 2013). Other research has yielded conflicting results. For instance, a study on a US breakfast program found little evidence to support breakfast benefits for student academic performance (Yao et al., 2019).

Furthermore, the literature lacks consensus on the optimal breakfast composition for mental wellbeing and cognitive functions (Hoyland et al., 2009; Bakhtiyari et al., 2020). This is particularly relevant in the UK context, where

carbohydrates are a staple of daily intake (NHS, 2023), yet there's limited evidence linking varying carbohydrate amounts at breakfast to cognitive functions. Similarly, research on the effects of protein and fat consumption at breakfast on cognitive functions has produced inconsistent results. This lack of consensus is especially problematic when considering first-year university students in the UK. There is a notable gap in research specifically addressing the relationship between breakfast consumption and cognitive functions among this population, particularly in the UK university system and considering the specific challenges faced by students (Macaskill, 2018).

As universities strive to support student success and wellbeing, addressing the issue of breakfast skipping among first-year students emerges as a key area for intervention. Understanding these factors is crucial for developing effective interventions to promote regular breakfast consumption and, by extension, support cognitive function and mental wellbeing among university students. By exploring the connections between breakfast consumption, cognitive function, and overall mental wellbeing, researchers and educators can develop targeted strategies to promote healthier eating habits and support overall student success during this critical transition period.

3.2 Aim and objectives

This study aimed to examine the potential impact of breakfast consumption on cognitive functions among Nottingham first-year university students.

Objectives:

- Understand how the transition to university life influences breakfast consumption patterns.

- Explore the effects of different breakfast compositions (carbohydrates, protein, and fat), and glycaemic load levels, on cognitive functions.

3.3 Materials and methods

3.3.1 Recruitment

The participants in this study were recruited according to the following inclusion criteria: first-year university students, 18 years old and older, who had access to an electronic device, were registered at the University of Nottingham for any degree and could be of any gender or ethnicity. However, students under the age of 18, adults who were not registered at UK universities or were not first-year students, and those who did not have access to electronic devices were excluded. Participation in this study was promoted via lecture shout-outs and poster announcements across all University of Nottingham UK campuses. The data were collected online during COVID-19 restrictions in the academic year 2021-2022, between October 13 and March 30, and therefore the study was conducted remotely.

Before obtaining participants' online consent to participate in the study, all participants were invited online via Microsoft Teams to read a participant information sheet and to ask any questions they may have had to decide whether or not to participate in the study (Appendix: Consent 1.1 and Participant Information Sheet 1.2). The School of Biosciences Research Ethics

Committee at the University of Nottingham approved this study (SBREC200122FEO).

3.3.2 Study design and participants recruitment

This study employed a crossover design so that each participant acted as their own control (Figure 3.1). Participants were asked to fast overnight for 12 hours (the night before the test session) and complete a general questionnaire to obtain sociodemographic and general health information, including normal breakfast consumption patterns, as well as the D2 test for cognition prior to consuming their 'normal' breakfast. Thirty minutes post-consumption, participants were asked to repeat the D2 test for cognition to assess any differences.
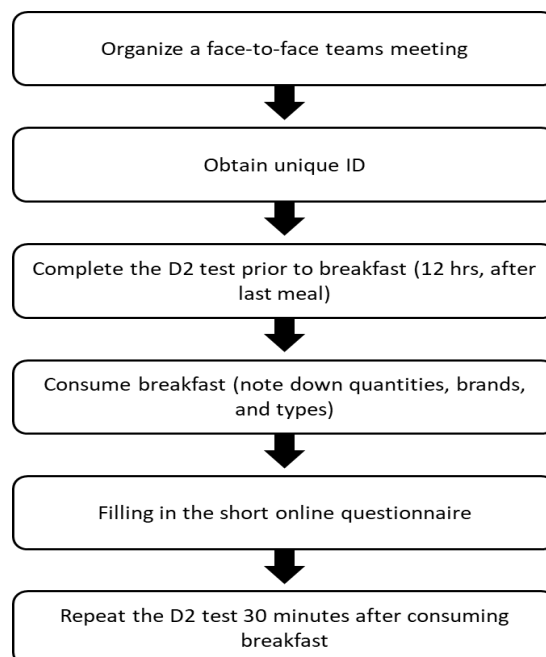
Figure 3.1: Process required for participants to follow in the study design.

3.3.2.1 Participant demographic questionnaire

Before launching the online survey among participants, a pilot survey was conducted with a small sample of university students to ensure that the questionnaire was effective in capturing accurate data that reflected the research objectives. After ensuring the validity of the questionnaire, participants were asked to complete a short online questionnaire. This questionnaire consisted of a series of questions to determine their sociodemographic information (e.g., gender, age, ethnicity, degree programme, and height and weight), health behaviours (e.g., sleeping, drinking alcohol, smoking, exercising, and dietary supplementation), and breakfast consumption patterns (Appendix 1.3).

3.3.2.2 The D2 test of cognition

The online D2 test of cognition was purchased from www.Hogrefe.com. As an online tool, it permits automated data collection and analysis, lowering the possibility of human error in data entry and allowing for more sophisticated statistical analyses (Gonzalez and Smith 2020). It is a reliable and internally consistent method of measuring cognitive functions through visual scanning (Bates and Lemay 2004). This test is a validated assessment tool and has been praised for measuring cognitive functions for most ages, from 18 to 55 years old, with a variety of versions valid for different countries. It measures a variety of facets, including concentration, attention, sustained attention, mental speed, processing speed, working speed, perceptual speed, and general

performance capacity. This study measured concentration performance (CP) and accuracy (A) using the UK version.

The D2 test is self-administered, with each participant having their own account to access the test, and it is required to be conducted online using an electronic device such as a laptop. The test consists of 14 screens with 60 symbols (in 6 rows of 10). Each character has a letter, 'd' or 'p' marked, with one, two, or more small dashes (Figure 3.2). The test taker is required to scan the lines and cross out all occurrences of the letter 'd' with any two dashes while ignoring all other characters. All screens work automatically, with a total duration of 10 minutes (Hogrefe, 2023).
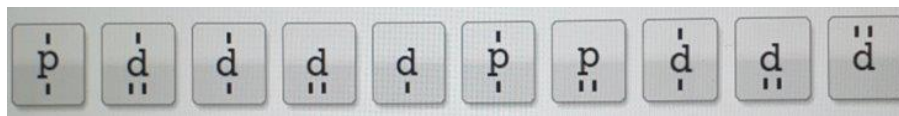
Figure 3.2: Example of character letters from the D2 test.

3.3.2.3 Breakfast meal measurements

In this study, breakfast was self-reported and considered to be any kind of meal participants consumed (breakfast, snack, light meal, or main meal). Hence, we confirmed that our breakfast variable was in line with those provided in order to be compatible with definitions that have existed in the literature. Breakfast was described as the most essential meal of the day, and one that comes after the longest period of fasting (Liyanage et al., 2017). The effect of macronutrient breakfast (carbohydrate, protein, and fat) and GL on cognition was measured. However, due to an unclear definition of what constitutes a low- and high-carbohydrate diet is, we followed the Oh et al. (2019) definition, which

indicates low carbohydrate (less than 26% carbohydrates) or less than 130 g/day and high carbohydrate (45% or greater). We considered low carbohydrates for a morning meal to be <40 g/meal and high carbohydrates to be ≥40 g/meal. The GL is defined as " a measure that takes into account the amount of carbohydrate in a portion of food together with how quickly it raises blood glucose levels." The GL is classified as low (0–10), medium (between 11 and 19), and high (20 and over) (Diabetes UK, 2023).

3.3.2.4 Data and statistical analysis

The questionnaire data were obtained from the JISC online platform as a self-administered questionnaire. The Statistical Package for Social Sciences (SPSS version 27; IBM, Hampshire, UK) was used to analyse the data. Descriptive statistics were used to summarise the sociodemographic characteristics. The Hogrefe Company automatically analysed the D2 cognition test and provided access to the results by reporting participant performance. The test evaluates two variables: concentration performance (CP) and accuracy (A) by calculating the total number of items processed (TN), raw score of errors (E), percentage of errors (E%), total number of items minus error scores (TN-E), and fluctuation rate (FR). CP refers to the ability to concentrate. It is determined by the speed with which the test was processed and, to a lesser extent, by the number of errors. A low score indicates a below-average ability to concentrate. A high score indicates an above-average ability to concentrate. A is a measure of how accurately the test was performed. The higher the raw score, the less accurate the test processing is. The amount of attention placed on speed influences

processing accuracy. A low score indicates that the test-taker makes more mistakes than average when performing simple tasks. A high score indicates that the test taker performs simple tasks with care and accuracy.

After obtaining the D2 test results, a paired t-test was used to assess the differences between the two types of D2 tests (CP and A: pre and post) with breakfast consumption. The Nutritics programme (https://www.nutritics.com/en/) was used to analyse the carbohydrate levels, protein, fat, and GL. This software programme can professionally analyse nutrition information. It only needs the information for each participant (e.g., age, height, and weight) to analyse the breakfast nutrition portion size. Nutrient calculations were performed for each individual participant and then presented as a nutrition log. A Pearson correlation test was used to measure the linear correlation between carbohydrate, protein, fat, and GL with cognitive functions (CP and A). Data were presented as mean ± standard deviation (SD). A P value of ≤ 0.05 was considered statistically significant at the 95% confidence interval.

3.4 Results

3.4.1 Participant sociodemographic characteristics

The study enrolled a total of 23 first-year university students. Female students represented 65.2% (n = 15) of the sample. The participants ranged in age from 18 to 27 years, with an average age of 19.2 ± 2.0 years. The interquartile range (IQR) of the age was 1, with the 25th percentile value at 18 and the 75th percentile value at 19. Participants in this study were from a variety of ethnic

groups, with Asian and White ethnicities having a higher participation rate at 52.2% of the total participants. Most of the participants were from the Faculty of Science (47.8%), followed by Medicine and Health Sciences (26.1%). The majority of the students had a healthy BMI (18.5–25 kg/m²), at 78.3% (n = 18), followed by 17.4% (n = 4) who were underweight (<18.5 kg/m²). Most of the students (82.6%) reported that they slept 7-9 hours regularly, did not consume alcohol (78.3%), and did not smoke (100%). More than half of the students (52.2%) engaged in light exercise for 0.5–1.5 hours per week. Most of the students (82.6%) reported not using any dietary supplements (Table 3.1).

Table 3.1: Descriptive statistics of sociodemographic characteristics of first-year University of Nottingham students (n = 23).

Variable	N (%)
Gender	
Male	8 (34.8)
Female	15 (65.2)
Age (Years)	
18-27	23 (100)
Ethnicity	
White British/EU	10 (43.5)
Black	1 (4.3)
White and Asia	12 (52.2)
Faculty	
Sciences	11 (47.8)
Medicine and Health Sciences	6 (26.1)
Social Sciences	4 (17.4)
Engineering	1 (4.3)
Art	1 (4.3)
BMI	
<18.5 kg/m²	4 (17.4)
18.5–25 kg/m²	18 (78.3)
25–30 kg/m²	1 (4.3)
Sleeping regularly	
4-6 hours	4 (17.4)
7-9 hours	19 (82.6)
Drinking alcohol	
Yes	5 (21.7)
No	18 (78.3)
Non-Smoking	23 (100)
Exercising /week	
None	3 (13.0)
0.5-1.5 hours	12 (52.2)
2-3 hours	2 (8.7)
4-5 hours	3 (13.0)
6-7 hours	3 (13.0)
Dietary supplements	
Yes	4 (17.4)
No	19 (82.6)

3.4.2 Prevalence of skipping breakfast and breakfast patterns

Table 3.2 shows that 21.7% (n = 5) of first-year university students skipped breakfast frequently. Those who stated they regularly consumed breakfast reported different patterns of their eating habits. Among these, 72.2% (n = 13) reported consuming breakfast every day, 22.2% (n = 4) consumed breakfast 5–6 times per week, and only 5.6% (n = 1) reported consuming breakfast 3–4 times per week. Skipping breakfast was more prevalent among male students (25%) than female students (20%), and White British students were more likely to skip breakfast at 30% compared to other ethnicities. The most common reasons for skipping breakfast were not being hungry or breakfast not being a daily habit (13%), followed by not having enough time, having no food in the house, or having a heavy meal at night (8.7%). Moreover, 13% of the students overall doubted that breakfast would enhance their mood and concentration during morning lectures. Of those who did not consume breakfast regularly, 20% (n = 4) thought that breakfast could improve their mood, compared to 80% (n = 16) of students who consumed breakfast regularly. In terms of concentration, only 15% (n = 3) of those who did not consume breakfast regularly thought that breakfast would not improve their concentration in lectures, compared to 85% (n = 17) who consumed breakfast regularly.

Table 3.2: Descriptive statistics of breakfast eating patterns among first-year University of Nottingham students.

Variable	N (%)
Eating breakfast regularly	
Yes	18 (78.3)
No	5 (21.7)
Often eat breakfast	
3-4 times per week	1 (5.6)
5-6 times per week	4 (22.2)
Every day	13 (72.2)
Does breakfast enhance mood positively	
Yes	20 (87.0)
No	3 (13.0)
Does breakfast help concentration in lectures	
Yes	20 (87.0)
No	3 (13.0)

3.4.3 Consumption of breakfast improved concentration and accuracy in performing the D2 test

We observed a significant increase in CP score following breakfast consumption (CP: pre-consuming breakfast 53.0 ± 9.1; post-consuming breakfast 63.0 ± 7.8, p ≤ 0.001, Figure 3.3) and a significant increase in A score (A: pre-consuming breakfast 48.5 ± 9.3; post-consuming breakfast 55.2 ± 7.0, p ≤ 0.001, Figure 3.3).
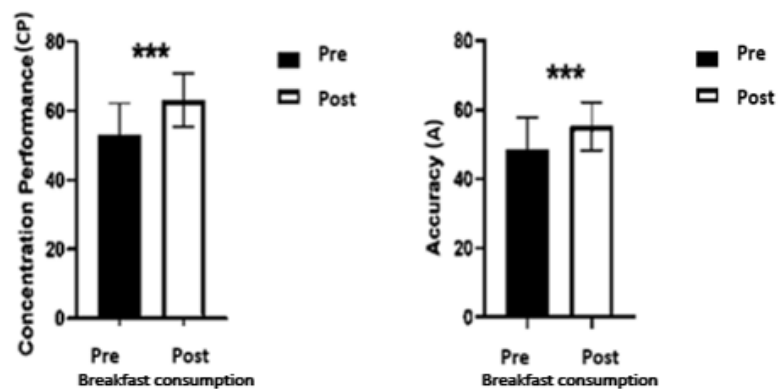
Figure 3.3: Breakfast consumption improved concentration performance (CP) and accuracy (A). CP and A were determined pre- and post-breakfast consumption using the D2 test, and a paired t-test was used to assess this difference. Data are presented as mean ± SD, ***P ≤ 0.001.

3.4.4 The association between carbohydrate, protein, fat, and GL with cognitive functions

Figure 3.4 demonstrates the relationship between carbohydrate, protein, fat, and GL with cognitive functions, with two subfigures for each nutrient to compare them with cognitive aspects CP and A separately. It shows that there is no association between GL (A, B) and macronutrients (carbohydrates (C, D), proteins (E, F), and fats (G, H)) with cognitive functions (CP and A).
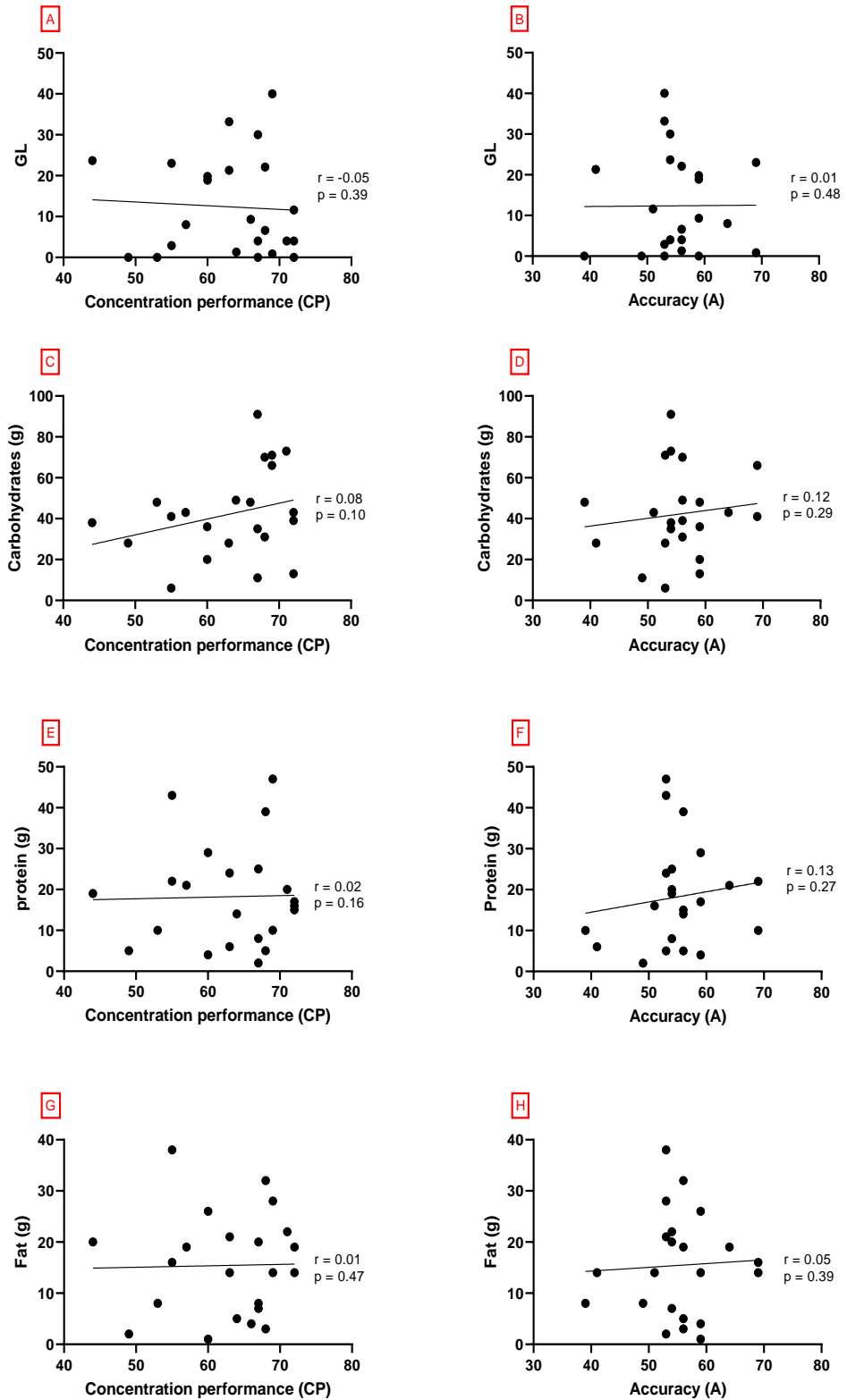
Figure 3.4: GL, carbohydrates, protein, and fat consumption had no effect on CP or A. The amounts of carbohydrates, protein, fat, and GL were calculated from the breakfast food diary using Nutritics and compared to CP and A scores obtained by the D2 test. A Pearson correlation test was used to measure the correlation. P ≤ 0.05 was deemed statistically significant.

3.5 Discussion

This study aimed to examine the potential impact of breakfast consumption on cognitive functions among first-year university students. It aimed to understand how the transition to university life influences breakfast patterns and explore the effects of different breakfast compositions (carbohydrates, protein, and fat), and GL levels, on cognitive functions. This was assessed through an online questionnaire, a food diary, and a cognitive test (pre-and post). The present study shows that the prevalence of skipping breakfast among first-year university students was 21.7%, which is higher than the prevalence among adults in the UK (5.7%) (Gaal et al., 2018) and within the range for global adolescents (10–30%) (Monzani et al., 2019), but lower than the range we found in Chapter 2 (33.3 to 71.92%). The most common reasons for skipping breakfast in this study were similar to those reported in previous studies; a lack of time (Abro et al., 2021) or a lack of hunger (Seedat, 2017; Arshad and Ahmed, 2014). Male students in our sample were more likely to skip breakfast compared to female students, similar to the findings of Gaal et al. (2018), Sun et al. (2013), and Keski-Rahkonen et al. (2003). This might be due to males being less skilled or less interested in preparing meals (Larson et al., 2011), having lower nutritional knowledge, and placing less importance on meal regularity compared to females (Mooney and Walbourn, 2001), leading to skipping breakfast. However, gender disparities in breakfast consumption could also depend on students' concerns, such as body image and/or diet (Sincovich et al., 2022).

The study found a significant relationship between breakfast consumption and improved cognitive functions (CP and A) when tested 30 minutes after eating, regardless of macronutrient composition or glycaemic load (GL). This aligns with numerous studies showing breakfast's positive impact on cognition in university students (Kerwani et al., 2020; Abbas et al., 2017; Lipsa et al., 2017; Khanna et al., 2016; Ackuaku-Dogbe and Abaidoo, 2014; Taheri et al., 2021; González-Garrido et al., 2018; Hutchison et al., 2014; Zeng et al., 2011; Schroll 2006; Nabb and Benton 2006; Fischer et al., 2002; Benton et al., 2003; Benton et al., 2001; Smith et al., 1999) and with a systematic review of children (Hoyland et al., 2009).

The improvement in cognitive function from breakfast consumption can be attributed to several critical factors supporting brain function and neurotransmitter synthesis. A primary mechanism is the glycaemic and insulinemic responses to breakfast consumption (Wolever et al., 2006). Glucose, the brain's essential fuel, functions through neurocognitive markers of episodic memory and attentional processing (Peters et al., 2020). Carbohydrates play a vital role in mood regulation by influencing serotonin synthesis and release. Consuming complex carbohydrates produces a more consistent glucose release, resulting in improved mood regulation and enhanced cognitive functions such as concentration, memory, and learning (Wurtman and Wurtman, 1995; Benton and Stevens, 2008). Protein intake is equally crucial, as adequate protein intake can significantly reduce the risk of mental health issues while boosting cognitive performance, including memory,

concentration, and problem-solving ability. This is largely due to the promotion of neurotransmitter-balancing amino acids such as tyrosine and tryptophan (Lakhan and Vieira, 2008; Bourre, 2006). Also, omega-3 fatty acids, especially DHA and EPA, are essential for optimal brain function. They are crucial in maintaining cell membrane integrity and fluidity, necessary for neuron activity and communication, and have been linked to lower levels of anxiety and sadness (McNamara and Carlson, 2006; Grosso et al., 2014). Therefore, a well-balanced breakfast providing adequate protein, fat, and carbohydrates is vital for cognitive function and mental wellbeing. Macronutrient deficiencies or imbalances can lead to cognitive deficits and mental health issues (Jacka et al., 2010).

However, when investigating individual nutrients, our study did not find significant differences in cognitive performance. This contrasts with previous research showing varying effects of high-protein, high-carbohydrate, or high-fat breakfasts on cognition (Nabb and Benton, 2006; Fischer et al., 2002; Wesnes et al., 2003; Ingwersen et al., 2007). Our findings align more with Cooper et al. (2011), who found no significant effect of protein content on cognitive performance. Similarly, we found no significant cognitive differences based on fat content or GL, consistent with Hoyland et al. (2009) and Lamport et al. (2009). These results suggest that while breakfast consumption generally improves cognitive performance, the specific macronutrient composition may not be as crucial as previously thought. Rather, the act of consuming breakfast itself appears to be the primary factor influencing cognitive performance. This

interpretation is supported by Sámano et al. (2019), who found that breakfast types may not be strongly related to cognitive functions, and Galioto and Spitznagel (2016), emphasised that eating breakfast was more important for cognitive functions than the specific type of breakfast consumed.

However, the lack of observed differences in this study could also potentially be due to the timing of cognitive tests (30 minutes post-consumption). This timing coincides with the initial peak in blood glucose, which may capture the immediate cognitive effects of glucose availability (Smith et al., 2001). Testing at different time points, such as 60- or 120-minutes post-consumption, might reveal different effects (Ingwersen et al., 2007; Donohoe and Benton, 1999). Another explanation could be a learning effect, with participants becoming familiar with the cognitive tests rather than the improvements being solely due to the nutritional interventions. Hence, this could explain why no significant differences were observed between different breakfast compositions. Therefore, using alternative versions of tests for each testing session may be considered in future research.

These considerations highlight the complexity of studying the effect of nutrition on cognition and underscore the importance of careful experimental design in future studies, particularly in light of the conflicting findings in the literature regarding the impact of specific macronutrients on cognitive function. Also, there is still a lack of evidence to recommend an ideal breakfast for cognitive functions (Hoyland et al., 2009) as well as to learn more about the metabolic influences, including potential dietary and physiological responses, which could

help us better grasp the connection between breakfast and cognitive function to achieve healthy mental wellbeing.

3.5.1 Limitation

This study encountered some limitations that need to be addressed. Firstly, the results of the current study may have been limited because the sample size was small, as this study was conducted during COVID-19 restrictions, which may have limited students from participating in this study. Secondly, because breakfast is frequently subjectively defined and understood by the respondent, self-reported measurements are vulnerable to bias, inaccurate recall, and misreporting. Thirdly, this study did not measure blood glucose levels to assess whether glucose levels are associated with increased cognition and which glucose level is more related to cognitive functions, considering the timing of measurement and whether the cognitive tests used were sensitive enough to detect subtle differences caused by varying macronutrient compositions. Fourthly, we did not consider the differences in the socioeconomic and nutritional status of students. Therefore, future larger interventional or experimental studies investigating long-term effects will be required to provide adequate data to support the relationship between different breakfast types, various components, and cognitive functions.

3.6 Conclusion

This study investigated the potential impact of breakfast consumption on cognitive functions among first-year university students. It aimed to understand how the transition to university life influences breakfast patterns

and to explore the effects of different breakfast compositions (carbohydrates, protein, and fat), and GL levels, on cognitive functions. The results showed that the prevalence of skipping breakfast was considered high compared to UK data. Also, the findings showed a statistically significant relationship between eating breakfast and cognitive domains (CP and A) when tested 30 minutes after consumption. The GL and macronutrient levels had no effect on CP or A. This study's findings can help develop guidelines to improve university lifestyle by encouraging students to consume breakfast. This could possibly reduce the number of individuals suffering from cognitive disorders and improve overall mental wellbeing. However, more experimental research is needed to investigate the underlying link between the effects of various types of breakfast and cognitive functions.

Chapter 4- The Prevalence of Food Insecurity and Associated Factors among UK University Students

4.1 Introduction

Food insecurity has emerged as a critical global public health concern affecting people of all ages (FAO, 2022). In high-income countries, university students are disproportionately affected compared to the general population (DeBate et al., 2021), with higher prevalence among ethnic minority groups and younger undergraduates (Hiller et al., 2021; Shi et al., 2021; Payne-Sturges et al., 2018). Over the past 15 years, food insecurity has dramatically increased worldwide (DeBate et al., 2021), particularly in countries like the US (Ryan et al., 2020), Australia (DeBate et al., 2021), and Malaysia (Bruening et al., 2018; Davitt et al., 2021; Ahmad et al., 2021), with overall prevalence ranging from 9.9% to 72.9% (Abbey et al., 2022).

While extensive research has been conducted in various countries, evidence about food insecurity levels among university students in European countries, especially the UK, remains limited. Recent studies, however, have begun to illuminate this issue in the UK context. A 2022 study for the Food Standards Agency revealed that 40% of university students in England experience food insecurity, with the highest rates in the Northwest (Armstrong et al., 2023). Furthermore, one in ten UK university students utilised a food bank during the 2021/2022 academic year (Brown, 2022). This situation has likely been exacerbated by a 14% rise in living costs since 2021, driven by higher tuition

fees and a 61% increase in rent over the past decade (Unipol, 2021), as well as the impact of the COVID-19 pandemic (DeBatea et al., 2021).

Financial concerns are pervasive among UK university students, with 82% worried about making ends meet, and four out of five contemplating dropping out of university, 52% of whom cited financial pressures as the primary reason (Brown, 2022). A 2022 survey of 3,500 UK university students found that 96% had cut their spending, with some having only £50 per month for food and personal items after paying essential bills (NUS, 2022). This financial strain has significant implications for students' wellbeing and academic performance.

The link between food insecurity and poor mental health among university students is well-established (Chaparro et al., 2009; Bruening et al., 2018; Pereira et al., 2017; DeBate et al., 2021). Among those who reduced their spending, 92% reported negative impacts on their mental well-being, yet only 20% received support for these issues (NUS, 2022). This is particularly concerning as poor mental health is associated with decreased academic achievement (Pereira et al., 2017; Payne-Sturges et al., 2018; Wooten et al., 2019; DeBate et al., 2021), potentially affecting individuals throughout their lives.

The severity of food insecurity among university students varies, ranging from worry about food running out to going entire days without eating due to lack of money (Nazmi et al., 2019). This spectrum of experiences underscores the complexity of the issue and the need for nuanced interventions.

Promoting food security and well-being among university students is critical for ensuring they have the resources and support needed to succeed academically and lead healthy, fulfilling lives. Universities that track food insecurity among their students will be better positioned to address college affordability and student financial aid, particularly in light of high food insecurity prevalence. This aligns with the UN Economic and Social Council's 2016 Sustainable Development Goals, specifically Target 2.1, which aims to end hunger and achieve universal food security (Pereira et al., 2017; United Nations, 2015).

4.1.1 Food insecurity, university students and financial factors

The association between food insecurity and socioeconomic status is well-established, particularly among university students facing new financial demands (Boyle and Power, 2021). The complex interplay of rising education costs, limited income, and increased enrollment of low-income students contributes to food insecurity in higher education settings (Macchi and Coccia, 2022; Wakeling and Jefferies, 2013).

Multiple factors exacerbate food insecurity among university students. Paradoxically, receiving financial aid (scholarships and loans) often correlates with higher food insecurity risk (Shi et al., 2021; Payne-Sturges et al., 2018; Owens et al., 2020). Living arrangements, whether off-campus, on-campus, or in shared accommodations, impact food security (Douglas et al., 2022; Owens et al., 2020). Student employment, while providing income, may also increase food insecurity risk due to time constraints and stress (McArthur et al., 2018; Owens et al., 2020).

Socioeconomic background significantly influences food security. Students from higher socioeconomic backgrounds often benefit from family support for critical expenses, while those from lower-income backgrounds struggle more with costs (Wooten et al., 2019). This disparity is intensified by rising tuition fees and living costs, leading to insufficient funds for nutritious food, restricted food access, and unhealthy dietary choices (Martinez et al., 2018; Ahmad et al., 2021).

The consequences of food insecurity extend beyond nutrition, affecting academic performance and overall well-being. Financial stress contributes to difficulty concentrating on studies and may lead to ineffective coping strategies, such as neglecting healthcare or prioritizing alcohol over food (Hughes et al., 2011; Martinez et al., 2018; Douglas et al., 2022). These behaviours can create a cycle that further exacerbates food insecurity (Broton and Goldrick-Rab, 2016).

Addressing food insecurity among university students requires a comprehensive approach. Key factors to consider include student loans, family financial support, university expenses, household revenue, food expenditure, and accommodation costs. Effective financial resource management is crucial for preventing and mitigating food insecurity in this population (Halfacre et al., 2021). Institutions and policymakers must recognize the multifaceted nature of this issue to develop targeted, effective interventions.

4.1.2 Food insecurity and university student mental wellbeing

Despite the rising prevalence of food insecurity among university students and its links to dietary, physical, and mental health, few studies have examined its specific impact on student mental health (Martinez et al., 2020; Darling et al., 2017). Research over the past two decades indicates a significant increase in mental health symptoms among university students. In the UK, there was a fivefold increase in the proportion of students reporting mental health issues from 2006–2016 (Thorley, 2017). In England, 19% of 16–24-year-olds had mental health disorders, up from 15% in 2003, with a notable gender disparity: 28% of females compared to 10% of males. Similar trends were observed in Scotland, Wales, and Northern Ireland (Thorley, 2017).

A comparable pattern emerged in the US (Oh et al., 2022), with the prevalence of mental disorders significantly higher (25.8%) among those aged 18 to 25 compared to adults aged 26–49 years (22.2%) and those aged 50 and above (13.8%) (Becerra and Becerra, 2020). These findings underscore the need for early intervention to address the growing mental health issues in this population.

Food insecurity can contribute to mental health problems through various mechanisms. Limited financial resources leading to food acquisition difficulties (Martinez et al., 2020), restricted food options, and anxiety about food availability (Myers, 2020) can result in feelings of alienation, powerlessness, shame, guilt (Becerra and Becerra, 2020), stress, depression (Ahmad et al.,

2021), anxiety (Rizk et al., 2023), and stigma. These factors, along with the increased risk of obesity and economic consequences (Nagata et al., 2019; Becerra and Becerra, 2020), may exacerbate mental health disorders.

Additionally, employment struggles and financial instability can both contribute to food insecurity (Nagata et al., 2019) and increase socioeconomic disparities, potentially aggravating cultural sensitivities and negatively impacting mental health (Becerra and Becerra, 2020). These factors can lead to a lack of motivation for essential activities like shopping, meal preparation, and making healthy eating decisions (Nagata et al., 2019).

Poor mental wellbeing has been consistently linked to poor academic performance among food insecure university students in high-income countries (Maguire et al., 2016; Soldavini and Berner, 2020; Maroto et al., 2015; Martinez et al., 2020; Raskind et al., 2019; Gallegos et al., 2014; Suardiaz-Muro et al., 2020; El Ansari et al., 2014). Anxiety, fatigue, and difficulty concentrating due to food insecurity can lead to lower GPAs, course failures, and higher dropout rates (Camelo and Elliott, 2019). Moreover, the need to work for essential expenses can negatively impact sleep quality, class attendance, and coursework completion (Farrington et al., 2012), further disrupting the learning process (Ahmad et al., 2021).

The relationship between food insecurity and mental health is complex and bidirectional. Factors such as low income, lack of social support (Martinez et al., 2020), and poor diet with inadequate macro- and micronutrients (Suardiaz-

Muro et al., 2020; El Ansari et al., 2014) can interact with various mental disorders, potentially intensifying the impact of food insecurity on mental health and vice versa (Myers, 2020). Ultimately, poor mental wellbeing threatens an individual's overall success and wellbeing, impeding their ability to lead a happy and healthy life (Ahmad et al., 2021).

4.1.3 COVID-19 pandemic, food insecurity, and mental wellbeing

The COVID-19 crisis precipitated a series of profound and interconnected crises in the academic year 2021–2022, emerging as a risk factor associated with food insecurity, health, and wellbeing that disrupted university students' health and academic performance (Marques et al., 2022; Abbey et al., 2022). Most studies indicate that university students were more likely than the general population to experience food insecurity (Marques et al., 2022). This heightened vulnerability could be attributed to COVID-19 restrictions, which, in an effort to reduce the spread of the virus, resulted in significant increases in unemployment, food insecurity, and hunger (Owens et al., 2020).

Early studies based on data collected during the COVID-19 crisis indicated that food insecurity had rapidly escalated above pre-pandemic levels (Owens et al., 2020; Hagedorn et al., 2022). In the US, for example, 34.5% of students experienced food insecurity, with some studies reporting rates as high as 46.8% during COVID-19 (DeBate et al., 2021). This increase in food insecurity correlated with a decline in mental health. According to some studies during COVID-19, 71% of university students in the US reported poor mental health

due to increased stress and anxiety, which affected their academic performance (Son et al., 2020). In Greece, COVID-19 had a severe impact on university students' mental health, increasing depression cases 25-fold and thoughts of suicide 8-fold, adversely affecting their academic performance (Kaparounaki et al., 2020). In China, 25% of university students reported feeling anxious, with higher rates among those living away from their parents (Cao et al., 2020).

In the UK, 41% of the university population was concerned about food availability due to the COVID-19 outbreak, and around 35% were food insecure, with a significant number of students suffering from poor mental health, depression symptoms, poor sleep quality (Defeyter et al., 2020; Evans et al., 2021; Hagedorn et al., 2022), and poor academic performance (DeBate et al., 2021). Notably, a recent study in the US showed that the high rate of food insecurity among university students had not been significantly affected by COVID-19, remaining consistent before and during the pandemic (Christensen et al., 2021). This finding suggests that food insecurity among university students in high-income countries existed prior to the pandemic. Food insecurity among university students is thus revealed to be complex and multifaceted issue that poses significant challenges to students' health and academic lives.

4.2 Aim and objectives

There is a critical gap in our understanding of food insecurity among the UK university student population, and its potential relationship with mental

wellbeing disorders. While both food insecurity and mental wellbeing issues have been reported to be on the rise among university students, it is not yet clear whether there is a direct link between these two phenomena in the UK context. Thus, this study aimed to examine the prevalence of food insecurity among UK university students, determine potential drivers, and assess how it affects mental wellbeing and students' ability to cope.

Objectives

- Explore the potential influence of food insecurity on health, with a particular focus on mental wellbeing.
- Investigate the association between food insecurity and students' ability to cope in stressful situations.

4.3 Materials and methods

4.3.1 Participant characteristics

University students across the UK were invited to complete an online questionnaire disseminated via email, social media, and a dedicated website (https://www.nottingham.ac.uk/toolkits/play_23013#page1) for the study. All those over the age of 18 years old and currently studying at a university in the UK for any degree, who could also be of any gender or ethnicity, and who had access to an electronic device, were eligible to participate to ensure equality and diversity. Students who were under the age of 18 years old and adults who were not students registered at UK universities were excluded. The School of Biosciences Research Ethics Committee at the University of Nottingham approved this study (SBREC2021_08). Prior to participating, all potential

participants were required to read the participant information sheet and to provide their online consent (Appendix: Online Consent 2.1 and Participant Information Sheet 2.2).

4.3.2 Study design

A newly designed questionnaire was developed for completion online via mobile devices or computers hosted by online surveys (JISC, Bristol, UK). Prior to launching the online survey among participants, a pilot survey was conducted with a small sample of university students to ensure the questionnaire's effectiveness in capturing accurate data that reflected the research objectives. The questionnaire collected sociodemographic data including demographic and financial status, eating habits alongside food security status, ability to cope and adapt to different situations, and mental wellbeing status (Appendix 2.3). These aspects were measured using validated tools that included the Household Food Insecurity Access Scale (HFIAS) (Coates et al., 2007), the Coping Flexibility Scale (CFS) (Kato, 2012), and the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) (Tennant et al., 2007; Marmara et al., 2022).

4.3.3 Measurements

4.3.3.1 Sociodemographic data

The sociodemographic data collected encompassed a wide range of personal, academic, and financial information. Personal characteristics included age, gender, ethnicity, height, and weight. Academic information covered studying status (whether undergraduate or postgraduate, full-time or part-time), subject

of study, and current grade band. We also gathered data on participants' living situations, specifically their accommodation type. Financial information was thoroughly assessed, including sources of financial support such as family or parental contributions, government or federal grants, scholarships, loans, and any other sources. We also recorded participants' employment status, disposable income, and the amount of money spent on food. Furthermore, we collected comprehensive information on health behaviours. This included eating habits and feeding behaviours, food literacy, physical activity levels, and food accessibility. We also gathered data on alcohol consumption, smoking habits, and shopping patterns. This extensive range of sociodemographic and behavioural data was collected to provide a holistic view of the participants' circumstances and lifestyle factors that might influence their food security status, ability to cope with stress, and overall mental wellbeing.

4.3.3.2 Household Food Insecurity Access Scale (HFIAS)

Food insecurity was measured using the Household Food Insecurity Access Scale (HFIAS) (Coates et al., 2007). There is no single "best" measure for evaluating the level of food security (Carrillo-Álvarez et al., 2021). However, the HFIAS is one of the most common indicators of food security (Alnafissa, 2017). It addresses many aspects of food insecurity, including anxiety and uncertainty about food supply, inadequate quality (diversity and preferences), and insufficient food intake (quantity), thus providing a comprehensive measure of food insecurity (Coates et al., 2007). The HFIAS is composed of a set of nine questions called "occurrence questions", with each question followed by a

"frequency-of-occurrence" question to determine how frequently the condition occurs. The participants were asked to choose the best answer that described their experience over the past four weeks. For each student, the HFIAS score questions were calculated by summing the codes for each frequency-of-occurrence question after the response to the occurrence questions, as they are coded as "No" with "0" and "Yes" with "1". The frequency-of-occurrence is coded as "Rarely 1", "Sometimes 2", and "Often 3". The maximum score is 27, and the minimum score is 0. The higher score indicates more food insecurity, while the lower score indicates less food insecurity. This scale has been used across various countries and populations, demonstrating its ability to distinguish between household food insecurity and food security across different cultural contexts. The HFIAS can assess the prevalence of household food insecurity (access component) and detect changes in a population's food insecurity situation over time, offering a straightforward method for determining food insecurity levels.

4.3.3.3 Coping Flexibility Scale (CFS)

The ability to cope with stressful situations was assessed using the Coping Flexibility Scale (CFS). The CFS is defined as "the ability to discontinue an ineffective coping strategy and produce and implement an alternative coping strategy." (Kato, 2012). The scale contains ten questions divided into two subscales based on dual process theory: evaluation coping (e.g., I only use certain ways to cope with stress) and adaptive coping (e.g., when a stressful situation has not improved, I try to think of other ways to cope with it); each

subscale has five items rated on a 4-point scale. Participants ranked how much each item applied to them over the last four weeks: "not applicable 0", "somewhat applicable 1", "applicable 2", and "very applicable 3" (Kato, 2012). The scale was calculated by summing the student scores and then presenting the results as a mean and standard deviation. Higher scores indicate more effective coping with stressful situations. The CFS has been used in several studies with adult populations, demonstrating its validity and reliability. Its robust psychometric qualities, applicability in clinical and research settings, and involvement in improving mental health interventions make it an important tool in psychological examinations. By using this scale to identify individuals with inadequate coping flexibility, mental health practitioners can create more effective programmes that promote adaptive coping skills (Kato 2014).

4.3.3.4 Warwick-Edinburgh Mental Wellbeing Scale (WEMWS)

Mental wellbeing was assessed using the Warwick-Edinburgh Mental Wellbeing Scale (NHS Health Scotland, University of Warwick and University of Edinburgh, 2006). The scale contains fourteen items, and participants were asked to choose the best answers that reflected their experience with each statement over the last four weeks. The statements, worded positively, cover individual wellbeing and psychological functioning. The scale is counted by summing responses to each item answered on a 1 to 5 Likert scale: "None of the time 1", "Rarely 2", "Some of the time 3", "Often 4", and "All of the time 5", then presenting the results as a mean and standard deviation. The minimum score is 14, and the maximum is 70, with high scores indicating better wellbeing.

Students' scores were classified following the WEMWBS cut points approach, where the top 15% of scores range from 60-70 and the bottom 15% range from 14–42 (Warwick Medical School, 2023). For statistical reasons, high-level scores were combined with medium scores due to the small number of students in the high-level range.

The scale was created to guarantee the general population's mental health and to evaluate projects, programmes, and policies that improve mental health rather than to identify diseases (Stewart-Brown and Janmohamed, 2008). As it can distinguish between various population groups in a way that is consistent with other population surveys and is comparatively impervious to bias. The scale is widely recognised for assessing mental health due to its comprehensiveness, robust psychometric properties, cross-cultural applicability, and relevance to health promotion and policy (Tennant et al., 2007). It has been validated for use in the UK with a large population sample over the age of 16, including students, the general population, and focus groups (Stewart-Brown and Janmohamed, 2008).

4.3.3.5 Data and statistical analysis

The questionnaire data were obtained from the JISC online platform as a self-administered survey. Food security questions were coded using HFIAS instructions, which involved summing the question codes. Students were then classified into four groups: food secure, mildly food insecure, moderately food insecure, and severely food insecure (Coates et al., 2007). The WEMWBS and CFS were analysed by summing each individual item score using ranking orders

and presenting it with means and standard deviations. In the WEMWBS, the students' scores were classified by following the scale's cut-point approach of the WEMWBS, where the top 15% of scores range from 60–70 and the bottom 15%, 14–42. Cronbach's alpha was used to assess internal consistency, indicating how closely linked scale items are as a group and serving as a measure of scale reliability. The general guideline for interpreting the reliability coefficient range is: 0.7 is regarded as acceptable, 0.8 as good, and greater than 0.9 as excellent reliability.

The Statistical Package for Social Sciences (SPSS version 27; IBM, Hampshire, UK) was used to analyse the data. Descriptive statistics were used to summarize the sociodemographic characteristics. A chi-square (χ^2) test was used to examine the associations between FI and other variables such as sociodemographic, socioeconomic, and food and health behaviours. An Independent-Samples t-test was used to determine significant differences in correlations between HFIAS, WEMWBS, and CFS scores. Binary logistic regression was applied to assess factors associated with food insecurity, with results expressed as odds ratios and 95% confidence intervals (CIs). A P value of ≤ 0.05 was considered statistically significant.

4.4 Results

This section presents the students' food security status at three distinct time points. The analysis covers food security levels during the lockdown period from February to April 2021, followed by the post-lockdown period from

October to December 2021. Additionally, it provides a comprehensive overview by combining data from both time periods.

4.4.1 Prevalence of food insecurity among UK university students

The HFIAS demonstrated acceptable to good internal consistency in our sample, with Cronbach's alpha values ranging from 0.781 to 0.805 across all data collection time points (Cronbach's α: lockdown 0.805; after lockdown 0.781; combined 0.802).

HFIAS scores varied across the different time periods of the study. During the lockdown, scores ranged from 0 to 18, with 25.7% (n = 46) of students experiencing food insecurity. After the lockdown, scores ranged from 0 to 16, with 31.8% (n = 35) reporting food insecurity. In the combined analysis of both periods, HFIAS scores ranged from 0 to 18, indicating that 28% (n = 81) of students experienced food insecurity overall (Figure 4.1). Those who were FI were classified as mild 34.8% (n = 16), moderate 32.6% (n = 15), and severe 32.6% (n = 15) during the lockdown, and 28.6% (n = 10) mild, 37.1% (n = 13) moderate, and 34.3% (n = 12) severe after the lockdown. In the combined data, 32.1% (n = 26) were mild, 34.6% (n = 28) moderate, and 33.3% (n = 27) severe.
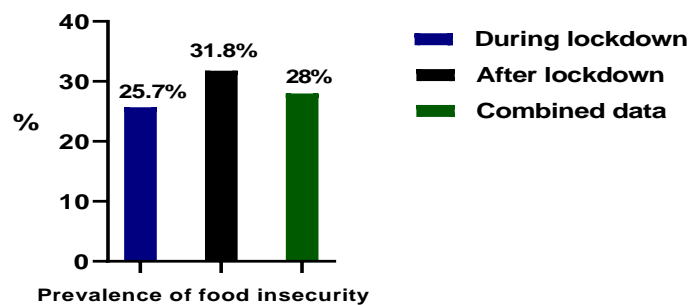
Figure 4.1: Prevalence of food insecurity among UK university students at all time investigation points.

4.4.2 Sociodemographic characteristics of the UK university students based on food security status

A total of 289 students (179 during the lockdown and 110 after the lockdown) participated in the study. A greater proportion of females than males were identified as food insecure at all points (FI: Females: Males) during the lockdown: 56.5%: 43.5%; after the lockdown: 80.0%: 14.3%; and with combined data: 68.4%: 31.6%. When comparing ethnicities, White British and Asian students were higher than other ethnicities during the lockdown (37.0%); White British students had a higher prevalence of food insecurity at 51.4% and 43.2% after the lockdown and when combined, respectively, which indicated that a higher proportion of food insecure students were among White British students, though this may have been due to a higher proportion of White British students participating (Table 4.1). The age distribution of food insecure students varied across time points. During the lockdown, the highest proportion was in the 21-25 years age group (56.5%), while after the lockdown, it shifted to the 18-20 years age group (71.4%). In the combined data, the 18-20 years group maintained the highest rate (44.4%). Most food insecure students had a normal BMI (18.5-24.9 kg/m^2) across all time points: 40.9% during the lockdown, 50% after the lockdown, and 44.7% in the combined data. This was followed by those who were overweight (BMI 25-30 kg/m^2): 27.3% during the lockdown, 25.0% after the lockdown, and 26.3% in the combined data. Undergraduate students were more likely to experience food insecurity than postgraduate students. During the lockdown, 65.2% of food insecure

students were undergraduates compared to 34.8% postgraduates. This disparity increased after the lockdown (74.3% vs 25.7%) and remained evident in the combined data (69.1% vs 30.9%). Most food insecure students were from the Faculty of Science: 28.3% during the lockdown, 60% after the lockdown, and 42.5% in the combined data. The majority of food insecure students lived in shared accommodations: 46.7% during the lockdown, 62.9% after the lockdown, and 53.8% in the combined data. Despite these observed trends, no statistically significant associations were found between participant characteristics and food insecurity (Table 4.1).

Table 4.1: Descriptive statistics of sociodemographic characteristics of UK university students based on food security status at all time points.

Variable	During lockdown HFIAS Score FS N= 133 (74.3%)	FI N= 46 (25.7%)	Total participants N= 179	P value	After lockdown HFIAS Score FS N= 75 (68.2%)	FI N= 35 (31.8%)	Total participants N= 110	P value	Combined data HFIAS Score FS N=208 (72%)	FI N= 81 (28%)	Total participants N=289 (100%)	P value
Gender												
Male	38 (28.6)	20 (43.5)	58 (32.4)	0.063	15 (20.0)	5 (14.3)	20 (18.2)	0.348	53 (25.6)	25 (31.6)	78 (27.3)	0.305
Female	95 (71.4)	26 (56.5)	121 (67.6)		59 (78.7)	28 (80.0)	87 (79.1)		154 (74.4)	54 (68.4)	208 (72.7)	
Age (Years)												
18-20	39 (29.3)	11 (23.9)	50 (27.9)		39 (52.0)	25 (71.4)	64 (58.2)		78 (37.5)	36 (44.4)	114 (39.4)	
21-25	75 (56.4)	26 (56.5)	101 (56.4)	0.617	25 (33.3)	6 (17.1)	31 (28.2)	0.139	100 (48.1)	32 (39.5)	132 (45.7)	0.416
26 and above	19 (14.3)	9 (19.6)	28 (15.7)		11 (14.7)	4 (11.4)	15 (13.6)		30 (14.4)	13 (16.0)	43 (14.9)	
Ethnicity												
White British	59 (44.4)	17 (37.0)	76 (42.5)		29 (38.7)	18 (51.4)	47 (42.7)		88 (42.3)	35 (43.2)	123 (42.6)	
Black	18 (13.5)	8 (17.4)	26 (14.5)	0.768	14 (18.7)	4 (11.4)	18 (16.4)	0.589	32 (15.4)	12 (14.8)	44 (15.2)	0.999
Asia	40 (30.1)	17 (37.0)	57 (31.8)		28 (37.3)	10 (28.6)	38 (34.5)		68 (32.7)	27 (33.3)	95 (32.9)	
Mixed	6 (4.5)	1 (2.2)	7 (3.9)		2 (2.7)	2 (5.7)	4 (3.6)		8 (3.8)	3 (3.7)	11 (3.8)	
Other White	10 (7.5)	3 (6.5)	13 (7.3)		2 (2.7)	1 (2.9)	3 (2.7)		12 (5.8)	4 (4.9)	16 (5.5)	
BMI												
<18.5 kg/m2	11 (8.7)	7 (15.9)	18 (10.5)		8 (11.3)	2 (6.3)	10 (9.7)		19 (9.6)	9 (11.8)	28 (10.2)	
18.5–25 kg/m2	76 (59.8)	18 (40.9)	94 (55.0)	0.108	37 (52.1)	16 (50.0)	53 (51.5)	0.820	113 (57.1)	34 (44.7)	147 (53.6)	0.242
25–30 kg/m2	20 (15.7)	12 (27.3)	32 (18.7)		14 (19.7)	8 (25.0)	22 (21.4)		34 (17.2)	20 (26.3)	54 (19.7)	
30kg/m2 and above	20 (15.7)	7 (15.9)	27 (15.8)		12 (16.9)	6 (18.8)	18 (17.5)		32 (16.2)	13 (17.1)	45 (16.4)	
Studying status												
Undergraduate	84 (63.6)	30 (65.2)	114 (64.0)	0.847	42 (56.0)	26 (74.3)	68 (61.8)	0.066	126 (60.9)	56 (69.1)	182 (63.2)	0.191
Postgraduate	48 (36.4)	16 (34.8)	64 (36.0)		33 (44.0)	9 (25.7)	42 (38.2)		81 (39.1)	25 (30.9)	106 (36.8)	
Full-time student	124 (93.2)	41 (89.1)	165 (92.2)	0.372	69 (92.0)	30 (85.7)	99 (90.0)	0.306	193 (92.8)	71 (87.7)	264 (91.3)	0.163
Faculty												
Science	53 (40.2)	13 (28.3)	66 (37.1)		39 (52.0)	21 (60.0)	60 (54.5)		92 (44.4)	34 (42.5)	126 (43.9)	
Social Sciences	46 (34.8)	11 (23.9)	57 (32.0)	0.031	18 (24.0)	7 (20.0)	25 (22.7)	0.439	64 (30.9)	18 (22.5)	82 (28.6)	0.284
Engineering	12 (9.1)	10 (21.7)	22 (12.4)		15 (20.0)	4 (11.4)	19 (17.3)		27 (13.0)	14 (17.5)	41 (14.3)	
Arts	21 (15.9)	12 (26.1)	33 (18.5)		3 (4.0)	2 (5.7)	5 (4.5)		24 (11.6)	14 (17.5)	38 (13.2)	
Average grade												
N/A	12 (9.8)	3 (7.0)	15 (9.0)		28 (43.1)	9 (25.7)	37 (37.0)		40 (21.3)	12 (15.4)	52 (19.5)	
59% and less	19 (15.4)	5 (11.6)	24 (14.5)	0.679	5 (7.7)	7 (20.0)	12 (12.0)	0.089	24 (12.8)	12 (15.4)	36 (13.5)	0.510
60% and above	92 (74.8)	35 (81.4)	127 (76.5)		32 (49.2)	19 (54.3)	51 (51.0)		124 (66.0)	54 (69.2)	178 (66.9)	
Accommodation												
Shared house	63 (48.1)	21 (46.7)	84 (47.7)		35 (46.7)	22 (62.9)	57 (51.8)		98 (47.6)	43 (53.8)	141 (49.3)	
Private sector	32 (24.4)	11 (24.4)	43 (24.4)	0.426	21 (28.0)	8 (22.9)	29 (26.4)	0.366	53 (25.7)	19 (23.8)	72 (25.2)	0.339
Live with family	28 (21.4)	7 (15.6)	35 (19.9)		11 (14.7)	2 (5.7)	13 (11.8)		39 (18.9)	9 (11.3)	48 (16.8)	
Live alone	8 (6.1)	6 (13.3)	14 (8.0)		8 (10.7)	3 (8.6)	11 (10.0)		16 (7.8)	9 (11.3)	25 (8.7)	

P ≤ 0.05 deemed as statistically significant.

4.4.3 Socioeconomic characteristics based on food security status

Our data revealed several financial characteristics associated with food insecurity among students. Food insecure students were more likely to consider themselves to be financially independent compared to food secure students across all time points (FI vs. FS: during the lockdown, 50.0%: 33.8%; after the lockdown, 40.0%: 33.3%; and combined, 46.3%: 33.8%; χ^2 = 3.793, p = 0.05). Furthermore, food insecure students were more likely to be employed (FI vs. FS: during the lockdown, 39.1%: 36.8%; after the lockdown, 45.7%: 33.3%; and combined, 42.0%: 35.6%) or seeking employment (FI vs. FS: during the lockdown, 60.7%: 42.9%; after the lockdown, 36.8%: 22.0%; and combined, 51.1%: 35.1%; χ^2 = 3.732, p = 0.05). Food insecure students reported lower disposable income (less than £100 per month) compared to food secure students across all time points (FI vs. FS: during the lockdown, 41.9%: 25.6%; after the lockdown, 36.4%: 24.6%; and combined, 39.5%: 25.3%).

Interestingly, although the difference did not reach statistical significance, food insecure students were more likely to spend money on food than those who did not, but only during the lockdown (35.6% vs. 18.5%) and with the combined data (23.8% vs. 19.4%). Moreover, food insecure students were more likely to have fewer savings compared to food secure students across all time points (FI vs. FS: during the lockdown, 43.2%: 63.5%; after the lockdown, 65.7%: 68.0%; and combined, 53.2%: 67.9%; χ^2 =5.240, p = 0.022), and tended to borrow money across all time points (FI vs. FS: during the lockdown, 21.7%: 14.6%; after

the lockdown, 20.6%: 8.1%; and combined, 21.3%: 12.3%; χ^2 =15.663, p =

0.002) (Table 4.2).

Table 4.2: Descriptive statistics of socioeconomic characteristics of UK university students based on food security status at all time points.

	During lockdown				After lockdown				Combined data			
Variable	**HFIAS Score**		**Total participants**	**P value**	**HFIAS Score**		**Total participants**	**P value**	**HFIAS Score**		**Total participants**	**P value**
	FS N= 133 (74.3%)	**FI** N= 46 (25.7%)	N= 179		**FS** N= 75 (68.2%)	**FI** N= 35 (31.8%)	N= 110		**FS** N= 208 (72%)	**FI** N= 81 (28%)	N=289 (100%)	
Financially independent												
Yes	44 (33.8)	23 (50.0)	67 (38.1)	0.052	25 (33.3)	14 (40.0)	39 (35.5)	0.651	69 (33.8)	37 (46.3)	106 (37.3)	0.051
No	86 (66.2)	23 (50.0)	109 (61.9)		49 (65.3)	20 (57.1)	69 (62.7)		135 (66.2)	43 (53.8)	178 (62.7)	
Job												
Yes	49 (36.8)	18 (39.1)	67 (37.4)	0.782	25 (33.3)	16 (45.7)	41 (37.3)	0.211	74 (35.6)	34 (42.0)	108 (37.4)	0.313
No	84 (63.2)	28 (60.9)	112 (62.6)		50 (66.7)	19 (54.3)	69 (62.7)		134 (64.4)	47 (58.0)	181 (62.6)	
Trying to find a job												
Yes	36 (42.9)	17 (60.7)	53 (47.3)	0.101	11 (22.0)	7 (36.8)	18 (26.1)	0.210	47 (35.1)	24 (51.1)	71 (39.2)	0.053
No	48 (57.1)	11 (39.3)	59 (52.7)		39 (78.0)	12 (63.2)	51 (73.9)		87 (64.9)	23 (48.9)	110 (60.8)	
Disposable income/month												
£0-100	30 (25.6)	18 (41.9)	48 (30.0)		15 (24.6)	12 (36.4)	27 (28.7)		45 (25.3)	30 (39.5)	75 (29.5)	
£101-200	32 (27.4)	7 (16.3)	39 (24.4)	0.104	19 (31.1)	11 (33.3)	30 (31.9)	0.345	51 (28.7)	18 (23.7)	69 (27.2)	0.076
£201 and greater	55 (47.0)	18 (41.9)	73 (45.6)		27 (44.3)	10 (30.3)	37 (39.4)		82 (46.1)	28 (36.8)	110 (43.3)	
Money spends on food/week												
£0-60	106 (81.5)	29 (64.4)	135 (77.1)	0.019	56 (78.9)	32 (91.4)	88 (83.0)	0.105	162 (80.6)	61 (76.3)	223 (79.4)	0.417
£61 and more	24 (18.5)	16 (35.6)	40 (22.9)		15 (21.1)	3 (8.6)	18 (17.0)		39 (19.4)	19 (23.8)	58 (20.6)	
Financial support												
Parental	90 (69.8)	25 (55.6)	115 (66.1)	0.083	56 (74.7)	27 (77.1)	83 (75.5)	0.486	146 (72.6)	52 (65.0)	198 (70.5)	0.205
Grants/ scholarships	44 (33.8)	21 (46.7)	65 (37.1)	0.125	19 (25.3)	11 (31.4)	30 (27.3)	0.648	63 (30.9)	32 (40.0)	95 (33.5)	0.143
Student loans	95 (72.0)	30 (65.2)	125 (70.2)	0.388	45 (60.0)	25 (71.4)	70 (63.6)	0.440	140 (68.0)	55 (67.9)	195 (67.9)	0.992
Savings	80 (63.5)	19 (43.2)	99 (58.2)	0.019	51 (68.0)	23 (65.7)	74 (67.3)	0.070	131 (67.9)	42 (53.2)	173 (63.6)	0.022
Borrowed money												
Never	87 (66.9)	18 (39.1)	105 (59.7)		56 (75.7)	20 (58.8)	76 (70.4)		143 (70.1)	38 (47.5)	181 (63.7)	
Sometimes	24 (18.5)	18 (39.1)	42 (23.9)	0.003	12 (16.2)	7 (20.6)	19 (17.6)	0.122	36 (17.6)	25 (31.3)	61 (21.5)	0.002
Often	19 (14.6)	10 (21.7)	29 (16.5)		6 (8.1)	7 (20.6)	13 (12.0)		25 (12.3)	17 (21.3)	42 (14.8)	

P ≤ 0.05 deemed as statistically significant.

4.4.4 Food behaviour based on food security status

We observed that food insecure students were significantly less likely to eat three meals per day regardless of when the data were collected compared to food secure students (FI vs. FS: during the lockdown, 39.1%: 64.7%; after the lockdown, 45.7%: 49.3%; and combined, 42.0%: 59.4%; χ^2 = 7.14, p = 0.008). They were also more likely to never have a snack between meals compared to food secure students (FI vs. FS: during the lockdown, 13.0%: 3.8%; after the lockdown, 11.4%: 4.0%; and combined, 12.3%: 3.9%; χ^2 = 8.187, p = 0.042). However, food insecure students were more likely to drink alcohol more than 2 days a week compared to food secure students; this was only observed after the lockdown (60.0% vs. 25.7%; χ^2 = 20.387, p < 0.001), which reflected a significant result when data were combined (42.5% vs. 30%; χ^2 = 9.042, p = 0.026), and smoke at least 1-4 days a week (FI vs. FS: during the lockdown, 24.4%: 9.8%, after the lockdown, 20.6%: 14.7%, and combined, 22.8%: 11.6%; χ^2 = 8.567, p = 0.05). However, no significant differences were found between food insecure and food secure students in the frequency of fruit and vegetable consumption at any time point (Table 4.3).

4.4.5 Food literacy skills based on food security status

Table 4.4 shows food literacy skills and their association with food security. No differences were found in food literacy skills between food insecure and food secure students, although food insecure students had less confidence in managing money to purchase healthy food during the lockdown and when the data were combined (FI vs. FS: during the lockdown, 13.6%: 30.1%; and

combined, 12.8%: 25.6%; χ^2 =11.520, p = 0.011). Also, food insecure students reported that they were more likely to run out of money to spend on food compared to food secure students at all time points (FI vs. FS: during the lockdown, 42.9%: 13.6%; after the lockdown, 32.4%: 8.2%; and combined, 38.2%: 11.7%; χ^2 = 37.297, p < 0.001), Table 4.4.

Table 4.3: Descriptive statistics of food behaviour status of UK university students based on food security status at all time points.

	During lockdown				After lockdown				Combined data			
Variable	**HFIAS Score**		**Total**	**P**	**HFIAS Score**		**Total**	**P**	**HFIAS Score**		**Total**	**P**
	FS	**FI**	**participants**	**value**	**FS**	**FI**	**participants**	**value**	**FS**	**FI**	**participants**	**value**
	N= 133 (74.3%)	**N= 46 (25.7%)**	**N= 179**		**N= 75 (68.2%)**	**N= 35 (31.8%)**	**N= 110**		**N= 208 (72%)**	**N=81 (28%)**	**N= 289 (100%)**	
Main meal/day												
1-2 meals	47 (35.3)	28 (60.9)	75 (41.9)	0.002	37 (49.3)	19 (54.3)	56 (50.9)	0.724	84 (40.6)	47 (58.0)	131 (45.5)	0.008
3 +meals	86 (64.7)	18 (39.1)	104 (58.1)		37 (49.3)	16 (45.7)	53 (48.2)		123 (59.4)	34 (42.0)	157 (54.5)	
Snack/day												
Never	5 (3.8)	6 (13.0)	11 (6.2)		3 (4.0)	4 (11.4)	7 (6.4)		8 (3.9)	10 (12.3)	18 (6.3)	
Once	38 (28.8)	14 (30.4)	52 (29.2)	0.089	28 (37.3)	14 (40.0)	42 (38.2)	0.359	66 (31.9)	28 (34.6)	94 (32.6)	0.042
Twice	52 (39.4)	12 (26.1)	64 (36.0)		18 (24.0)	9 (25.7)	27 (24.5)		70 (33.8)	21 (25.9)	91 (31.6)	
More than twice	37 (28.0)	14 (30.4)	51 (28.7)		26 (34.7)	8 (22.9)	34 (30.9)		63 (30.4)	22 (27.2)	85 (29.5)	
Eating habits in the term time												
Unhealthy	36 (27.1)	15 (33.3)	51 (28.6)		23 (30.7)	12 (34.3)	35 (31.8)		59 (28.4)	27 (33.8)	86 (29.9)	
Healthy	82 (61.7)	27 (60.0)	109 (61.2)	0.554	45 (60.0)	20 (57.1)	65 (59.1)	0.929	127 (61.1)	47 (58.8)	174 (60.4)	0.556
I do not know	15 (11.3)	3 (6.7)	18 (10.1)		7 (9.3)	3 (8.6)	10 (9.1)		22 (10.6)	6 (7.5)	28 (9.7)	
Eating habits outside of term time												
Unhealthy	16 (12.0)	12 (26.1)	28 (15.6)		16 (21.3)	8 (22.9)	24 (21.8)		31 (14.9)	20 (24.7)	51 (17.6)	
Healthy	109 (82.0)	32 (69.6)	141 (78.7)	0.076	56 (74.7)	26 (74.3)	82 (74.5)	0.946	166 (79.8)	58 (71.6)	224 (77.5)	0.137
I do not know	8 (6.0)	2 (4.3)	10 (5.6)		3 (4.0)	1 (2.9)	4 (3.6)		11 (5.3)	3 (3.7)	14 (4.8)	
Eating fruit												
0-1 a week	20 (15.0)	10 (22.2)	30 (16.9)		11 (14.9)	7 (20.6)	18 (16.7)		31 (15.0)	17 (21.5)	48 (16.8)	
2-4days/week	42 (31.6)	20 (44.4)	62 (34.8)	0.130	31 (41.9)	14 (41.2)	45 (41.7)	0.213	73 (35.3)	34 (43.0)	107 (37.4)	0.112
5-6 days/week	29 (21.8)	5 (11.1)	34 (19.1)		14 (18.9)	10 (29.4)	24 (22.2)		43 (20.8)	15 (19.0)	58 (20.3)	
Everyday	42 (31.6)	10 (22.2)	52 (29.2)		18 (24.3)	3 (8.8)	21 (19.4)		60 (29.0)	13 (16.5)	73 (25.5)	
Eating vegetables												
0-1 a week	10 (7.5)	6 (13.0)	16 (8.9)		10 (13.5)	5 (14.7)	15 (13.9)		20 (9.7)	11 (13.8)	31 (10.8)	
2-4days/week	37 (27.8)	16 (34.8)	53 (29.6)	0.376	19 (25.7)	11 (32.4)	30 (27.8)	0.699	56 (27.1)	27 (33.8)	83 (28.9)	0.407
5-6 days/week	22 (16.5)	8 (17.4)	30 (16.8)		18 (24.3)	5 (14.7)	23 (21.3)		40 (19.3)	13 (16.3)	53 (18.5)	
Everyday	64 (48.1)	16 (34.8)	80 (44.7)		27 (36.5)	13 (38.2)	40 (37.0)		91 (44.0)	29 (36.3)	120 (41.8)	
Consuming alcohol												
Never	44 (34.1)	19 (42.2)	63 (36.2)		29 (39.2)	12 (34.3)	41 (37.6)		73 (36.0)	31 (38.8)	104 (36.7)	
Once a week	43 (33.3)	13 (28.9)	56 (32.2)	0.621	26 (35.1)	2 (5.7)	28 (25.7)	<0.001	69 (34.0)	15 (18.8)	84 (29.7)	0.026
More than 2 days/week	42 (32.6)	13 (28.9)	55 (31.6)		19 (25.7)	21 (60.0)	40 (36.7)		61 (30.0)	34 (42.5)	95 (33.6)	

Variable	During lockdown HFIAS Score FS N= 133 (74.3%)	FI N= 46 (25.7%)	Total participants N= 179	P value	After lockdown HFIAS Score FS N= 75 (68.2%)	FI N= 35 (31.8%)	Total participants N= 110	P value	Combined data HFIAS Score FS N= 208 (72%)	FI N=81 (28%)	Total participants N= 289 (100%)	P value
Smoking												
Never	100 (75.8)	27 (60.0)	127 (71.8)	0.039	61 (81.3)	25 (73.5)	86 (78.9)	0.651	161 (77.8)	52 (65.8)	213 (74.5)	0.050
1-4 days/ week	13 (9.8)	11 (24.4)	24 (13.6)		11 (14.7)	7 (20.6)	18 (16.5)		24 (11.6)	18 (22.8)	42 (14.7)	
More than 5days/week	19 (14.4)	7 (15.6)	26 (14.7)		3 (4.0)	2 (5.9)	5 (4.6)		22 (10.6)	9 (11.4)	31 (10.8)	
Sleeping/night												
1-6 hours	31 (23.3)	13 (28.9)	44 (24.7)	0.453	25 (33.3)	16 (45.7)	41 (37.3)	0.211	56 (26.9)	29 (36.3)	85 (29.5)	0.120
7-12 hours	102 (76.7)	32 (71.1)	134 (75.3)		50 (66.7)	19 (54.3)	69 (62.7)		152 (73.1)	51 (63.7)	203 (70.5)	
Physical activity level												
Light	63(47.4)	21 (47.7)	84 (47.5)		30 (40.5)	15 (42.9)	45 (41.3)		93 (44.9)	36 (45.6)	129 (45.1)	
Moderate	56 (42.1)	17 (38.6)	73 (41.2)	0.827	40 (54.1)	14 (40.0)	54 (49.5)	0.103	96 (46.4)	31 (39.2)	127 (44.4)	0.228
Very active	14 (10.5)	6 (13.6)	20 (11.3)		4 (5.4)	6 (17.1)	10 (9.2)		18 (8.7)	12 (15.2)	30 (10.5)	
Cooking classes												
Yes	14 (10.5)	7 (15.2)	21 (11.7)	0.394	7 (9.3)	7 (20.0)	14 (12.7)	0.118	21 (10.1)	14 (17.3)	35 (12.1)	0.093
No	119 (89.5)	39 (84.8)	158 (88.3)		68 (90.7)	28 (29.2)	96 (87.3)		187 (89.9)	67 (82.7)	254 (87.9)	

P ≤ 0.05 deemed as statistically significant.

Table 4.4: Descriptive statistics of food literacy skills of UK university students based on food security status at all time points.

	During lockdown				After lockdown				Combined data			
Variable	**HFIAS Score FS** N= 133 (74.3%)	**FI** N= 46 (25.7%)	**Total participants** N= 179	**P value**	**HFIAS Score FS** N= 75 (68.2%)	**FI** N=35 (31.8%)	**Total participants** N=110	**P value**	**HFIAS Score FS** N= 208 (72%)	**FI** N=81 (28%)	**Total participants** N= 289 (100%)	**P value**
Plan meals ahead												
Never	13 (9.8)	7 (15.6)	20 (11.2)		6 (8.0)	7 (20.0)	13 (11.8)		19 (9.1)	14 (17.5)	33 (11.5)	
Sometimes Most of	59 (44.4)	18 (40.0)	77 (43.3)		32 (42.7)	16 (45.7)	48 (43.6)		91 (43.8)	34 (42.5)	125 (43.4)	
the time	41 (30.8)	15 (33.3)	56 (31.5)	0.663	28 (37.3)	9 (25.7)	37 (33.6)	0.243	69 (33.2)	24 (30.0)	93 (32.3)	0.219
Always	20 (15.0)	5 (11.1)	25 (14.0)		9 (12.0)	3 (8.6)	12 (10.9)		29 (13.9)	8 (10.0)	37 (12.8)	
Make shopping lists												
Never	13 (9.8)	5 (11.4)	18 (10.2)		8 (10.7)	2 (5.7)	10 (9.1)		21 (10.1)	7 (8.9)	28 (9.8)	
Sometimes	29 (21.8)	15 (34.1)	44 (24.9)	0.354	23 (30.7)	10 (28.6)	33 (30.0)	0.823	52 (25.0)	25 (31.6)	77 (26.8)	0.663
Most of the time	37 (27.8)	11 (25.0)	48 (27.1)		20 (26.7)	11 (31.4)	31 (28.2)		57 (27.4)	22 (27.8)	79 (27.5)	
Always	54 (40.6)	13 (29.5)	67 (37.9)		24 (32.0)	12 (34.3)	36 (32.7)		78 (37.5)	25 (31.6)	103 (35.9)	
Plan balanced meals												
Never	39 (29.5)	12 (26.7)	51 (28.8)		22 (30.6)	14 (41.2)	36 (34.0)		61 (29.9)	26 (32.9)	87 (30.7)	
Sometimes	36 (27.3)	19 (42.2)	55 (31.1)	0.234	29 (40.3)	14 (41.2)	43 (40.6)	0.298	65 (31.9)	33 (41.8)	98 (34.6)	0.097
Most of the time	39 (29.5)	8 (17.8)	47 (26.6)		14 (19.4)	2 (5.9)	16 (15.1)		53 (26.0)	10 (12.7)	63 (22.3)	
Always	18 (13.6)	6(13.3)	24 (13.6)		7 (9.7)	4 (11.8)	11 (10.4)		25 (12.3)	10 (12.7)	35 (12.4)	
Choose healthy choices												
Never	6 (4.5)	3 (6.7)	9 (5.1)		6 (8.1)	2 (5.9)	8 (7.4)		12 (5.8)	5 (6.3)	17 (5.9)	
Sometimes	33 (24.8)	12 (26.7)	45 (25.3)		29 (39.2)	10 (29.4)	39 (36.1)		62 (30.0)	22 (27.8)	84 (29.4)	
Most of the time	63 (47.4)	20 (44.4)	83 (46.6)	0.933	24 (32.4)	13 (38.2)	37 (34.3)	0.704	87 (42.0)	33 (41.8)	120 (42.0)	0.978
Always	31 (23.3)	10 (22.2)	41 (23.0)		15 (20.3)	9 (26.5)	24 (22.2)		46 (22.2)	19 (24.1)	65 (22.7)	
Feel confident managing money for healthy food												
Never	6 (4.5)	6 (4.5)	12 (6.8)		6 (8.1)	6 (17.6)	12 (11.1)		12 (5.8)	12 (15.4)	24 (8.4)	
Sometimes	42 (31.6)	17 (38.6)	59 (33.3)	0.046	23 (31.1)	12 (35.3)	35 (32.4)	0.408	65 (31.4)	29 (37.2)	94 (33.0)	0.011
Most of the time	45 (33.8)	15 (34.1)	60 (33.9)		32 (43.2)	12 (35.3)	44 (40.7)		77 (37.2)	27 (34.6)	104 (36.5)	
Always	40 (30.1)	6 (13.6)	46 (26.0)		13 (17.6)	4 (11.8)	17 (15.7)		53 (25.6)	10 (12.8)	63 (22.1)	
Use information on food labels												
Never	17 (12.9)	4 (8.9)	21 (11.9)		24 (32.0)	10 (29.4)	34 (31.2)		41 (19.8)	14 (17.7)	55 (19.2)	
Sometimes	52 (39.4)	16 (35.6)	68 (38.4)		23 (30.7)	11 (32.4)	34 (31.2)		75 (36.2)	27 (34.2)	102 (35.7)	
Most of the time	35 (26.5)	17 (37.8)	52 (29.4)	0.528	18 (24.0)	5 (14.7)	23 (21.1)	0.475	53 (25.6)	22 (27.8)	75 (26.2)	0.937
Always	28 (21.2)	8 (17.8)	36 (20.3)		10 (13.3)	8 (23.5)	18 (16.5)		38 (18.4)	16 (20.3)	54 (18.9)	

	During lockdown				After lockdown				Combined data			
Variable	HFIAS Score FS N= 133 (74.3%)	FI N= 46 (25.7%)	Total participants N= 179	P value	HFIAS Score FS N= 75 (68.2%)	FI N=35 (31.8%)	Total participants N=110	P value	HFIAS Score FS N= 208 (72%)	FI N=81 (28%)	Total participants N= 289 (100%)	P value
Cook at home												
Never	3 (2.3)	2 (4.7)	5 (2.8)		1 (1.4)	1 (2.9)	2 (1.9)		4 (1.9)	3 (3.9)	7 (2.5)	
Sometimes	27 (20.3)	12 (27.9)	39 (22.2)		19 (26.0)	9 (26.5)	28 (26.2)		46 (22.3)	21 (27.3)	67 (23.7)	
Most of the time	59 (44.4)	13 (30.2)	72 (40.9)	0.354	35 (47.9)	9 (26.5)	44 (41.1)	0.124	94 (45.6)	22 (28.6)	116 (41.0)	0.066
Always	44 (33.1)	16 (37.2)	60 (34.1)		18 (24.7)	15 (44.1)	33 (30.8)		62 (30.1)	31 (40.3)	93 (32.9)	
Confident cook healthy meals												
Never	8 (6.1)	5 (11.4)	13 (7.4)		3 (4.1)	3 (8.8)	6 (5.6)		11 (5.3)	8 (10.3)	19 (6.7)	
Sometimes	29 (22.0)	9 (20.5)	38 (21.6)	0.715	28 (37.8)	7 (20.6)	35 (32.4)	0.286	57 (27.7)	16 (20.5)	73 (25.7)	0.356
Most of the time	51 (38.6)	16 (36.4)	67 (38.1)		25 (33.8)	13 (38.2)	38 (35.2)		76 (36.9)	29 (37.2)	105 (37.0)	
Always	44 (33.3)	14 (31.8)	58 (33.0)		18 (24.3)	11 (32.4)	29 (26.9)		62 (30.1)	25 (32.1)	87 (30.6)	
Try a new recipe												
Never	7 (5.3)	4 (9.1)	11 (6.2)		6 (8.1)	4 (11.8)	10 (9.3)		13 (6.3)	8 (10.3)	21 (7.4)	
Sometimes	54 (40.6)	19 (43.2)	73 (41.2)	0.748	39 (52.7)	13 (38.2)	52 (48.1)	0.564	93 (44.9)	32 (41.0)	125 (43.9)	0.677
Most of the time	41 (30.8)	11 (25.0)	52 (29.4)		18 (24.3)	10 (29.4)	28 (25.9)		59 (28.5)	21 (26.9)	80 (28.1)	
Always	31 (23.3)	10 (22.7)	41 (23.2)		11 (14.9)	7 (20.6)	18 (16.7)		42 (20.3)	17 (21.8)	59 (20.7)	
Change recipes for healthier meals												
Never	24 (18.0)	5 (11.4)	29 (16.4)		17 (23.0)	6 (17.6)	23 (21.3)		41 (19.8)	11 (14.1)	52 (18.2)	
Sometimes	50 (37.6)	20 (45.5)	70 (39.5)	0.658	34 (45.9)	14 (41.2)	48 (44.4)	0.771	84 (40.6)	34 (43.6)	118 (41.4)	0.708
Most of the time	34 (25.6)	12 (27.3)	46 (26.0)		15 (20.3)	9 (26.5)	24 (22.2)		49 (23.7)	21 (26.9)	70 (24.6)	
Always	25 (18.8)	7 (15.9)	32 (18.1)		8 (10.8)	5 (14.7)	13 (12.0)		33 (15.9)	12 (15.4)	45 (15.8)	
Compare prices of foods												
Never	11 (8.4)	4 (8.9)	15 (8.5)		5 (6.7)	1 (3.0)	6 (5.6)		16 (7.8)	5 (6.4)	21 (7.4)	
Sometimes	32 (24.4)	11 (24.4)	43 (24.4)	0.716	24 (32.0)	6 (18.2)	30 (27.8)	0.172	56 (27.2)	17 (21.8)	73 (25.7)	0.235
Most of the time	46 (35.1)	12 (26.7)	58 (33.0)		25 (33.3)	10 (30.3)	35 (32.4)		71 (34.5)	22 (28.2)	93 (32.7)	
Always	42 (32.1)	18 (40.0)	60 (34.1)		21 (28.0)	16 (48.5)	37 (34.3)		63 (30.6)	34 (43.6)	97 (34.2)	
Run out of money for food												
Never	74 (56.1)	11 (26.2)	85 (48.9)		56 (76.7)	11 (32.4)	67 (62.6)		130 (63.4)	22 (28.9)	152 (54.1)	
Sometimes	40 (30.3)	13 (31.0)	53 (30.5)	<0.001	11 (15.1)	12 (35.3)	23 (21.5)	<0.001	51 (24.9)	25 (32.9)	76 (27.0)	<0.001
Most of the time	18 (13.6)	18 (42.9)	36 (20.7)		6 (8.2)	11 (32.4)	17 (15.9)		24 (11.7)	29 (38.2)	53 (18.9)	
Thaw meat at room temperature												
Never	46 (35.4)	15 (34.9)	61 (35.3)		28 (40.0)	13 (39.4)	41 (39.8)		74 (37.0)	28 (36.8)	102 (37.0)	
Sometimes	40 (30.8)	16 (37.2)	56 (32.4)	0.698	23 (32.9)	11 (33.3)	34 (33.0)	0.787	63 (31.5)	27 (35.5)	90 (32.6)	0.909
Most of the time	28 (21.5)	6 (14.0)	34 (19.7)		11 (15.7)	7 (21.2)	18 (17.5)		39 (19.5)	13 (17.1)	52 (18.8)	
Always	16 (12.3)	6 (14.0)	22 (12.7)		8 (11.4)	2 (6.1)	10 (9.7)		24 (12.0)	8 (10.5)	32 (11.6)	

P ≤ 0.05 deemed as statistically significant.

4.4.6 Food accessibility pattern based on food security status

Students who were food insecure were less often able to shop for food (FI vs. FS: during the lockdown 28.9%: 71.2%; after the lockdown 34.3%: 56.0; and combined 31.3%: 65.7%; χ^2 =34.877, p < 0.001). While showing difficulties acquiring a variety of nutritious foods compared to food secure students across all time points (FI vs. FS: during the lockdown 20.5%: 5.3%; after the lockdown 28.6%: 9.7%; and combined 24.1%: 6.9%; χ^2 =16.332, p < 0.001; Table 4.5). This may potentially be due to the distance to food shops (FI vs. FS: during the lockdown, 45.7%: 24.1%; after the lockdown, 48.6%: 40.0%; and combined, 46.9%: 29.8%; χ^2 = 7.538, p = 0.006), the price of food, which showed a significant difference across all time points (FI vs. FS: during the lockdown 47.8%: 24.8%; χ^2 = 8.505, p = 0.004), after the lockdown (45.7%: 18.7%; χ^2 = 8.802, p = 0.003), and combined (46.9%: 22.6%; χ^2 = 16.605, p < 0.001), and the availability of food storage rooms and cooking equipment (FI vs. FS: during the lockdown 26.1%: 17.3%; after the lockdown 31.4%: 17.3%; and combined 28.4%: 17.3%; χ^2 = 4.411, p = 0.036) (Table 4.5).

Table 4.5: Descriptive statistics of food accessibility pattern of UK university students based on food security status at all time points.

Variable	During lockdown				After lockdown				Combined data			
	HFIAS Score FS N= 133 (74.3%)	FI N= 46 (25.7%)	Total participants N= 179	P value	HFIAS Score FS N= 75 (68.2%)	FI N= 35 (31.8%)	Total participants N= 110	P value	HFIAS Score FS N=208 (72%)	FI N= 81 (28%)	Total participants N= 289 (100%)	P value
Shopping ability for food												
Sometimes	16 (12.1)	23 (51.1)	39 (22.0)		15 (20.0)	11 (31.4)	26 (23.6)		31 (15.0)	34 (42.5)	65 (22.6)	
Often	22 (16.7)	9 (20.0)	31 (17.5)	<0 .001	18 (24.0)	12 (34.3)	30 (27.3)	0.103	40 (19.3)	21 (26.3)	61 (21.3)	<0.001
Always	94 (71.2)	13 (28.9)	107 (60.5)		42 (56.0)	12 (34.3)	54 (49.1)		136 (65.7)	25 (31.3)	161 (56.1)	
Shopped for food												
1-2/month												
Once/week	25 (18.9)	11 (24.4)	36 (20.3)		14 (18.7)	11 (31.4)	25 (22.7)		39 (18.8)	22 (27.5)	61 (21.3)	
Twice/ week	52 (39.4)	19 (42.2)	71 (40.1)	0.695	39 (52.0)	16 (45.7)	55 (50.0)	0.462	91 (44.0)	35 (43.8)	126 (43.9)	0.292
Three times or	40 (30.3)	12 (26.7)	52 (29.4)		14 (18.7)	6 (17.1)	20 (18.2)		54 (26.1)	18 (22.5)	72 (25.1)	
more/week	15 (11.4)	3 (6.7)	18 (10.2)		8 (10.7)	2 (5.7)	10 (9.1)		23 (11.1)	5 (6.3)	28 (9.8)	
Typically purchased food												
In person	114 (86.4)	37 (82.2)	151 (85.3)		65 (87.8)	32 (91.4)	97 (89.0)		179 (86.9)	69 (86.3)	248 (86.7)	
Online	9 (6.8)	3 (6.7)	12 (6.8)	0.654	7 (9.5)	1 (2.9)	8 (7.3)	0.362	16 (7.8)	4 (5.0)	20 (7.0)	0.428
Adults (family/friends)	9 (6.8)	5 (11.1)	14 (7.9)		2 (2.7)	2 (5.7)	4 (3.7)		11 (5.3)	7 (8.8)	18 (6.3)	
Transportation used for food shopping												
Bus/Tram	17 (12.8)	8 (17.4)	25 (14.0)	0.437	24 (32.0)	13 (37.1)	37 (33.6)	0.595	41 (19.7)	21 (25.9)	62 (21.5)	0.248
Own car	46 (34.6)	7 (15.2)	53 (29.6)	0.013	12 (16.0)	6 (17.1)	18 (16.4)	0.880	58 (27.9)	13 (16.0)	71 (24.6)	0.036
Friend's /relative's car	27 (20.3)	9 (19.6)	36 (20.1)	0.915	11 (14.7)	7 (20.0)	18 (16.4)	0.481	38 (18.3)	16 (19.8)	54 (18.7)	0.771
Taxi	10 (7.5)	0 (0.0)	110 (5.6)	0.056	5 (6.7)	3 (8.6)	8 (7.3)	0.720	15 (7.2)	3 (3.7)	18 (6.2)	0.268
Walk	81 (60.9)	31 (67.4)	112 (62.6)	0.433	52 (69.3)	25 (71.4)	77 (70.0)	0.823	133 (63.9)	56 (69.1)	189 (65.4)	0.405
Bicycle	2 (1.5)	1 (2.2)	3 (1.7	0.760	1 (1.3)	1 (2.9)	2 (1.8)	0.577	3 (1.4)	2 (2.5)	5 (1.7)	0.551
Difficulty for shopping												
Difficult	7 (5.3)	9 (20.5)	16 (9.1)		7 (9.7)	10 (28.6)	17 (15.9)		14 (6.9)	19 (24.1)	33 (11.7)	
Not difficult at all	125 (94.7)	35 (79.5)	160 (90.9)	0.002	65 (90.3)	25 (71.4)	90 (84.1)	0.012	190 (93.1)	60 (75.9)	250 (88.3)	<0.001

	During lockdown				After lockdown				Combined data			
Variable	HFIAS Score FS N= 133 (74.3%)	FI N= 46 (25.7%)	Total participants N= 179	P value	HFIAS Score FS N= 75 (68.2%)	FI N= 35 (31.8%)	Total participants N= 110	P value	HFIAS Score FS N=208 (72%)	FI N= 81 (28%)	Total participants N= 289 (100%)	P value
Factors affected ability to access foods												
Distance to food shops	32 (24.1)	21 (45.7)	53 (29.6)	0.006	30 (40.0)	17 (48.6)	47 (42.7)	0.397	62 (29.8)	38 (46.9)	100 (34.6)	0.006
Reliable and adequate public transport	6 (4.5)	1 (2.2)	7 (3.9)	0.481	4 (5.3)	3 (8.6)	7 (6.4)	0.517	10 (4.8)	4 (4.9)	14 (4.8)	0.963
Knowledge and cooking skills to prepare healthy meals	23 (17.3)	5 (10.9)	28 (15.6)	0.301	14 (18.7)	7 (20.0)	21 (19.1)	0.868	37 (17.8)	12 (14.8)	49 (17.0)	0.545
Availability of healthy foods	19 (14.3)	10 (21.7)	29 (16.2)	0.237	7 (9.3)	5 (14.3)	12 (10.9)	0.438	26 (12.5)	15 (18.5)	41 (14.2)	0.188
Availability of culturally appropriate foods	16 (12.0)	5 (11.1)	21 (11.8)	0.869	8 (10.7)	4 (11.4)	12 (10.9)	0.905	24 (11.5)	9 (11.3)	33 (11.5)	0.945
Food storage room and cooking equipment available at home	23 (17.3)	12 (26.1)	35 (19.6)	0.195	13 (17.3)	11 (31.4)	24 (21.8)	0.095	36 (17.3)	23 (28.4)	59 (20.4)	0.036
Space to prepare food and cooking facilities (e.g., stove, oven, microwave) at home	16 (12.0)	6 (13.0)	22 (12.3)	0.857	6 (8.0)	6 (17.1)	12 (10.9)	0.152	22 (10.6)	12 (14.8)	34 (11.8)	0.315
Inadequate time to shop, prepare and cook food	33 (24.8)	13 (28.3)	46 (25.7)	0.644	28 (37.3)	14 (40.0)	42 (38.2)	0.789	61 (29.3)	27 (33.3)	88 (30.4)	0.506
Price of food	33 (24.8)	22 (47.8)	55 (30.7)	0.004	14 (18.7)	16 (45.7)	30 (27.3)	0.003	47 (22.6)	38 (46.9)	85 (29.4)	<0.001
Not applicable	45 (33.8)	7 (15.2)	52 (29.1)	0.017	21 (28.0)	2 (5.7)	23 (20.9)	0.007	66 (31.7)	9 (11.1)	75 (26.0)	<0.001

P ≤ 0.05 deemed as statistically significant.

4.4.7 Mental wellbeing and food insecurity among university students

In this study, the WEMWBS reflected strong internal consistency in our sample, with high Cronbach's alpha at all data collection time points (Cronbach's α: lockdown 0.93; after lockdown 0.92; combined 0.91). We observed a significant decrease in mental wellbeing in those deemed as FI when compared to FS particularly during the COVID-19 lockdown (WEMWBS score (mean ± SD): During lockdown, FI, 39.7 ± 9.9, FS, 45.6 ± 10.0; p < 0.001; after the lockdown, FI, 44.0 ± 8.6, FS, 45.1 ± 9.5; p = n.s.; combined, FI, 41.6 ± 9.6, FS, 45.4 ± 9.8; p = 0.003). Furthermore, the prevalence of low mental wellbeing in those deemed as FI was high compared to FS students during lockdown (Mental wellbeing prevalence (%): Low FI, 56.5%, FS, 41.4%; Medium-high FI, 43.5%, FS, 58.6%, p = 0.001). Interestingly, although the prevalence was still high between the two groups after the lockdown, food secure students had higher levels of poor mental wellbeing although this failed to reach statistical significance between the two groups (Mental wellbeing prevalence (%): Low FI, 41.2%, FS, 46.7%, Medium-high: FI, 58.8% FS, 53.3%, p = n.s.). However, when the data were combined, the WEMWBS showed that food insecure students had a higher prevalence of low mental wellbeing compared to food secure students (Mental wellbeing prevalence (%): Low FI, 50.0%, FS, 43.3%; Medium-high FI, 50.0%, FS, 56.7%; p = 0.003). The average WEMWBS score is classified as having low mental wellbeing (WEMWBS score 14–42) and medium-high wellbeing (WEMWBS score 43–70; Table 4.6).

Table 4.6: The association between food insecurity status (assessed using HFIAS) and mental wellbeing (assessed using WEMWBS) during and after COVID-19 lockdown, and for combined data, among UK university students. An Independent-Samples t-test was used to assess this correlation. Data are presented as (%), mean ± SD.

Time points	WEMWBS	N (%)	Low scores 14-42 N (%)	Medium- high scores 43-70 N (%)	Mean ± SD	P value
During lockdown	FS	133 (74.3)	55 (41.4)	78 (58.6)	45.6 ± 10.0	<0.001
	FI	46 (25.7)	26 (56.5)	20 (43.5)	39.7 ± 9.9	
After lockdown	FS	75 (68.8)	35 (46.7)	40 (53.3)	45.1 ± 9.5	0.590
	FI	34 (31.2)	14 (41.2)	20 (58.8)	44.0 ± 8.6	
Combined data	FS	208 (72.2)	90 (43.3)	118 (56.7)	45.4 ± 9.8	0.003
	FI	80 (27.8)	40 (50.0)	40 (50.0)	41.6 ± 9.6	

P ≤ 0.05 deemed as statistically significant.

4.4.8 Coping flexibility and food insecurity among university students

In this study, the CFS showed acceptable to good internal consistency in our sample, with a Cronbach's alpha value at all data collection points (Cronbach's α: lockdown 0.71; after lockdown 0.86; combined 0.78). We observed that those deemed as food insecure had significantly lower evaluation coping scores compared to the food secure students; however, this was only observed in the participants after the lockdown and when the data were combined (Evaluation, (mean ± SD): (lockdown: FI, 11.9 ± 2.6, FS, 11.3 ± 2.6; p = n.s.; after the lockdown: FI, 10.4 ± 3.5, FS, 13.4 ± 2.7; p < 0.001; combined: FI, 11.3 ± 3.1, FS, 12.1 ± 2.8; p = 0.036, Table 4.7), suggesting an inability to abandon any ineffective coping strategies. Whereas no difference was observed in the willingness to consider alternative coping strategies between the food secure and food insecure groups in the adaptive strategies regardless of when the data were collected (Adaptive, (mean ± SD): (lockdown: FI, 12.4 ± 3.3, FS, 12.3 ± 3.3;

after the lockdown: FI, 11.5 ± 3.1, FS, 12.1 ± 3.8; combined: FI, 12.0 ± 3.2, FS, 12.3 ± 3.5; p = n.s., Table 4.7).

Table 4.7: The association between food insecurity status (assessed using HFIAS) and coping flexibility skills (assessed using CFS) during and after COVID-19 lockdown, and for combined data, among UK university students. An Independent-Samples t-test was used to assess this correlation. Data are presented as (%), mean ± SD.

Time points	CFS	N (%)	Mean ± SD	P value
During lockdown				
	Evaluation coping:			
	FS	133 (74.3)	11.3 ± 2.6	0.189
	FI	46 (25.7)	11.9 ± 2.6	
	Adaptive coping:			
	FS	133 (74.3)	12.3 ± 3.3	0.916
	FI	46 (25.7)	12.4 ± 3.3	
After lockdown				
	Evaluation coping:			
	FS	75 (68.2)	13.4 ± 2.7	<0.001
	FI	35 (31.8)	10.4 ± 3.5	
	Adaptive coping:			
	FS	75 (68.2)	12.1 ± 3.8	0.435
	FI	35 (31.8)	11.5 ± 3.1	
Combined data				
	Evaluation coping:			
	FS	208 (72.0)	12.1 ± 2.8	0.036
	FI	81 (28.0)	11.3 ± 3.1	
	Adaptive coping:			
	FS	208 (72.0)	12.3 ± 3.5	0.607
	FI	81 (28.0)	12.0 ± 3.2	

P ≤ 0.05 deemed as statistically significant.

4.4.9 Potential predictors of food insecurity among UK university students

Table 4.8 shows an analysis of the logistic regression that investigated the predictor factors of food insecurity in our sample. During the lockdown, those who were food insecure were three times more likely to run out of money for food (OR 2.94; 95% CI 1.09, 7.89; p = 0.032), six times less confident in managing money to purchase healthy food (OR 6.82; 95% CI 1.49, 31.25; p = 0.013), three times more likely to borrow money (OR 2.78; 95% CI 1.14, 6.76; p = 0.024), and

seven times more likely to reduce level of snacking (OR 7.64; 95% CI 1.00, 58.05; p = 0.049). Also, the difficulty of shopping tended to be a significant factor in food insecurity, but this failed to achieve significance (OR 0.244; 95% CI 0.05, 1.19; p = 0.081). After the lockdown, only running out of money for food was the most significant factor affecting the food insecure students ten times (OR 10.63; 95% CI 3.25, 34.81; p < 0.001). However, when it comes to combining data to provide comprehensive insight and an accurate analysis of the predicted factors affecting food insecure students, the results showed that those who never ate snacks were four times more likely to be food insecure (OR 4.261; 95% CI 1.30, 13.87; p = 0.02), and those who shopped for food frequently were 3 to 7 times more likely to be food insecure (Sometimes: OR 6.564; 95% CI 3.23, 13.30; p < 0.001; Often: OR 3.139; 95% CI 1.53, 6.43; p = 0.002). Food insecurity was similarly predicted by price, with those who thought food was expensive having a threefold increased risk (OR 2.954; 95% CI 1.67, 5.21; p < 0.001). Interestingly, even though financially independent students were more likely to experience food insecurity, this did not achieve statistical significance at all time points (OR: 1.654; 95% CI: 0.91, 3.00; p = 0.09), Table 4.8.

Table 4.8: Potential predictors associated with food insecurity status and its consequences for financial status and food behaviors at all time points.

	During the lockdown			After the lockdown			Combined data		
Characteristics	**Beta**	**OR (95%CI)**	**P value**	**Beta**	**OR (95%CI)**	**P value**	**Beta**	**OR (95%CI)**	**P value**
Financial independence	0.687	1.98 (0.76- 5.16)	0.158	0.333	1.39 (0.03- 62.07)	0.864	0.503	1.654 (0.91-3.00)	0.09
Running out of money for food	-1.77	2.94 (1.09- 7.89)	0.032	0.522	10.63 (3.25- 34.81)	<0.001	-1.356	0.258 (0.13-0.49)	<0.001
Less confidence in managing money to purchase healthy food	2.97	6.82 (1.49- 31.25)	0.013	1.09	2.46 (0.48- 12.42)	0.276	-1.314	0.269 (1.0-7.30)	0.010
Borrowing money	0.198	2.78 (1.14- 6.76)	0.024	0.871	2.39 (0.05- 97.67)	0.654	-0.642	0.526 (0.28-0.99)	0.05
Difficulty shopping for food	-1.40	0.244 (0.05- 1.19)	0.081	-0.636	0.529 (0.11- 2.39)	0.409	-1.383	0.251 (0.11-0.54)	<0.001
Shopping ability									
Sometimes	1.27	3.59 (0.94- 13.65)	0.061	-0.131	0.877 (0.14- 5.27)	0.886	1.882	6.564 (3.23-13.30)	<0.001
Often	.877	2.40 (0.72- 7.95)	0.151	-0.113	0.893 (0.21- 3.64)	0.874	1.144	3.139 (1.53-6.43)	0.002
Snack									
Never	2.03	7.64 (1.00-58.05)	0.049	-1.981	0.138 (0.01- 1.62)	0.115	1.450	4.261 (1.30-13.87)	0.02
Price	0.558	1.74 (0.65- 4.65)	0.265	-0.994	0.370 (0.09- 1.38)	0.139	1.083	2.954 (1.67-5.21)	<0.001
Food storage	1.03	2.80 (0.90- 8.70)	0.074	-1.06	0.345 (0.09- 1.30)	0.116	0.540	1.716 (0.90-3.26)	0.09

OR = odds ratio; CI = confidence intervals. P ≤ 0.05 deemed as statistically significant.

4.5 Discussion

The purpose of this study was to examine the prevalence of food insecurity and its associated drivers and explore their potential influence on mental wellbeing and the ability to cope in stressful situations among UK university students. Food insecurity was common in this population, with 25.7–31.8% reporting food insecurity during lockdown and after lockdown, respectively, and 28% of the prevalence when the data were combined, which is similar to the prevalence reported by Sackey et al. (2021) in the US and lower than Australia's 41.9% (Kent et al., 2022) and Malaysia's 62.8% (Ahmad et al., 2021). However, it is worryingly double the national UK average (UK Food Security Report 2021; Pool and Dooris, 2022). The trend of the high prevalence of food insecurity was more notable post-lockdown in our sample, different from most studies that indicated increasing food insecurity prevalence was higher during COVID-19 (Owens et al., 2020; Hagedorn et al., 2022). This is consistent with Christensen et al. (2021), who mentioned that US university students had a higher rate of food insecurity regardless of whether COVID-19 affected them. It might be due to the fact that many students had returned to live at home during the COVID-19 lockdown, considering that returning completely to normal life has not taken place after COVID-19 (Aristovnik et al., 2020). However, this could be a sign that the prevalence of food insecurity among UK university students is common, which raises concern, as this could be a hidden problem that may be faced nowadays, which highlights the importance of understanding potential drivers to develop effective interventions.

We found no significant differences in food security status with demographics such as age, gender, ethnicity, BMI, accommodation, or type of degree over the time points, which is similar to studies conducted in the US (Ryan et al., 2020), Australia (DeBate et al., 2021), and Malaysia (Bruening et al., 2018; Davitt et al., 2021; Ahmad et al., 2021; Gooding et al., 2012; Azmi et al., 2022). Despite the fact that food insecurity was more common among females in our sample, this could be related to the high number of females participating in this study or to other factors such as household income, as described by Broussard, 2019, but we did not measure household income backgrounds.

Although some studies have indicated that food insecurity impacted students' academic performance (Martinez et al., 2018; Ryan et al., 2020; Ukegbu et al., 2019; Ahmad et al., 2021) and their ability to meet academic responsibilities (Simon et al., 2018), which eventually made them less successful in completing their degrees (Britt et al., 2017; Wolfson et al., 2022), we found no significant differences between the two groups. Potential reasons for this difference could be that we did not distinguish between undergraduate and postgraduate students. Bruening et al. (2018) showed that food insecurity only negatively impacted the academic performance of first-year university students, and others linked this association to only black students (Camelo and Elliott, 2019). Also, the GPA was self-reported in this study, which some research experts believe has less construct validity and should be used with caution (Kuncel et al., 2005). It may also be related to the socio-economic status of the individual, as it has been observed that students from high-income families perform better

academically than those from low-income families (Braunstein et al., 2000). Thus, the self-report method was unable to determine the student's GPA accuracy, and family income was not measured, which makes it difficult to directly report the relationship between food insecurity and academic performance, requiring future research with consideration of students' family financial backgrounds and employing reliable methodologies for determining GPA.

During the lockdown and post the lockdown, food insecurity was higher among those who had financial difficulties due to insufficient finance, loans or scholarships, and high living expenses, according to studies conducted around the world (Bruening et al., 2017; Owens et al., 2020; Mialki et al., 2021; Payne-Sturges et al., 2018; Martinez et al., 2018; Ahmad et al., 2021), and our findings were no different. We found that food insecure students were more likely to be financially independent, lived in shared accommodation, were less likely to have their own car, had less disposable income, had fewer savings, and borrowed money more than food secure students, which could in part explain the high number of food insecure students trying to find a job. Our regression analysis emphasises that financial factors could potentially increase the risk of developing food insecurity. Additionally, due to a lack of funds to purchase food, poor financial management could increase the chance of food insecurity. For instance, previously published studies showed that students with extra money have a tendency to spend it on other items other than food, such as clothing, cell phones, and alcohol (Silva et al., 2017), or eating out and shopping

(Wooten et al., 2019). Our data support this, as a greater proportion of students who experienced FI spent more money on food during lockdown, and they were more likely to smoke at all times. This eventually left them struggling with having money, as we noted that students who were food insecure were significantly more likely to run out of money to buy food and were more likely to borrow money frequently at all time points than students who were food secure.

Additionally, at all-time points, no difference was found in consuming fruits and vegetables between the two groups, similar to Graham et al., (2023). However, in our sample, food insecure students lacked confidence in their ability to buy healthy foods, which may have limited their access to enough food and ultimately resulted in them eating fewer meals, as observed by us and others (Gundersen and Ziliak, 2015; Coates et al., 2007). The three most common coping mechanisms for coping with food shortages were eating less expensive, less-liked food and cutting back on portion sizes (Akerele et al., 2013), as well as lower prices and incomes, both of which are associated with unhealthier eating choices (Delley and Brunner, 2019). This led food insecure students to report that the price of food was the most influential factor affecting their ability to access enough food, regardless of whether they were in lockdown or post-lockdown periods. This may be because they had less total income; therefore, food would naturally comprise a greater proportion of income. This result is consistent with a UK food security report on food security, which found that low-income households often spend a large portion of their income on

food (UK Food Security Report 2021; Gundersen and Garasky, 2012). This finding was found across all time points of the investigation. Furthermore, it may potentially be related to the overreliance on the consumption of processed and prepared foods (Bernardo et al., 2017; Papadaki et al., 2007), lack of storage facilities, difficulty in shopping, and distance to food shops, along with poor culinary knowledge, as observed by Davitt et al., 2021. Additionally, they found that lower cooking self-efficacy increased the risk of food insecurity in university students during the COVID-19 pandemic (Davitt et al., 2021). Also, due to COVID-19 restrictions, such as the closure of university eating halls and cafeterias, many university students were forced to purchase and prepare their own meals (Owens et al., 2020). In this case, if students lack food literacy and the resources necessary for appropriate meal preparation, it could increase the risk of being food insecure (Marques et al., 2022).

More comparison of the potential factors of food insecurity at both times of investigation indicates that poor financial management could be a common predictor factor of food insecurity, as observed at both time points, but it was higher during the time after the lockdown, as 17.6% did not feel confident in managing money compared to 4.5% during the lockdown, and they had fewer savings after the lockdown, 65.7% compared to 43.2% during the lockdown. Therefore, it is probable that food insecure students perceive their ability to manage money as lower because they have a greater need to manage money and the consequences are greater, which may put them under financial pressure and in precarious situations. This result was also confirmed when we

compared the CFS, as the students' abilities to evaluate stressful situations were lower at the time of investigation (after the lockdown and with combined data), suggesting an inability to abandon any ineffective coping strategies and showing poor management skills. Thus, CFS findings could confirm that poor management of money may be linked to higher food insecurity prevalence and potentially lower mental wellbeing. This is supported by what was found among US households, as those with better financial management skills were less likely to be food insecure compared to those who had poor financial skills (Gundersen and Garasky, 2012), and adults who had better financial skills tended to have higher mental wellbeing, which in turn was reflected in their academic success (Shim et al., 2009). It has also been well established that a lack of nutrition can interfere with the wellbeing of an individual; a recent meta-analysis showed that food insecurity had a significant effect on the likelihood of being stressed or depressed (Pourmotabbed et al., 2020), supporting the results of this study. We observed that food insecure students had significantly lower mental wellbeing scores during the lockdown and when the data were combined, along with a lower ability to cope with stressful situations that were seen following the lockdown, and when the data were combined according to CFS. This may result in the use of ineffective strategies, such as changing eating habits for the worse (Broton and Goldrick-Rab, 2016). This is not different from our observation that food insecure students changed their food intake by consuming fewer than three meals per day and snacking less, and they were more likely to smoke and consume more alcohol when the data were combined, factors associated with appetite suppression (Perkins et al., 1996;

Yeomans, 2010). This may lead them to fail to reach the health benefits of regularly consuming meals and snacks, such as maintaining healthy energy and nutrient intake as well as benefiting metabolism and cognitive function (Miller et al., 2013). However, whether these students consumed unhealthy food choices as a result of low coping strategies with food insecurity was beyond the scope of this study, although many studies have reported that food insecure individuals are more likely to have unhealthy dietary practices (Shi et al., 2021; Ranjit et al., 2020; Becerra et al., 2017). Thus, there is a possibility for higher education settings to provide advice on financial management and may improve cooking skills based on the facilities available to the students.

4.5.1 Limitations

This study has several limitations to consider. The sample was restricted to current university students in the UK. While the study potentially captured students across the country, we were unable to identify participants' specific geographical locations. Despite setting inclusion and exclusion criteria and using a specific platform (Jisc), we had limited control over the context in which respondents completed the online surveys. This may limit our ability to verify participants' status and fully authenticate their responses. The self-reporting nature of the study may result in bias, although all participants were informed that the questionnaire was solely for research use and confidential, with no personal information collected. Moreover, it would have been beneficial to gather more detailed information about eating habits, particularly breakfast behaviours, to better link breakfast consumption with food security and mental

wellbeing, as investigated in Chapter 3. While all the tools used in this study were validated, it's important to acknowledge that validated tools can still have limitations. To address this, we conducted Cronbach's alpha analyses to assess the internal consistency of our measures. These analyses may provide additional support for the reliability of our tools in this specific context. However, the potential limitations of these tools should be considered when interpreting the results. Despite these limitations, this study contributes valuable insights into food insecurity among UK university students, a topic that has been understudied in the UK context. We found that food insecurity is common among UK university students, similar to findings in other countries, along with low mental wellbeing. The study also highlighted that the inability to manage stressful situations, as demonstrated by the CFS, could be a predictor of poor money management and may be linked to food insecurity and poor mental wellbeing. However, it remains unclear whether this is the primary reason behind the lack of nutritious food consumption and decreased mental wellbeing. Further investigation is needed to establish these causal relationships. These limitations and findings underscore the need for future research to employ more robust methodologies, including in-person verifications, more comprehensive dietary assessments, and longitudinal designs, to better understand the complex relationships between food insecurity and mental wellbeing among university students.

4.6 Conclusion

Food insecurity is common among UK university students in line with other countries; however, whether the financial burden of managing money, low coping strategies with stressful situations, or the lack of nutritious food leads to a decline in mental wellbeing is unknown and requires further investigation. Because this investigation is new, it may be advantageous to evaluate food security status throughout the financial aid review process to identify students who may require additional support or resources to meet their studies successfully. Furthermore, future research is required to clarify the numerous dimensions of socioeconomic influences on food security status among university students. Universities can improve food insecurity among students by providing education and resources about healthy eating and cooking. This can involve providing cooking classes, nutrition workshops, and access to resources and meal recipes, as demonstrated by the beneficial effects of interventions undertaken by West et al. (2020) for six weeks and Rivera et al. (2023) for 16 weeks among those who were food insecure. Additionally, universities can work to reduce food waste on campus by implementing recycling programmes and advocating for policy changes at the local and national levels that support food security and wellbeing.

Chapter 5- Improving Food Security Status, Dietary Intake, and Mental Wellbeing among Nottingham University Students

5.1 Introduction

Our findings in Chapter 4 revealed a significant prevalence of food insecurity among UK university students, with 25.7% affected during the lockdown and 31.8% post-lockdown. overall, 28% of UK university students were food insecure when data were combined, which is double the national average (UK Food Security Report 2021). This issue may stem from difficulties in managing money or a lack of access to nutritious food, leading to a decline in mental wellbeing, similar to findings among US university students (Gaines et al., 2014). Food insecure students often struggle to afford healthy meals, forcing them to rely on cheaper, less nutritious options, which compromises their nutrition and overall wellbeing (Bruening et al., 2017; Choi et al., 2022).

Poor nutrition due to food insecurity can lead to deficiencies in essential nutrients, impairing cognitive function and academic performance (Seligman et al., 2010) and increasing the risk of mental health disorders such as depression, anxiety, and stress (Davison and Kaplan, 2015; Martinez et al., 2020). Additionally, unhealthy eating habits are linked to long-term negative health outcomes such as obesity, malnutrition, and increased mortality (West et al., 2020).

To enhance food security and wellbeing among university students, several strategies can be implemented (Bruening et al., 2018). One key approach is improving food literacy, which encompasses the knowledge, skills, and

behaviours needed to choose, cook, and store food effectively (West et al., 2020). A lack of food literacy and the ability to access a sufficient quality and quantity of food exacerbates food insecurity (Begley et al., 2019). While some studies suggest that food literacy and nutrition knowledge programs are associated with improvements in food security, health, and income (Begley et al., 2017), other research indicates no significant effect on food security status despite observed enhancements in food literacy and skills (Kaiser et al., 2015; Huisken et al., 2016).

Furthermore, there is limited knowledge about the effects of evidence-based interventions to reduce food insecurity among UK university students. Our observations indicate that most factors affecting food security are linked to the lack of access to nutritious food and low financial stability, both of which correlate with poorer wellbeing.

5.1.1 Understanding food literacy

Over the past decade, the use of the concept of "food literacy" in policy, practice, and research has greatly increased, with many definitions published. Howard and Brichta (2013) demonstrated that the concept of "food literacy" is used to refer to a wide range of topics, including food preparation and cooking skills, food science and safety, food production, and consumption aspects such as food marketing (Truman et al., 2017). Vidgen and Gallegos (2014, p. 54) provide a comprehensive definition of food literacy as "a collection of inter-related knowledge, skills, and behaviours required to plan, manage, select,

prepare, and eat food to meet needs and determine intake" and "the scaffolding that empowers individuals, households, communities, or nations to protect diet quality through change and strengthen dietary resilience over time".

The knowledge component of food literacy relates to understanding food types, origins, production methods, ingredients, and basic nutritional knowledge. This information aids in making decisions for a balanced food intake (Perry et al., 2017). The concept is applied at both micro and macro levels, from individual skills to broader food ecosystems. For instance, the Canadian Museum of Agriculture's food literacy campaign educates "children and families about keeping food nutritious and safe from farm to fork" (Food Literacy Initiative), while the 2013 Conference Board of Canada report focused on "household attitudes, skills, and knowledge about food" (Howard and Brichta, 2013).

The Australian food literacy model identifies four interconnected areas: plan and manage, select, prepare, and eat. These areas support an individual's capacity to maintain stable diet quality and quantity (Vidgen and Gallegos, 2014). Begley et al.'s (2019) study, using the "Food Sensations" program based on this model, found that food insecurity was associated with all four domains, with planning, management, and selection being the most significant indicators. Food self-efficacy, defined as "an individual's belief in his or her ability to perform food-related skills" (Perry et al., 2017), is closely linked to food literacy. Higher food self-efficacy is associated with healthier eating

habits, such as increased fruit and vegetable consumption (Rees et al., 2022).

Truman et al. (2017) identified six themes in food literacy definitions: skills and behaviours, food/health choices, culture, knowledge, emotions, and food systems. These themes encompass various aspects, from physical abilities surrounding food to understanding complex food systems. While many food literacy definitions and themes have been published, not all concepts include all six themes. This variation could be attributed to the specific research purposes and contexts in which these definitions were developed.

5.1.2 Food literacy and food insecurity

Research suggests that food literacy is associated with improvements in aspects of food insecurity (Begley et al., 2019). Enhanced knowledge, skills, and behaviours related to food literacy may contribute to more effective income utilisation (Begley et al., 2019; Perry et al., 2017). Those with fewer financial management skills may not optimise their food consumption in light of income and pricing, while those with higher money management abilities may be able to find promotions and take advantage of deals (e.g., food club memberships and coupons) (Gundersen and Garasky, 2012). Consequently, some households remain food secure despite having less income, whereas others are food insecure despite having greater incomes. This discrepancy has frequently been attributed to financial management skills (Gundersen and Garasky, 2012).

Furthermore, a lack of food literacy is linked to unhealthy behaviours and poor nutrition status (Begley et al., 2019). Those who experience food insecurity

tend to consume unhealthy foods, which are low-cost and high-energy (Ranjit et al., 2020), and have unhealthy purchasing behaviours such as spending more money at convenience stores rather than grocery stores (Spees et al., 2017), because convenience stores are less distant (Ma et al., 2017) and more accessible, although these stores often offer foods with the worst diet quality ratings (Spees et al., 2017; Ranjit et al., 2020). Food insecure individuals also made fewer shopping trips (Ma et al., 2017) and/or shopped more frequently for food than those who were food secure (Seefeldt, 2010).

Additionally, various modifiable food-related behaviours and attitudes have been found to influence food selection and purchasing, such as limitations on food storage, a lack of shopping plans (Gorman et al., 2017), a lack of time for cooking, less confidence in cooking skills, and higher consumption of convenience foods, which were associated with difficulties in eating healthily (Ranjit et al., 2020). These underlying issues, including poor food management and purchase habits, may exacerbate food insufficiency among those who are food insecure (Ranjit et al., 2020).

Moreover, psychosocial factors that mediate food procurement and consumption decisions, such as education about healthy eating, cooking skills, and self-efficacy in relation to fruit and vegetable intake, present potentially appealing targets for policy and/or behavioural interventions. However, there is little published evidence of the effects of nutrition education and food literacy programmes aimed at vulnerable people (Begley et al., 2019).

5.1.3 Nutrition education, food insecurity, and mental health

Educational tools have emerged as crucial instruments in addressing the complex, interrelated issues of nutrition, food insecurity, and mental wellbeing. These tools, which range from interactive workshops to digital applications, provide individuals with essential knowledge and skills to make informed decisions about their diet, manage resources effectively, and understand the critical connection between nutrition and mental health (Vidgen and Gallegos, 2014). In recent years, there has been growing recognition of the interconnectedness of these issues and the potential for educational interventions to create positive change. Research has suggested that improving food literacy can lead to better dietary choices and health outcomes (Vaitkeviciute et al., 2015). Gundersen and Ziliak (2018) have associated enhanced budgeting skills with improved food security, while Kutcher et al. (2016) have suggested that increasing awareness of mental health resources can promote overall wellbeing.

Effective educational tools in this domain often incorporate practical, hands-on learning experiences, peer support mechanisms, and ongoing engagement strategies. For instance, studies suggest that cooking classes are associated with improvements in dietary habits and food security (Garcia et al., 2018). Similarly, peer-led mental health education programmes have been linked to increased mental health literacy and reduced stigma (Patalay et al., 2017). These tools can be tailored to specific populations, such as university students, who often face unique challenges in maintaining proper nutrition and mental

health. For example, studies suggest that campus-based food pantries combined with nutrition education may be effective in addressing food insecurity among university students (Bruening et al., 2017).

As research continues to demonstrate the interconnected nature of these issues, the development and implementation of comprehensive educational tools become increasingly important in public health and social welfare initiatives. These tools aim not only to impart information but also to foster behavioural changes that can lead to long-term improvements in nutrition, food security, and mental health outcomes (Contento, 2008). Dietary modifications can affect mental wellbeing disorders directly by impacting mood, while mental wellbeing disorders themselves may lead to changes in dietary habits (Freeman and Rapaport, 2011). This intricate interplay has been the subject of numerous studies, revealing the profound impact of nutrition on mental wellbeing. Various nutrients, nutritional abundance and distribution or shortages, food items, the quality of diet, and diet types are all associated with mental health outcomes (Hepsomali and Groeger, 2021). Research indicates that certain dietary patterns, particularly those rich in fruits, vegetables, whole grains, and lean proteins, correlate with better mental health outcomes (Lassale et al., 2019). Conversely, diets high in processed foods, saturated fats, and refined sugars have been associated with an increased risk of mental health disorders (O'Neil et al., 2014).

This relationship has been observed specifically among students and adolescents. A longitudinal study by Jacka et al. (2011). found that those who

follow a well-balanced or better-quality diet can indeed improve health and reduce the risk of developing mental disorders. Similarly, O'Neil et al. (2014) reported that dietary improvements were associated with better mental health outcomes in adolescents. It's important to note that while diet plays a significant role in mental health, it is just one factor among many. Genetic predisposition, environmental stressors, and other lifestyle factors also contribute to mental health outcomes. Therefore, dietary interventions should be considered as part of a holistic approach to mental health promotion and treatment (Sarris et al., 2015).

5.2 Aim and objectives

Offering educational opportunities as incentives can help increase participation in nutrition and food security programmes. Participants who receive nutrition, budgeting, and meal planning education can be more motivated to make healthy food choices (Eicher-Miller et al., 2009). Additionally, providing access to nutritious meals by offering financial resources or food supplies can help to alleviate food insecurity in the short term (Seligman et al., 2015), and promote long-term sustainable behaviour changes that enhance mental wellbeing (Gundersen and Ziliak, 2015). Therefore, this pilot study aimed to determine whether a nutrition and culinary education intervention focused on preparing nutritious meals on a budget with limited cooking facilities can reduce food insecurity and subsequently improve mental wellbeing and food intake among food insecure university students.

Objectives

- Implement and evaluate the impact of a 5-week nutrition and culinary education intervention for university students to: i. Assess the intervention's effectiveness in reducing food insecurity. ii. Analyse changes in dietary intake patterns resulting from the intervention. iii. Measure the intervention's impact on participants' mental wellbeing.

5.3 Materials and methods

5.3.1 Study design

The study employed a combination of quantitative and qualitative measurement methods. We used an online questionnaire (pre- and post-intervention) in conjunction with a 5-week nutritional education intervention, which was complemented by focus group discussions, as described in Figure 5.1.
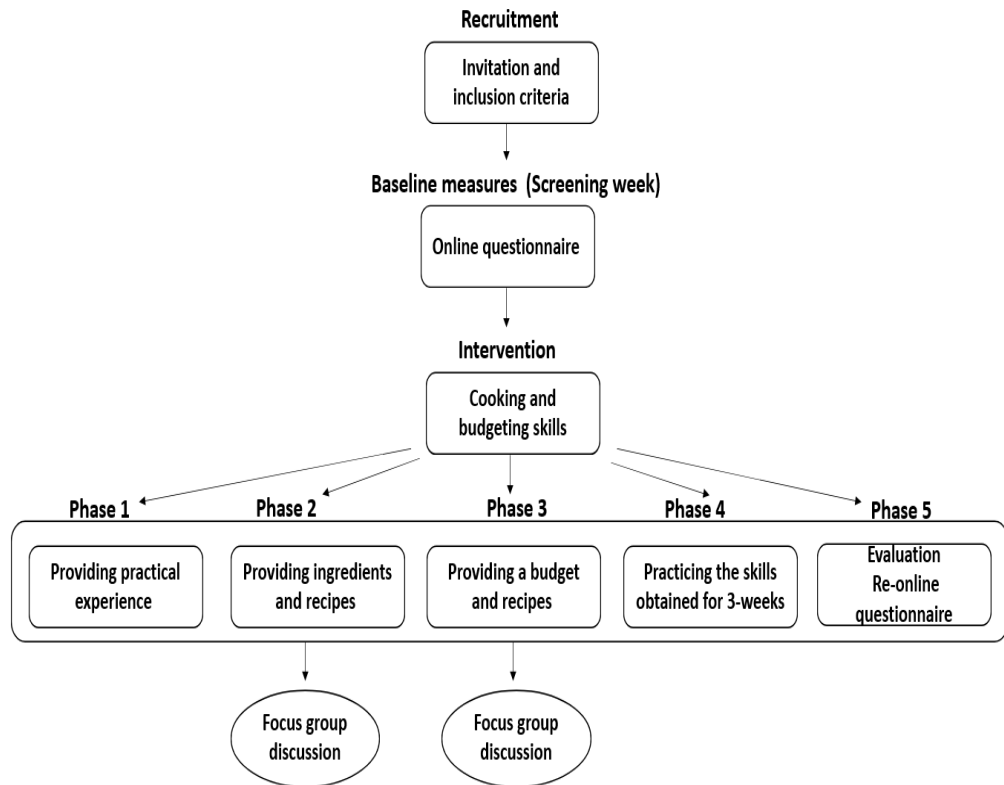
Figure 5.1: Summary of all processes of the study design and timeline.

5.3.1.1 Recruitment

Students at the University of Nottingham were invited to take part in an experimental study. They were recruited via emails, posters, and advertisements placed within academic buildings and halls of residence on the University of Nottingham campuses. All those who met our inclusion criteria were eligible and invited to complete an online baseline questionnaire. The criteria included being over the age of 18 years old, studying at the University, not having lactose intolerance, coeliac disease, or any other food-based allergies, being of any ethnicity, gender, or level of education, and having access to cooking facilities.

The School of Biosciences Research Ethics Committee at the University of Nottingham approved this study (FMHS 470-0322). Prior to beginning any part of the study, all participants were required to read the participant information sheet and provide their consent, both online and on paper (see Appendix 3.1 for Consent Form and Appendix 3.2 for Participant Information Sheet).

5.3.1.2 Baseline measures (Screening week)

Participants were screened and deemed suitable if their status indicated that they were experiencing food insecurity prior to starting the experiment, as determined by the food security scale result HFIAS (this was described in Chapter 4, Section Materials and Methods, P. 126). This information was obtained after participants completed a baseline online questionnaire (Appendix 3.3). After determining suitability in the first screening step, suitable days for intervention visits were scheduled. The baseline online questionnaire consisted of questions covering the following domains:

5.3.1.2.1 Sociodemographic information

Participants were asked to complete the baseline online questionnaire that collected information about their age, gender, ethnicity, height, weight, study status, accommodation, financial status including financial dependency, job, disposable monthly income, money spent on food weekly, financial support, and eating habits such as frequency of main meals, snacks, consuming fruits, vegetables, and alcohol, smoking, and shopping patterns.

5.3.1.2.2 Food security scale (HFIAS)

Described in the Materials and Methods section of Chapter 4, P. 127.

5.3.1.2.3 Mental wellbeing scale (WEMWBS)

Described in the Materials and Methods section of Chapter 4, P. 129.

5.3.1.2.4 Food literacy (Cooking confidence and Food preparation behaviours)

Food literacy was measured online within the questionnaire. Cooking confidence was measured using a validated scale with a 5-point response range, ranging from 1 "not confident" to 5 "extremely confident." (West et al., 2020). It included six items, and participants were asked to choose the responses that best reflected their skills for each statement. Food behaviours were measured using a tool with a 4-point response scale, ranging from 0 "never" to 3 "always" (West et al., 2020). It included seven items, and participants were asked to choose the responses that best reflected their behaviours for each statement. Scores for both scales were calculated by summing responses to each item answered, with results presented as means and standard deviations. This food literacy scale was chosen for its comprehensive approach, combining cooking confidence and food preparation behaviours to provide a holistic view of food literacy (Vidgen and Gallegos, 2014). The tool is validated, enhancing result reliability and credibility (West et al., 2020), and is effective for identifying intervention areas and increasing food-related education.

In research, food literacy measures are often paired with food security assessments to offer a more complete picture of an individual's food situation.

This scale's focus on cooking skills and food preparation knowledge is crucial, as these competencies can help individuals manage limited food resources more effectively. People with higher food literacy can often stretch food budgets further, prepare meals from basic ingredients, and make informed purchasing decisions. By assessing these areas, the scale provides valuable insights for developing targeted interventions to improve food literacy and potentially reduce food insecurity. Its use in this study offers a robust foundation for understanding the relationship between food literacy and food security.

5.3.1.2.5 Three-day food estimate record

A three-day food estimate record is a valid method used to record all foods and beverages consumed (Yang et al., 2010). A study published in the Journal of the American Dietetic Association found that shorter recording periods are more practical for participants and may result in higher compliance rates (Hongu et al., 2015). Additionally, 3-day records produce similar estimates of nutrient intake as longer recording periods, such as 7 days (Tooze et al., 2010). This technique was chosen because it is accurate and reliable for monitoring nutritional consumption in diverse groups (Tooze et al., 2010).

In the baseline and evaluation weeks, participants were asked to record their three-day food and beverage intake, including two weekdays and one weekend day, to measure their average macronutrient consumption (energy, carbohydrate, protein, and fat). For more accurate measurement of portion

size, participants were requested to estimate all food consumed in detail, including the amounts using home tableware and/or weight, cooking methods used, and food brands. The Nutritics programme was used to analyse students' food and dietary intake pre- and post-intervention, with results as means and standard deviations.

5.3.2 Intervention

The intervention consisted of five phases over a five-week period (Figure 5.1). It was conducted during the term time, from November to the middle of December of the academic year 2022–23.

5.3.2.1 Phase 1 (Week 1): Providing practical experience

After determining food insecurity among students in the screening step, participants were invited to attend a 2-hour cooking class at the Clinical Skills Suite, North Lab, School of Biosciences, Sutton Bonington Campus. Regardless of their existing cooking and financial skills, they were introduced to meal planning, budgeting, portion control, and how to make a set of ingredients last beyond one meal. Additionally, we created an online web page (https://xerte.nottingham.ac.uk/play_42598#page1) that contained all information regarding the study, such as food security, cooking recipes, meal preparation, budgeting, shopping skills, and storing food, as well as some recommended cooking resources to help students obtain more insight into planning meals and finances.

5.3.2.2 Phase 2 (Week 2): Providing ingredients and recipes to show how far a particular budget can go

Each participant was provided with a healthy food box, including step-by-step instructions for making at least five meals (e.g., dinner or lunch). The total cost of the food box was £17.08 (£3.41 per meal). Participants were asked to use skills obtained from the cooking class (week 1) to prepare healthy meals with the provided foods in their own accommodations for a week. The ingredients were based on a recipe that could be adapted and used in a variety of ways. We used a base meal as a main meal (which could be easily modified to be vegetarian, vegan, or suit any other dietary requirement). This base meal, "easy chicken and vegetables" could be adapted for many meals using the same ingredients but with different recipes. It could be transformed into a club sandwich, red pasta with chicken and vegetables, cheesy quesadillas, white rice with chicken and vegetables, or chicken soup, as well as many other recipes. Participants were guided on how to use leftovers to make different meals of their preference. All these meals were nutritionally analysed and presented to the students with nutritional facts for each serving size (Appendix 3.4).

5.3.2.3 Phase 3 (Week 3): Providing a budget and recipes

Students were provided with a monetary voucher card of £20 to purchase food (no alcohol or other items). This amount was chosen depending on the average monthly spend on groceries and takeaway: £199 (Save the Student, 2024), which equates to £49.75 per week and £7.10 per day. It also considered the approximate cost of a meal at a university campus: £5. This figure is consistent

with data from the National Union of Students (NUS) (National Union of Students, 2023), as well as recent studies on student expenditure according to the Department for Education's Student Income and Expenditure Survey 2021-2022 for food costs among UK students (Department for Education, 2021).

This step allowed students to practice the lessons from the previous phase (budget planning, shopping skills, and the preparation of healthy meals) to be practiced for a week. We asked the students to provide their food receipts to ensure they spent all the money provided on needed food. We also provided a range of online recipe resources along with the study web page to help them find their preferred recipes (Appendix 3.5). Additionally, the students were also asked to share their meal pictures throughout the intervention period.

- **Conducting focus group discussions on phases 2 and 3**

Qualitative focus groups are a technique for collecting in-depth information about a particular subject through the exchange of points of view by a purposefully small group of people (Morgan, 1997). This method was useful for understanding the conceptual and methodological aspects of issues related to food insecurity. Therefore, in this study, at the end of each phase (phases 2 and 3), participants were invited back to take part in a focus group discussion to explore:

- How the practical application of food literacy skills and experience (meal preparation) affected participants' food-related confidence and skills
- The effectiveness of budget management tools in improving food security

- The difficulties food insecure students encounter in implementing their nutritional knowledge in practical scenarios

- The possible discrepancies between students' understanding of nutrition and their capacity to choose healthful foods within financial limitations

- The significance of food literacy in overcoming obstacles to healthy eating among these students

The focus group questions and students' views can be found in Appendix 3.6 (3.6.1, 3.6.2).

5.3.2.4 Phase 4 (Week 4): Putting the skills obtained over the 3 phases into practice

Participants were asked to put their skills in cooking, budgeting, and meal preparation into practice over a 3-week period. During this phase, the students had access to a range of online materials (recipe resources available on the study web page) and were asked to record what they had made for any substantial meal (e.g., lunch or dinner).

5.3.2.5 Phase 5 (Week 5): Evaluation week

At the end of the 3-week practice period, students were asked to complete the baseline online questionnaire again to assess their post-intervention food security, mental wellbeing, and food literacy status.

5.3.3 Data and statistical analysis

The questionnaire data were obtained from the JISC online platform as a self-administered questionnaire used in the pre-screening and post-assessment steps. The Statistical Package for Social Sciences (SPSS version 27; IBM, Hampshire, UK) was used to analyse the data. Descriptive statistics were used to summarise the sociodemographic student characteristics.

The food security questions were coded using HFIAS instructions that required summing the question codes, and students were classified into four groups: food security, mild, moderate, and severe (Coates et al., 2007), with results presented as prevalence percentages, means, and standard deviations.

The WEMWBS and food literacy (cooking confidence and food preparation behaviours) were analysed by summing each item score using ranking orders and presenting results with means and standard deviations. For the WEMWBS, the students' scores were classified following the cut-point approach, where the top 15% of scores range from 60–70 and the bottom 15% from 14–42.

The Nutritics programme (https://www.nutritics.com/en/) was used to analyse students' food and dietary intake pre- and post-intervention. This programme can professionally analyse nutrition information. It only requires enough information for each participant (age, height, and weight) to analyse the nutrition portion size consumed. Macronutrient calculations were performed for each participant, presented as a nutrition log, and then reported as means and standard deviations. A paired samples t-test was used to measure mean

correlation and determine the students' performance pre- and post-intervention in the HFIAS, WEMWBS, Food Literacy Scale (cooking confidence and food preparation behaviours), and dietary intake.

For focus groups, the students' transcript views and comments were converted into themes for qualitative analysis. These were reviewed based on the HFIAS and a thematic analysis of respondents' answers to provide detailed insight into students' experiences and challenges during cooking and budgeting weeks. This was done to determine how students' skills improved their food insecurity status after following the study steps and what possible strategies could contribute to preventing them from becoming food insecure. Data were presented as percentages and as mean ± standard deviation (SD). A P value of ≤ 0.05 was considered statistically significant at the 95% confidence interval.

5.4 Results

5.4.1 Participant characteristics

Of the participants who enquired, 16 were eligible because they were deemed food insecure on the screening questionnaire. They were all female with an average age of 23 ± 2.9 years, mostly white British (68.8%), and primarily home students (81.3%). They had a normal BMI (average 22.1 ± 2.3 kg/m^2). There was an equal number of undergraduate (50.0%) and postgraduate students; most were studying Veterinary Medicine (n = 11; 68.7%), although a few Biotechnology (n = 3; 18.7%). The majority lived in shared accommodation (81.3%) and did not consider themselves financially independent (62.5%). Overall, they had a disposable income of less than £100 (56.3%) and spent £40

or less on food (81.3%) per week. More than half had financial support from parents, loans, and savings (56.3%), and 43.8% received grants. Interestingly, a large proportion tended to borrow money (68.8%). Most of them considered their eating habits healthy (75%), but only 43.8% were always able to shop for food when needed. The majority (75%), however, had not taken a cooking class (Table 5.1).

Table 5.1: Sociodemographic characteristics of university students (n = 16).

Variable	N (%)
Gender	
Female	16 (100)
Age (Years)	
20- 23	10 (62.5)
24 and above	6 (37.5)
Ethnicity	
White British	11 (68.8)
Other	5 (31.3)
BMI	
<18.5 kg/m2	2 (12.5)
18.5–25 kg/m2	14 (87.5)
Studying status	
Undergraduate	8 (50.0)
Postgraduate	8 (50.0)
Home students	13 (81.3)
International students	3 (18.8)
Full-time student	16 (100)
Accommodation	
Shared house	13 (81.3)
Private sector (university halls/catered/not catered)	1 (6.3)
Live alone	2 (12.5)
Financially independent	
Yes	6 (37.5)
No	10 (62.5)
Currently in paid employment	
Yes	7 (43.8)
No	9 (56.3)
Trying to find a job	
Yes	3 (33.3)
No	6 (66.7)
Disposable income/month	
£0-100	9 (56.3)
£101 and greater	7 (43.8)
Money spends on food/week	
£0-40	13 (81.3)
£41 and more	3 (18.8)
Financial support	
Parental	9 (56.3)
Grants/ scholarships	7 (43.8)
Student loans	9 (56.3)
Savings	9 (56.3)
Borrowing money since started university studying	
No	5 (31.3)
Yes	11 (68.8)
Perception of own eating habits during term time	
Unhealthy	4 (25.0)
Healthy	12 (75.0)
Attending cooking class	
Yes	4 (25.0)
No	12 (75.0)
Ability to shop for food when required	
Yes	7 (43.8)
Usual	9 (56.3)

5.4.2 Food security status (HFIAS)

Before the intervention, all the participants were food insecure; (100%) of these, 43.8% were classified as mildly food insecure, 43.8% as moderately food insecure, and 12.5% as severely food insecure. Five-weeks post-intervention, the prevalence of food insecurity was reduced to 37.5%, with 62.5% becoming food secure. The mean food insecurity score significantly decreased between pre- and post-intervention (HFIAS score: pre-intervention, 4.6 ± 2.4; post-intervention, 0.75 ± 1.2; p <0.001), indicating an improvement in participants' food security status. These improvements were evidence by:

- Participants no longer needing to worry about having enough food (worrying about food: pre-intervention, 25%; post-intervention, 0%).

- Increased ability to eat their preferred foods (lack of preferred food: pre-intervention, 81.25%; post-intervention, 18.8%).

- Improvement in the variety of foods consumed (limited in food variety: pre-intervention, 87.5%; post-intervention, 12.5%).

- Increased availability of food resources (lack of resources: pre-intervention, 31.3; post-intervention, 18.8%).

Furthermore, pre-intervention, 18.8% of participants were eating smaller meals and 31.3% were eating fewer meals due to limited resources (6.3%), while 6.3% slept without eating. None of the participants experienced these problems at the end of the intervention (Figure 5.2).
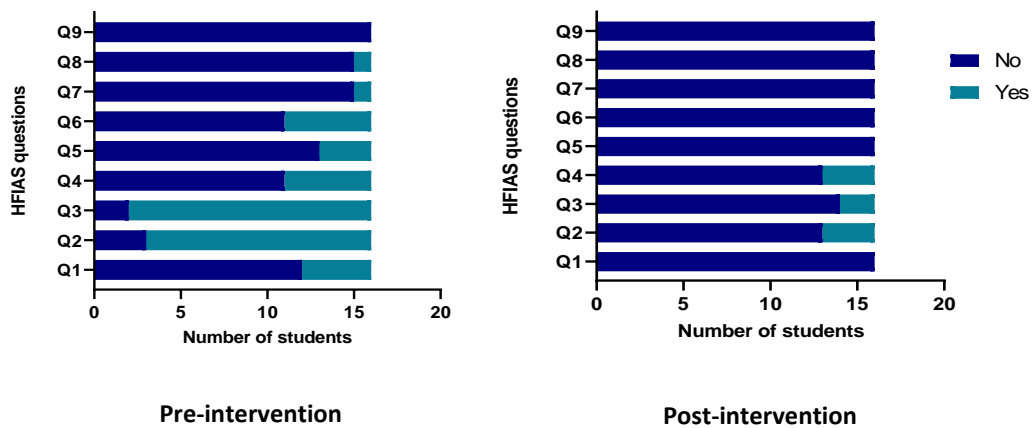
Figure 5.2: Food security status improved by 62.5% in university students 5 weeks post-dietary intervention. Food security was measured pre- and post-intervention using the HFIAS. The improvement was based on the HFIAS question domains "*Q1: Worry about food; Q2: Unable to eat preferred foods; Q3: Eat just a few kinds of foods; Q4: Eat foods they really do not want eat; Q5: Eat a smaller meal; Q6: Eat fewer meals in a day; Q7: No food of any kind in the household; Q8: Go to sleep hungry; Q9: Go a whole day and night without eating".* Data are presented as % prevalence.

5.4.3 Mental wellbeing status (WEMWBS)

At recruitment, 18.8% of the participants had low mental wellbeing, while 81.3% had medium mental wellbeing. No participant achieved a high score. Five weeks post-intervention, mental wellbeing improved, with 18.8% of the participants scoring high mental wellbeing, 68.8% scoring medium mental wellbeing, and only 12.5% scoring low mental wellbeing. The mean mental wellbeing score significantly increased between pre- and post-intervention (WEMWBS score: pre-intervention, 47.7 ± 6.2; post-intervention, 51.9 ± 8.1; $p < 0.05$), suggesting an improvement in participants' mental wellbeing status from pre- to post-intervention (Figure 5.3).
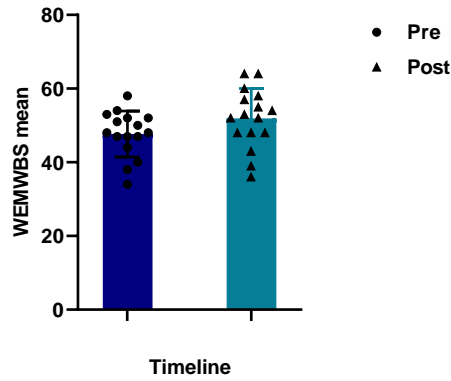
Figure 5.3: Mental wellbeing status significantly improved in university students following a 5-week intervention. Mental wellbeing was measured pre- and post-intervention using WEMWBS. Data are presented as mean ± SD, *P < 0.05.

5.4.4 Dietary intake and eating habits

5.4.4.1 Dietary intake

The change in daily macronutrient consumption was captured using a self-reported three-day food record. Average daily intake increased significantly from pre- to post-intervention in energy (pre-intervention 938.3 ± 255.6; post-intervention 1263.6 ± 408.2; p = 0.001), protein (pre-intervention 35.4 ± 10.7g; post-intervention 58.5 ± 17.1g; p < 0.001), fat (pre-intervention 32.6 ± 14.2g; post-intervention 50.7 ± 26.5g; p = 0.001), and carbohydrates (pre-intervention 125.3 ± 29.7g; post-intervention 144.5 ± 37g.6; p = 0.055).

Table 5.2: Average macronutrient intake from food and beverages (no. of serves/day) pre- and post-intervention over 5 weeks. Data are presented as mean ± SD.

Dietary food intake	RDA	Pre Mean (±SD)	Post Mean (±SD)	P Value
Energy	2000 kcal	938.2 (255.6)	1263.6 (408.2)	0.001
Carbohydrate	267 g	125.3 (29.7)	144.5 (37.6)	0.055
Protein	45 g	35.4 (10.7)	58.5 (17.1)	<0.001
Fat	78 g	32.6 (14.2)	50.7 (26.5)	0.001

P ≤ 0.05 deemed as statistically significant.

5.4.4.2 Eating behaviour

Eating behaviour showed slight improvements following the 5-week intervention, with the prevalence of consuming 2-3 meals per day increasing from 62.5% to 87.5% post-intervention (Table 5.3); however, this did not reach statistical significance. No changes were observed in the number of snacks consumed, or in the consumption of fruits, vegetables, and alcohol, or smoking patterns (Table 5.3).

Table 5.3: Eating behaviour of university students pre- and post-intervention over 5 weeks.

Variable	Pre N (%)	Post N (%)	P Value
Main meal/day			
1-2 meals	6 (37.5)	2 (12.5)	ns
2-3 meals	10 (62.5)	14 (87.5)	
Snack/day			
0-1 /day	8 (50.0)	7 (43.8)	
Twice	5 (31.3)	6 (37.5)	ns
More than twice	3 (18.8)	3 (18.8)	
Eating fruit			
1-4 days/week	4 (25.0)	7 (43.8)	
5-6 days/week	6 (37.5)	2 (12.5)	ns
Everyday	6 (37.5)	7 (43.8)	
Eating vegetables			
2-4days/week	4 (25.0)	3 (18.8)	ns
Everyday	12 (75.1)	13 (81.3)	
Consuming alcohol			
Never	2 (12.5)	6 (37.5)	
Once a week	9 (56.3)	5 (31.3)	ns
More than 2 days/week	5 (31.3)	5 (31.3)	
Smoking			
Never	15 (93.8)	15 (93.8)	ns
1-4 days/ week	1 (6.3)	1 (6.3)	

P ≤ 0.05 deemed as statistically significant.

5.4.4.3 Factors associated with meal preparation

We observed no differences in the ability to shop for food, nor in changes in food purchasing, or the number of meals prepared per week. However, when asked what affected their ability to make food for themselves, the most

common factors were a lack of time (87.5%) and a lack of funds (43.7%), followed by a lack of equipment (18.7%) and cooking knowledge (18.7%). Unfortunately, the intervention did not significantly change any of these factors. Notably, post-intervention, while lack of funds was no longer cited as a reason, lack of time was still reported by 81.2% of participants (Table 5.4).

Table 5.4: Factors associated with meal preparation of university students pre- and post-intervention over 5 weeks.

Variable	Pre N (%)	Post N (%)
In the past 4 weeks:		
Shopping for food		
1-2/month	4 (25.0)	5 (31.3)
Once/week	9 (56.3)	7 (43.8)
Twice or more/ week	3 (18.8)	4 (25.0)
Typically purchased food		
In person	12 (75.0)	10 (62.5)
Online	4 (25.0)	6 (37.6)
Frequently preparing meals/week		
2-3 times/week	8 (50.1)	6 (37.5)
More than 4 times/week	8 (50.1)	10 (62.6)
Factors effecting meal preparation		
Lack of time	14 (87.5)	13 (81.2.)
Lack of fund	7 (43.7)	0 (0.0)
Lack of equipment (e.g., food storages)	3 (18.7)	3 (18.7)
Cooking knowledge	3 (18.7)	0 (0.0)
Distance	1 (6.2)	1 (6.2)
Availability of culturally food	1 (6.2)	0 (0.0)
Motivation	0 (0.0)	4 (25.0)
Access for food charities or organizations	1 (6.2)	0 (0.0)

5.4.5 Food literacy (Cooking confidence and Food preparation behaviours)

Food literacy, measured as cooking confidently, and food preparation behaviours significantly improved post-intervention (cooking confidence: pre-intervention, 22.1 ± 4.4; post-intervention, 25.5 ± 3.0; $p < 0.001$; food preparation behaviour: pre-intervention, 10.5 ± 3.6; post-intervention, 13.2 ± 2.9; $p < 0.001$. (Figure 5.4, Tables 5.5 and 5.6).
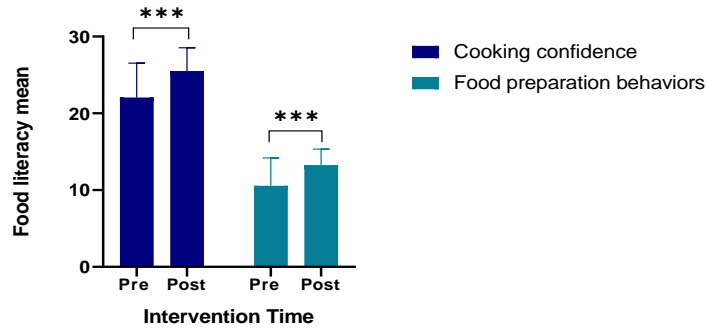
Figure 5.4: Food literacy (cooking confidence and food preparation behaviours) significantly improved in university students following a 5-week intervention. Food literacy was measured pre- and post-intervention using the Food Literacy Scale. Data are presented as mean ± SD, ***P < 0.001.

5.4.5.1 Cooking confidence

The improvements in cooking confidence were due to increased confidence in the ability to buy healthy food on a budget (pre-intervention, 3.0 ± 1.2; post-intervention, 4.6 ± 0.6; p < 0.001), cooking from basic ingredients (pre-intervention, 3.6 ± 0.9; post-intervention, 4.3 ± 0.7; p = 0.011), and preparing and cooking new foods from recipes (pre-intervention, 3.6 ± 1.0; post-intervention, 4.2 ± 0.9; p 0.013), (Table 5.5).

Table 5.5: Food literacy (cooking confidence) among university students pre- and post-intervention over 5 weeks. Data are presented as mean ± SD.

Food literacy measurements	Pre Mean (±SD)	Post Mean (±SD)	P Value
Cooking confidence			
Confidence to eat the recommended servings of fruit and vegetables/day	3.4 ± 1.0	3.8 ± 0.9	0.111
Confidence in ability to buy healthy food on a budget	3.0 ± 1.2	4.6 ± 0.6	<0.001
Confidence to cook from basic ingredients	3.6 ± 0.9	4.3 ± 0.7	0.011
Confidence in following a simple recipe	4.4 ± 0.7	4.5 ± 0.6	0.333
Confidence in tasting foods not eaten before	4.1 ± 1.1	4.4 ± 0.7	0.136
Confidence in preparing and cooking new foods and recipes	3.6 ± 1.0	4.2 ± 0.9	0.013
Average total of cooking confidence	22.1 ± 4.4	25.5 ± 3.0	<0.001

P ≤ 0.05 deemed as statistically significant.

5.4.5.2 Food preparation behaviours

The improvements in food preparation behaviours were due to increased ability to identify foods with low salt (pre-intervention, 0.6 ± 0.9; post-intervention, 1.1 ± 0.6; p 0.027), increased tendency to choose whole meal and wholegrain bread (pre-intervention, 1.6 ± 1.0; post-intervention, 2.2 ± 0.9; p = 0.006), more frequent reading of the ingredients list (pre-intervention, 1.0 ± 0.9; post-intervention, 1.6 ± 0.9; p = 0.014), and increased likelihood of using a shopping list (pre-intervention, 1.9 ± 1.2; post-intervention, 2.4 ± 1.0; p = 0.027), (Table 5.6).

Table 5.6: Food literacy (food preparation behaviours) among university students pre- and post-intervention over 5 weeks. Data are presented as mean ± SD.

Food literacy measurements	Pre Mean (±SD)	Post Mean (±SD)	P Value
Food preparation behaviours			
Look for low-salt food varieties	0.6 ± 0.9	1.1 ± 0.6	0.027
Choose whole meal or wholegrain bread	1.6 ± 1.0	2.2 ± 0.9	0.006
Read nutrition information panels when shopping	1.4 ± 0.8	1.7 ± 0.8	0.136
Read ingredient list when shopping	1.0 ± 0.9	1.6 ± 0.9	0.014
Look at price per kilo when shopping	2.5 ± 0.9	2.6 ± 0.6	0.333
Change recipes to make them healthier	1.3 ± 0.9	1.4 ± 0.8	0.544
Use a shopping list	1.9 ± 1.2	2.4 ± 1.0	0.027
Average total of food preparation behaviours	10.5 ± 3.6	13.2 ± 2.9	<0.001

P ≤ 0.05 deemed as statistically significant.

5.4.6 Challenges facing the students (Focus group discussions)

Focus group discussions were conducted to gain a deeper understanding of the study process and the food insecurity status of students during each phase of the study. The focus group discussions revealed two major challenges: (i) a lack of ability to budget by planning ahead and (ii) a limitation on food storage

space. A summary of the focus group discussion analysis results is presented in Figure 5.5.

5.4.6.1 A lack of budget planning

The majority of participants (69%; n = 11) admitted to not spending time planning their budget and meals, which resulted in a lack of finance and inability to control their budget, which led to the development of unhealthy habits such as shopping for food several times per week, not knowing what to cook and eat weekly, purchasing foods they didn't need, purchasing convenience foods such as meal deals, and/or waiting until they were hungry, which resulted in spending more money on randomly selected food most of the time. This was illustrated by student No. 4 when she said:

"I think I just realised that if I do take time to plan in advance, then I can make it last longer. Whereas before, I thought I wouldn't plan as much, and then it would end up being more expensive because I'd be buying things that I didn't need or didn't kind of fit within the meal."

Following the intervention methodology allowed the students to improve their skills in planning their meals during weeks 2 and 3, which resulted in them spending less money than usual and eating enough to be full. This was illustrated by student No. 1 when she said:

"I definitely had enough food and probably spent less money because it was far more controlled than usual."

5.4.6.2 A limitation on food storage space

Most of the participants (69%; n = 11) emphasised that a lack of space in the fridge and freezer was an issue they faced, since most of the participants lived in shared university accommodation. The lack of storage space thus affected the participants' ability to purchase sufficient quantities of food to allow meals to be prepared in advance, resulting in shopping for food more than once a week and increasing the amount of money spent on food, such as by tending to buy convenience foods. Furthermore, this lack of space in the fridge and freezer resulted in food waste or overeating as they were not able to store food chilled. Indeed, student No. 4 stated:

"*I think the one thing that is still limiting is obviously kind of like fridge freezer space. When you're living in a student house, there is no more space to store things. So, you can, like, freeze meals and make them last longer, but obviously you can't. There's not much that we could really do about that.*"

5.4.6.3 Other themes identified throughout the intervention

The discussions revealed additional themes associated with the individual intervention weeks. The cooking week's theme components included: meal planning (recipes and ingredients); simplicity and quickness of recipes provided; reducing food waste by using leftovers to make new meals; improving cooking skills; food prep experience; and managing money and time. The budget week's components included being more cautious and stricter with the budget; spending less money and eating enough; eating generous amounts

of meals with £20; inspiring confidence; managing money more wisely; improving cooking skills; and improving shopping skills.

5.4.7 Cooking week (Week 2)

The focus group following week 2 (cooking week) identified a number of themes such as effectively planning their meals, improvements in the ability to read and follow recipes, improvements in cooking skills and ability to meal prep and reducing food waste, thus improving their ability to budget their finances (Appendix 3.6.1).

5.4.7.1 Meal planning (recipes and ingredients)

Some participants (63%; n = 10) mentioned that the cooking week helped them create effective meal plans. They stated that having a detailed weekly plan with ingredients and recipes prepared in advance helped ease their anxiety about what they should eat daily, whether they were eating enough, and whether it was good in quantity, and quality and enabled them to manage their time efficiently. Thus, knowing what they were going to eat for the entire week helped them feel organised, leaving extra time throughout the day to focus on other things. As student No. 4 illustrated:

"It helped me learn to plan really, and I know that I could use it for other meals."

5.4.7.2 Simplicity and quickness of recipes provided

All of the participants (100%; n = 16) were confident in their abilities to understand and follow the instructions, as well as in the simplicity of the recipes and ingredients provided. The students were able to prepare all of the meal

recipes for their lunches and dinners using healthier ingredients and cooking methods. They felt that finding recipes was not more difficult than figuring out how to arrange them in a way that makes them easy to follow, which was a key tool for helping them keep cooking for themselves on a regular basis and save time. As we found previously, saving time was the most important factor affecting their ability to cook and eat regularly. As illustrated by student No. 8:

"*I made the base meal twice, and it literally took like 10 minutes. So, I kind of made it easier, and it's fast.*"

5.4.7.3 Reducing food waste by using leftovers to make new meals

All the participants described their experience of reducing food waste in different ways, including using leftovers to make new meals and/or healthy snacks. As student No. 10 said:

"*I used the leftover wraps; I just added peanut butter or jam or something like that as a snack.*"

They became more mindful of making new recipes from leftovers and became more selective of foods that last longer, such as frozen fruits and vegetables. For example, some students had never used frozen vegetables before to make their meals. As they stated, they often used fresh vegetables, which, if not consumed quickly or not stored due to space, lose their quality as well as being more expensive than frozen. Student No. 4 expressed that by saying:

"*I didn't know that you could get frozen peppers. So that's something that I know in the future I can get rather than throwing away fresh peppers.*"

They also gained more confidence in their ability to use some ingredients they had for many different meals. Student No. 12 demonstrated this by saying:

"*I've used some of the leftover veg in my other meals, so like the beans and the peppers, and then I plan to use the wraps next week for like other stuff, which is good because it's often hard to use an entire pack of wraps as one person.*"

They were also able to make new flavours from the ingredients they already had. Student No. 11 described that by saying:

"*I think I managed to sort of improvise on some of the meals. So, like with the rice one, I'm not a fan of just having no sauce with rice. So, I added some leftover tomato sauce to it, and I think it was more improvising than I normally do. I usually plan things quite a lot, so it's quite a good way of using up things that I would have probably forgotten about normally.*"

Thus, improving students' skills through reducing food waste was an important domain that helped them enhance their food security status through financial benefits, keeping food waste out of their behaviours, and improving cooking skills.

5.4.7.4 Improving cooking skills

According to 56% (n = 9) of the students, the perceived results clearly demonstrated that the shift to cooking was a significant skill. It showed that the

students practised cooking skills more than they normally did and learned new healthy cooking methods to cook their meals, which resulted in more nutritious meals consumed that week. This was illustrated by students No. 10 and No. 13 when they said:

"I've done more cooked lunches than I normally would like. I'd normally just have a sandwich, but I actually cook food, which I suppose is a bit more nutritious." Others said, *"I actually learned a new way to cook rice, and I quite like the new way of cooking rice; I thought it was much better than my old way of doing it."*

The students also improved their skills by adapting one meal or a set of ingredients to other meals in order to produce a variety of meals with different tastes, which prevented them from feeling bored and consuming food that they did not want to eat. Student No. 11 said:

"I like the idea of using the base meal to make different meals because I do get very bored of food, so it's quite interesting that I hadn't thought to do that before."

It is apparent that cooking skills helped them not just eat well but also become more creative in making new recipes and avoid getting bored by eating the same meals daily.

5.4.7.5 Food prep experience

Even though only 31% (n = 5) of the students had experience with meal prep, they encountered challenges that discouraged them from continuing with the

prep approach. They provided several reasons for not keeping up with meal prep:

(1) Feeling bored having the same meal every day, as student No. 5 said:

"*When I did meal prep before that, having the same meal all the time was quite boring.*"

(2) Lacking recipes and meal-prepping ideas, as student No. 6 said:

"*I didn't have any ideas. I think that's what made it difficult for me to find what to eat.*"

(3) Lacking food storage space, as student No. 2 said:

"*I have very little space in the fridge and the freezer. I feel that's the hardest thing for me, like I would be if I could prep more and freeze more.*"

However, all the participants' experiences after the cooking week were totally different. This was illustrated by student No. 1 when she said:

"*I hadn't really thought before about making a base meal and then using and like prepping that all in advance and then just using that to make different meals. So, I guess that was a bit different from what I've done before.*"

With a variety of ideas and ways to make meals from the ingredients they had, they were able to make new meals instead of having the same meal every day, which helped avoid boredom. Preparing one meal in advance and cooking it differently each day helped them save money and reduce food waste by avoiding purchasing takeout food and relying on the meals they had prepared,

which helped them stay on track with eating healthy food. Also, since they knew exactly what they should eat for breakfasts, lunches, or dinners, it helped save time from thinking about food or even worrying about eating.

5.4.7.6 Managing money and time

Participants described how the cooking week increased their understanding of meal planning. As a result, 25% (n = 4) and 44% (n = 7) were more adapt at managing their time and money, respectively, which obviously showed that food planning could help them become more mindful of money and time. It demonstrated that planning meals ahead of time helped them alleviate some of their thoughts and worries about what they had to eat every day, which is one of the important aspects of reaching food security status. It also certainly helped them save money on food by keeping them from buying unnecessary grocery items, and even more importantly, it helped them avoid stepping foot inside a food store mid-week and kept them away from tempting purchases of fast or unnecessary food. This was illustrated by student No. 8 when she said:

"*It really helped me manage time, and like I had in my head that I had to eat those two main meals. So, it just helped me improve my time skills, basically time management skills.*"

Student No. 1 said:

"*I probably improved the budgeting because I usually would go to the shops a few times a week, whereas now I've realised you can actually just go once and have enough ingredients if you plan ahead.*"

5.4.8 Budgeting week (Week 3)

The focus group following week 3 (budgeting week) identified a number of themes, such as caution and being strict with the budget. spending less money and eating enough; eating generous amounts of meals with £20; inspiring and building confidence; managing money more wisely; and improving cooking and shopping skills (Appendix 3.6.2).

5.4.8.1 More cautious and strict with the budget

Although budgeting can be challenging, particularly for students who are in low-income status and lack budgeting skills and meal planning abilities, setting a specific amount of money aside for food shopping and providing it as a card voucher was beneficial to approximately 75% (n = 12) of the students. Knowing how much money they should spend on food made them more aware of their meal plans, money spent, and food choices during their shopping. It also assisted them in learning and comprehending the weekly cost of food, which promoted a healthy diet and helped them manage their finances effectively. This was illustrated by student No. 2 when she said:

"*I was more careful while I was actually shopping to make sure I wasn't spending unnecessary amounts because, I guess, if you're just buying it normally, you haven't really set a certain amount that you can spend.*"

5.4.8.2 Spending less money and eating enough

Most of the students were able to stick to the budget and buy enough food while spending less money than usual. This allowed them to have a variety of foods, which is one of the significant aspects of reaching food security status. Student No. 2 expressed this by saying:

"*I definitely spent a lot less money, and I think I did have sufficient quantities.*"

However, only 19% (n = 3) of students stated that they overspent during the budgeting week. These students attributed their overspending to the additional money they had, as £20 allowed them to buy meat compared to their previous status, when due to a lack of funds, they tended to eat vegetarian meals because meat was a bit pricey for them. Student No. 12 explained that by saying:

"*I spent more price per meal this week because I was able to buy more expensive ingredients and I bought meat, which I never buy meat for the week. I guess it comes down to money and especially having meat or fish for lunch feels like an extravagance. So, I could have vegetarian meals instead.*"

Furthermore, 63% (n = 10) of the participants were able to purchase a variety of affordable foods and healthier diet options while saving money. Student No. 5 described that:

"*I've bought quite a variety of different foods. I've bought vegetables, meat, and carbohydrates.*"

5.4.8.3 Eating generous amounts of meals with £20

Despite their varying viewpoints on the types and quantities of food purchased with the budget supply, all of the students were able to create at least five meals and some snacks using the budget provided for the week, as they were able to stretch their budget further when they followed the budgeting techniques. According to the students, the number of meals prepared ranged from 5 to 20, with multiple snacks in between. This suggests that sticking to the budgeted amount this week revealed improvements in the participants' abilities to eat enough food, which is an important aspect of achieving food security status. Student No. 8 demonstrated this by saying:

"*I've made about six meals, and then I've made quite a few lunches, I'd say like. You know, close to maybe 15.*" (See Appendix 3.7 of meals made by students).

5.4.8.4 Inspiring and confident

When the students were asked how they felt and how they found cooking with the budget allotted, some of the participants, 62% (n = 10) said that they did not expect the number of meals they cooked, whereas others stated that since the previous cooking week had taught them to make more than five meals with only £17, the ingredients provided and the total cost of the food helped them understand how crucial a meal and budget plan are. This insight encouraged them to become confident in meal and budget planning. They were therefore confident in this phase and knew that, with previous planning, they could

prepare a considerable number of meals throughout the budgeting week. This was illustrated by student No. 3 when she said:

"I was kind of inspired, I guess, from the previous week because I knew that shop was £17.00. So, I thought that I would be able to make the meals."

5.4.8.5 Managing money more wisely

The majority of the students (69%, n = 11) found that the budget card provided helped them manage their money more wisely. This aligns with one of our main objectives: to prepare nutritious meals on a budget to reduce food insecurity and thus improve mental wellbeing and food intake. The students noticed a difference in their budget compared to what they normally do, such as poor behaviours that included going shopping without a plan and spending more money by buying foods that they did not need, resulting in running out of money for food, increasing food waste, and eating less. However, the limited amount on the card encouraged the students to make a meal plan and stick to it. This helped students consider how they could spend their money on necessary food while avoiding the temptation to buy extra food, eating a sufficient number of meals, and limiting food waste. Student No. 8 demonstrated this by stating:

"I didn't realise how much money I was actually spending but having only £20.00 this week to buy that or to spend that money was just really helpful."

5.4.8.6 Improving cooking skills

Some students (37%; n = 6) improved their cooking skills in a variety of ways by being able to prepare a new meal each time. Student No. 2 commented:

"I think I would say I developed some skills of, like, adapting meals."

Others were able to improve their cooking skills by using ingredients they had on hand or leftovers. This allowed them to cook a wide range of meals, which was a practical strategy for ensuring an adequate food supply, saving money, and reducing food waste. Student No. 10 expressed that:

"I found myself improvising with leftovers."

5.4.8.7 Improving shopping skills

Shopping skills are essential for managing finances and ensuring food security. Students improved their financial situation (100%; n = 16) by practicing this skill. The majority of them improved their purchasing abilities and became more cautious while selecting food items. Most of the students realised that planning ahead is the key to reducing frequent shopping, saving money, having enough food, stretching finances further, and becoming more organised compared to what they usually do. This plan includes recipes and ingredients, the amount of money they need to spend, and a shopping list that depends on the meal or recipe they plan to make. This was illustrated by student No. 9 when she said:

"I quite liked having a set amount that we had to stick to because usually I just kind of get things when I need them, and I don't really look at the amount until the end when I've put in all my lists that I've created through the week."

Student No. 1 said:

"I probably say it improved the budgeting because I usually would go to the shops a few times a week, whereas now I've realised you can actually just go once and have enough ingredients." Sticking to a budget is an important shopping skill, particularly with the cost of food rising after the COVID-19 pandemic. Knowing exactly how much they could spend helped them stick within that limit. Indeed, the students discovered that spending a bit of time planning helped reduce their shopping frequency, allowing them to eat for longer periods of time and avoid purchasing food that was unnecessary, which helped them save money by spending less and having enough food compared to their previous habits. This was illustrated by student No. 4 when she said:

"I think I just realised that if I do take time to plan in advance, then I can make it last longer."

Furthermore, after planning what they have to eat, making a shopping list before going shopping is one of the important shopping skills that the students learned. The students stated that making a list of everything in a pantry as well as what needed to be bought before going shopping helped them manage

money better than buying haphazardly or off the top of their heads, which was an effective way to save money. Student No. 5 demonstrated this by saying:

 "*Having written a list, especially beforehand, was really helpful. So, I knew which foods I could actually get to have a variety of different foods*."

Students also increased their ability to compare brands and evaluate the price per kilogramme before purchasing. Students demonstrated how to shop for less expensive brands, such as store brands, which are typically less expensive than general brands, and how to compare different brands that have the same quality but may be less expensive. Student No. 4 commented:

"*Checking other brands and different prices that could be cheaper. I think it's definitely a skill I've learned.*"

Additionally, the students increased their ability to compare foods by looking at bulk and price before purchasing, making it easier to save money. Student No. 7 demonstrated this by saying:

"*I feel like the differences in the budget, I was able to get a lot more for less. properly looking at, like, the price per kilo for everything*."

Moreover, buying frozen food and substituting food options is a new skill that most students have not thought about. They found purchasing frozen fruits and vegetables was not only cheaper but lasted longer than fresh food, particularly with the limited space they had in their accommodation. This also made a

difference in their budget by reducing the number of shopping trips, reducing food waste, and therefore actually saving money. Student No. 13 commented:

"*I learned that I could buy frozen food, but I had never thought about it; having frozen vegetables, I think, will last so much longer for me.*"

Also, because the students were given a limited amount of money and their shopping relied on meal recipes, they felt that it was more important when budgeting to replace an ingredient that was in their recipes but was a bit expensive with similar items that were cheaper and had comparable nutritional values. Student No. 1 demonstrated this by saying:

"*There were some things in the recipes that a whole only needed, like 3 tablespoons of peanuts, for example, and a whole bag was £1.60, which out of £20 is quite a considerable percentage. So, I ended up kind of substituting that for something I could use for another meal instead.*"
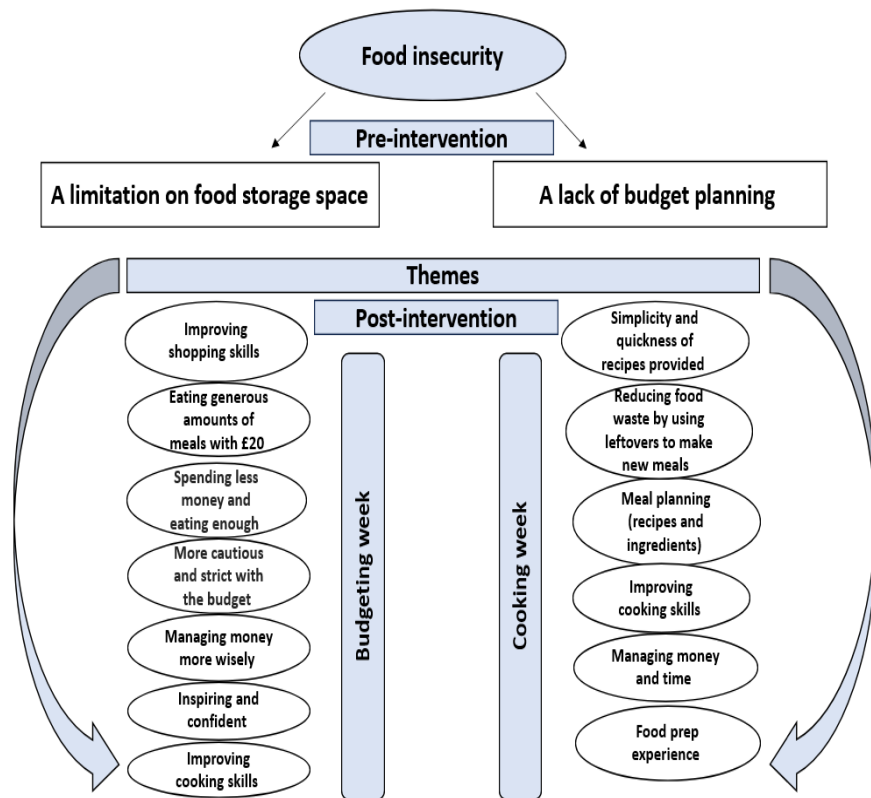
Figure 5.5: Summary of the focus group discussion analysis with qualitative themes ranked from the most improved to the least improved.

5.4.9 Identification strategies for preventing the risk of food insecurity among university students

When the students were asked if they were able to continue following the techniques they learned from this study and what other skills they needed to maintain their food security status, they expressed several suggestions and comments that could contribute to preventing food insecurity among university students, according to their responses in both focus groups (cooking week and budget week). These are listed below:

1. **Tools and references for recipes**

Even though the students found that the tools used in this study were quite useful and helped them in both planning meals and budgeting, half of the students (50%, n = 8) highlighted the challenges of continuing to practice their budgeting and cooking skills. Finding new tools for further recipes and ideas to make new meals to help them stick to their budget were the most important tools needed to keep them on track with their plans and budget. Student No. 2 demonstrated this by saying:

"*I guess one thing that I probably do first is maybe try and research different recipes to get other ideas of, like, what I could use as a different base meal and what other meals I could make out of that*."

This may be a particularly significant suggestion to help students avoid worrying about food in the future, as this is the first sign that could indicate food insecurity.

2. **Nutrition knowledge**

Planning to cook at home leads to better food choices and a healthier diet. Because of this, the majority of students (56.25%, n = 9) are curious to find out more about planning meals, whether they are eating healthy, and how much nutrition they should include when making meal plans. Also knowing about alternative food items seems interesting for students. Some students suggested that if they were lacking the food products in their recipes, finding alternatives with similar nutrition values or switching out more expensive ingredients for cheaper ones would be a valuable solution for their meals and

budget if they considered it in the future. Student No. 2 demonstrated this by saying:

"Maybe suggestions for alternatives if you like run out of chicken but you still want to use some kind of protein if you have like chickpeas you can use this or if you have like these things this would be like a similar nutritional value or exposing you wanted to adapt to the meal if you wanted to make it for someone that was also a vegetarian or had different diet requirements like how could you change them and how would it affect the nutritional value I think would be useful."

Moreover, meal planning and cooking demonstrated that the students lacked knowledge about healthy food, and these skills encouraged them to become more interested in learning about healthy diets and whether they were eating healthy food or not. Student No. 3 demonstrated this by saying:

"Figuring out how to plan healthy meals because I can plan meals, but I don't know how healthy they were, but then the study obviously gave like an in depth like coverage of the calories and the fibre and that kind of thing, which would be really helpful to know if I'm if I'm supposed to be eating healthy."

Also, learning how to cook with spices is perhaps one of the easiest ways to add flavour to meals. It could help them keep meal prep going as adding different spices each time makes a new taste even if it is the same meal, which would lead them to eat the same meal without complaining or finding it boring as it has a different taste every time. A few students expressed that they lacked information about using spices to add flavour or that changing the spices while

using the same recipes could give different meals a new taste. Student No. 10 demonstrated this by saying:

"*The spices thing, I think when you go to the shops, there's like 50 lined up or whatever, and like, I know a few from home, but there's a lot more that I haven't tried before. So, I don't really know what they would go with*."

Indeed, nutritional knowledge would be an important factor in managing food security, as knowing healthy food choices helps to access a healthy lifestyle.

3. Teaching the first-year students cooking skills

Some participants (25%, n = 4) expressed that the biggest challenge to eating meals regularly that they faced was during the first year of starting to study at the university, as this was the beginning of living independently. Thus, they suggested that releasing a cooking and budgeting programme for first-year university students would be an effective way of preventing food insecurity among university students. This was illustrated by students No. 7, 11, and 2, respectively, when they said:

"If I compare it to like in the first year, I think my cooking skills were a lot more questionable and so I think doing something like this in the first year would have really helped with those Uin."

"I wouldn't have known to do it in the first year. So, I think if I'd been taught about this in the first year, this would have been mind-blowing for me."

"There were quite a few people that I met in the first year that had clearly like never cooked themselves before and I think maybe having, I don't know if the Union could send round like some videos."

4. Motivation

Building motivation to keep the students eating well and prevent food insecurity could be a contributing factor to food security. This could also be a link between food insecurity and poor mental health, as keeping the motivation to plan and cook could prevent food insecurity and may improve mental wellbeing. A few students (12%, n = 2) comments suggested that motivation was the only aspect they needed to keep planning meals and budgeting. Student No. 8 described this:

"I think the only problem is that I just need to have the motivation to continue to do it."

5. Long-term budget for food

Only Student No. 5 was concerned about financial education, such as how a long-term budget would be helpful to manage all the necessities, like foods that last longer or even household items, and how they could plan a budget for food and other household items. She said:

"If I bought a huge bag of pasta that would last me a month and I don't know how I would incorporate that into my budget because obviously I wouldn't have to buy pasta, but then I'd have to buy other things. So, kind of incorporating the kind of the product that lasts longer into a budget."

5.4.10 Results of the students who remained food insecure post-intervention

Post-intervention, even though none of the students had access to financial incentives during the follow-up period, most of them had improved in both food security status and mental wellbeing. However, six students (37.5%) remained food insecure: four were in a mild status and two were in a moderate status. When we compared their food insecurity status pre-intervention to post-intervention, two of them improved their status from moderate to mild, while the other four stayed in the same status. According to their perspectives in focus group discussions, three of them highlighted the limited space in the fridge and freezer, two indicated a lack of time and organisation, and one mentioned distance, which we could link to these factors as being the reasons for remaining in a food insecure status in this study. For the mental wellbeing status, only two of the six food insecure students improved from medium to high status, while two remained at the same status (medium), and two decreased their status from medium to low.

5.5 Discussion

We previously observed that 28% of the university population was food insecure and had poor mental health (Chapter 4). Therefore, this study aimed to evaluate the impact of a 5-week nutrition and culinary education intervention on food insecurity, dietary intake, and mental wellbeing, and determine whether this education on how to prepare nutritious meals on a budget with limited cooking facilities can reduce food insecurity and thus improve mental wellbeing and food intake among food insecure university

students. Our study revealed a strong association between low income and food insecurity among students. The majority of food insecure students reported living in shared housing and having limited disposable income, both indicators of financial constraints that likely contribute to their vulnerability to food insecurity. This finding aligns with our observations in Chapter 4, where we found that most food insecure students lived in shared houses. These results reinforce the established link between socioeconomic status and food insecurity, as previous research has demonstrated that low socioeconomic status negatively influences household food security (Kim and Oh, 2015; Oh and Hong, 2003). Indeed, income has been identified as the strongest predictor of food insecurity (Carter et al., 2010).

From pre-intervention to post-intervention, both the focus groups and the questionnaires showed improvements in participants' food security and mental wellbeing, which may be related to the food literacy intervention. The quantitative data from the questionnaires demonstrated significant improvements in food security status and mental wellbeing scores for the majority of participants. These improvements were corroborated by qualitative data from the focus groups. For example, student No. 10 stated:

"I've done more cooked lunches than I normally would like. I'd normally just have a sandwich, but I actually cook food, which I suppose is a bit more nutritious." Another participant commented (Student No. 11):

"I think I made more than I expected because usually I would make these sorts of things like I'd prepare breakfast or meal prep lunches or dinners, but not in

one week. So, I think the fact that I was able to do it all in one week. It was quite

a lot of food."

These quotes illustrate an improvement in food behaviours and dietary intake of meals, which are key components of food security. This aligns with the questionnaire data, which indicated improvements in energy, carbohydrate, protein, and fat intakes.

Another participant (Student No. 11) commented on the impact of saving time, which was one of the major factors affecting students' food status. This may reflect an improvement in mental wellbeing by reducing stress over what they need to eat:

"I actually spent quite a lot of time in the library. It really helped me manage time and like I had in my head that I had to eat those two main meals. So, it just helped me improve my time skills, basically time management skills."

It's important to note that while the overall trend was positive, individual experiences varied. The questionnaire data showed that a few students experienced a reduction in their mental wellbeing scores, and some remained food insecure. We could attribute this to the challenges they mentioned in the post-questionnaire, as some students still reported a lack of time as a reason affecting their food preparation. By triangulating the quantitative data from questionnaires with the qualitative insights from focus groups, we can see a more comprehensive picture of the intervention's impact. The majority of participants experienced improvements in food security and mental wellbeing, but individual experiences varied, highlighting the complex nature of these issues and the need for personalised approaches in future interventions.

In greater detail, food insecurity improved significantly by 62.5% from baseline to post-intervention among the students. This is higher than what has been observed in prior food insecurity interventions, which have found 25% (Rivera et al., 2016) and 28% (West et al., 2020) improvements in food security, or no improvement (Kaiser et al., 2015). The significant improvement observed in our intervention could be attributed to the students feeling more settled and organised during the intervention period, possibly due to the provision of food and financial resources. However, participants in the focus group discussion stated that they were becoming more organised because the skills they obtained from the intervention helped them plan their meals, enabled them to stick to a budget without compromising nutritional content, and helped them save money. Previous research on food insecurity interventions found that food insecurity was linked to a lack of nutrition knowledge (Oh and Hong, 2003), while changing attitudes and improving food knowledge increased the ability to stretch the food budget and improve food security status (West et al., 2020; Carman and Zamarro, 2016; Kaiser et al., 2015). However, further monitoring is needed over a period of time after the intervention to assess how sustainable these changes are for the students.

This is supported by our finding that participants' food literacy showed a significant improvement in both cooking confidence and food preparation behaviours from pre- to post-intervention. The most significant improvements were in their confidence in buying healthy food on a budget, cooking from basic ingredients, and preparing and cooking new foods and recipes, as well as

looking for low-salt food varieties, choosing whole-meal or wholegrain bread, reading ingredient lists when shopping, and using a shopping list. It has been demonstrated that improved food literacy increases an individual's ability to meet both the access and use components of food security status (West et al., 2020; Begley et al., 2019; Jomaa et al., 2022; Carman and Zamarro, 2016).

According to the focus groups, the key factors that affected the students' ability to be food secure were a lack of budget planning and limitations in food storage space. This aligns with other findings, where food insecurity was associated with difficulties in planning meals and managing money to purchase food, as well as limitations on food storage (Begley et al., 2019; Gorman et al., 2017). However, during the intervention, we found that the students were able to enhance their abilities to plan meals and budgets through the cooking and budgeting programme. They were able to prepare healthy meals with basic ingredients, cook with confidence, and reduce food waste while also saving money.

Furthermore, during the cooking week, the most influential theme identified by the students was the simplicity and low cost of the recipes. This may have increased their motivation to continue cooking with the foods they had received from us and to make all the meal recipes in the programme, as they expressed being impressed by the low cost of the food provided and how many meals they could make. This finding supports results from US food insecurity interventions that showed that people could not continue in food security programmes if they were expensive (Huisken et al., 2016; Hamelin and Hamel,

2009). However, the least common improvement in the cooking week was meal prep. We attribute this to the limited food storage in the students' accommodations, which was one of the major challenges they faced. One of our objectives was to assist students in improving their finances and making their money go further, as these are the most critical factors determining their food security status. Hence, according to our results, the most improved skill throughout the budgeting week was shopping skills (Figure 5.5). Previous research has linked this skill to food security status, as the majority of people who were food insecure had poor shopping skills (Gorman et al., 2017), indicating that improving shopping skills could improve food insecurity status, which could be a factor in enhancing finances, the key influencing factor in the food insecurity issue.

Overall, post-intervention, the participants learned to stretch their food budgets and make meaningful changes by improving their skills in both financial management and food planning. Previous research suggests that food assistance, such as a food literacy programme, is associated with improvements in food security (West et al., 2020; Begley et al., 2019). The qualitative component of this study confirmed this, with some participants acknowledging that providing education classes in cooking and budgeting helped them access and maintain their foods and improved their financial resources, as none of the participants mentioned funding as a reason affecting their ability to prepare meals post-intervention, compared to 43.8% pre-intervention.

This aligns with previous findings indicating that food literacy is linked to socioeconomic determinants of health that can either improve or hinder an individual's ability to develop and practice food literacy, and that highlighted financial factors as an essential component of food literacy (Perry et al., 2017). Those from low-income households who improved their food literacy were less likely to experience food insecurity (Carman and Zamarro, 2016). Thus, a mixed-methods approach was advantageous for analysing how the intervention programme positively affected food insecurity because it was able to capture the participants' developing self-efficacy and food budgeting abilities. The importance of ensuring that evaluations of cooking and budgeting interventions are sensitive and comprehensive enough to be used by individuals experiencing food insecurity has been highlighted by West et al. (2020) and Begley et al. (2019).

Mental wellbeing appears to be associated with food security, as observed in our previous study in Chapter 4 and as documented in the literature (Myers, 2020; Men et al., 2021). Research suggests that individuals who experience chronic concerns about food insufficiency, skip meals, or face hunger may be deprived of both material and social resources that support mental health and wellbeing. This association seems particularly pronounced in areas where food insecurity is less common, with studies indicating poorer mental wellbeing among food insecure individuals in these contexts (Elgar et al., 2021). Our data support those findings, as the food insecure students reported poor mental health on the self-reported scale pre-intervention, whereas a significant

improvement in mental wellbeing was observed post-intervention when there was an improvement in food security status.

We could attribute the improvement in mental wellbeing to increased protein consumption. Our sample showed a high level of protein consumption post-intervention compared to pre-intervention. It was previously found that inadequate protein intake may raise the risk of mental health issues such as depression and anxiety, while adequate protein intake can help decrease these risks by promoting neurotransmitter balance (Lakhan and Vieira, 2008). Furthermore, the mental wellbeing improvement may be related to physical gathering and engaging in social activities with those who have the same social situation, which may promote overall mental wellbeing, especially since most of our participants had the same situation in both accommodation and food accessibility (shared university housing and the same food security status). There is evidence suggesting that social activities may be associated with increased mental health because individuals' perceptions of shared identity may lead them to feel that others are a source of social support, resulting in improved mental health (Hopkins and Reicher, 2016). Even though a few students did not show improvement in their mental wellbeing status, we could attribute that to the factors mentioned in the focus group discussion, such as limitations in food storage and a lack of organisation. It could also be linked to other factors such as academic pressure, family pressure, and emotional stability (Slimmen et al., 2022), which have been indicated to affect university students' mental wellbeing, or other factors, which were not explored. Overall,

mental wellbeing is sensitive to life conditions, so there are overlapping factors that could influence it.

Research indicates an association between food insecurity and low macronutrient intake (Kubo et al., 2020; Kim and Oh, 2015). In our sample, food insecure students had lower food intake pre-intervention, whereas they significantly improved their macronutrient intake post-intervention. However, despite the overall increase in average 3-day habitual intake among the participants, levels of energy, carbohydrate, and fat were still lower than the recommended daily allowance (RDA). Interestingly, only protein levels improved above the RDA recommendations, according to the BNF for Female Adults 2023. This could be due to an increase in their caloric intake, which leads to more food, which means more protein. It could also be because most of the students pre-intervention were less likely to eat protein due to its high cost, particularly animal protein, as mentioned in the focus group discussion by students No. 12: "I was able to buy more expensive ingredients and like I bought meat, which I never buy meat for the week.". This is consistent with previous findings, as those who were food insecure were more likely to have a lower intake of essential nutrients, including protein (Johnson et al., 2018; Castro et al., 2022; Kim and Oh, 2015). During the study phases, students were able to eat more protein, which showed higher levels post-intervention. We also noted that the students' consumption of macronutrients pre-intervention was very low. This may be due to the limited resources they had, as Student No.10 stated that *"I've done more cooked lunches than I normally would like. I'd normally just*

have a sandwich, but I actually cook food, which I suppose is a bit more nutritious." And Student No. 4 said: *"Definitely. I think I feel like the food that I bought is healthier than what I might buy normally. and I think the meals that I made were healthy and I felt it was sufficient. So, like, I didn't feel hungry at all after like the meals that I made."* This may also be related to the fact that the students may not have reported all food consumed accurately when they filled out the record, or if so, this is considered a deficiency that could be a risk to their health. Furthermore, there was no significant difference in fruit and vegetable consumption between pre- and post-intervention, which is consistent with a recent study that showed the consumption of fruits and vegetables was not linked to food security (Graham et al., 2023). We could attribute that to the fact that most of the participants in this study tended to consume vegetables and fruits because they were cheaper than meat, so they used them as a part of their recipes, according to the views expressed in the focus group discussion. It has been observed that the three most common coping mechanisms for food shortages were eating less expensive and less-liked foods and cutting back on portion sizes (Akerele et al., 2013). Generally, dietary intake results reflected how the students were able to improve their food intake by planning and preparing healthy meals at home.

Successful food security programmes may help low-income people make a balanced budget that can be used to improve their quality of life through a better diet and nutrition, as a balanced budget is important for improved and long-term health (Rivera and Qamar, 2003). However, the upstream factors of

food insecurity, such as the cost of food or level of income, cannot be addressed by food literacy interventions (Begley et al., 2019), as evidenced by our inability to improve the food security status of all our participants. Interventions in food literacy may only be expected to be a component of a more comprehensive strategy to increase food security, as there is still a critical need for upstream interventions and policies.

Moreover, measuring food literacy is especially difficult for educational interventions aimed at teaching it (Truman et al., 2017), as most of the studies conducted focus on knowledge acquisition, which results in limited outcomes in terms of health-related measures such as behavioural changes (Truman et al., 2017), which could be due to the fact that identifying and teaching food literacy components is more challenging, as each study approaches food literacy depending on their objective.

Furthermore, addressing food insecurity requires more collaboration and policies, particularly among university students, in terms of social and economic factors to ensure adequate socioeconomic conditions for the most vulnerable. This includes developing and implementing food aid programmes for low-income students that consider nutritional and food recommendations for an affordable and healthy diet. Thus, food literacy is an area that could be enhanced by developing nutritional skills and behaviours, whereas many of the variables that contribute to food insecurity are unchangeable. An individual who is food literate may be able to build some resilience regarding shifting

personal circumstances, but considering the numerous causes of food insecurity, this is not the only possible solution (Begley et al., 2019).

5.5.1 Limitations

This study showed improvements in food security status, which in turn improved dietary intake and mental wellbeing in most of the participants. This study used a mixed methods approach, which is a descriptive evaluation study that has been strengthened by the use of qualitative data, which has provided an analytical framework for the quantitative results. However, some limitations appeared in this study.

The experience with qualitative methods permitted the researcher to communicate with individuals to collect data, which potentially induced bias that was difficult to eliminate from the critical analysis. The study's limitations include a small sample size and the absence of a control or comparison group. Aside from the short duration of the intervention used in this study, it has been proven that randomised control trials with a control group provide the best level of evidence of a food literacy intervention's impact (West et al., 2020). However, due to the limitations of our resources and the timeline of this study project, we assessed the intervention utilising a pre-and post-test design with no control group.

Furthermore, the improvement in food security status among participants may have been due to more stable and organised lives (increased food security) throughout the intervention weeks, and hence they had a greater potential to

respond to the programme. Thus, despite the positive findings, they are not generalisable due to the limitations the study faced. Randomised control trials with a large group and a control group are needed to explore the long-term impact of this intervention.

5.6 Conclusion

This study confirmed that understanding food insecurity coping techniques such as nutritional education, including enhancing participants' financial budgeting, meal preparation, and food waste reduction skills, improves food security status and food intake, which in turn may contribute to improvements in mental wellbeing and dietary intake. However, to determine whether the teachings would be utilised beyond the study, further research is needed to explore the long-term impact of this intervention in a large group, using a control group to measure it with more accuracy.

Chapter 6- General Discussion

6.1 Summary of potential drivers of low mental wellbeing among UK university students

This final chapter presents a summary of the four studies in this thesis. The overarching aim of this thesis was to investigate factors affecting mental wellbeing among UK university students. Taken together, the studies have examined data from 328 university students using qualitative and quantitative methods, scales, and time points (during and post-COVID-19).

My thesis journey began with a comprehensive systematic review of 18 studies, assessing the effect of breakfast consumption on cognitive functions. This was followed by a cross-sectional study that evaluated breakfast consumption patterns to determine whether there is a relationship between breakfast consumption containing macronutrients (carbohydrates, protein, and fat) or GL levels with mental wellbeing, particularly cognitive functions (CP and A).

Initially, pre-COVID-19, we aimed to provide different types of breakfasts to measure this relationship experimentally. However, the pandemic and subsequent laboratory restrictions necessitated a shift to a completely online approach. We adapted our methodologies to accommodate remote data collection and online surveys, utilising platforms such as Microsoft Teams and Jisc. This adaptation required flexibility and changes to our ethics approval process. As COVID-19 affected food availability, accessibility, and overall health globally, we expanded our focus to explore the prevalence of food insecurity

and its associated drivers among university students. We also investigated the potential influence of food insecurity on mental wellbeing and the ability to cope in stressful situations, particularly given the limited knowledge about food insecurity in the UK context.

Finally, in 2023, after COVID-19 restrictions eased and we had identified the most common factors contributing to food insecurity and low mental wellbeing among students, we conducted a 5-week nutrition and culinary education intervention. This study aimed to evaluate the impact of the intervention on food insecurity, dietary intake, and mental wellbeing. Specifically, we sought to determine whether education on preparing nutritious meals on a budget with limited cooking facilities could reduce food insecurity and improve mental wellbeing among food insecure university students. This series of studies provides a comprehensive exploration of the complex interplay between nutrition, food security, and mental wellbeing among UK university students, adapting to the challenges posed by the COVID-19 pandemic and evolving our research focus to address emerging issues in this population.

After analysing the results from all studies in this thesis, we can identify the most common factors affecting university students' mental wellbeing. Food insecurity emerged as a significant issue among UK university students, with a prevalence of 28% in our sample. This aligns with the trends observed in other high-income countries and exceeds the UK Food Security Report 2021 figures (Nazmi et al., 2019; Shi et al., 2021). Notably, food insecurity increased post-COVID-19 lockdown (31.8% vs. 25.7% during lockdown), indicating persistent

challenges such as exacerbated limited availability of nutritious food (Nettle and Bateson, 2019; Pautz and Dempsey, 2022), which could explain the increase in food insecurity (Pautz and Dempsey, 2022). This situation resulted in poor coping mechanisms (Morales and Berkowitz, 2016) such as eating less expensive foods, eating less-preferred foods, or reducing portion sizes (Akerele et al., 2013). It also led to an increase in applying the "substitution" hypothesis, where higher-quality, less calorie-dense foods (like lean proteins) are replaced by more energy-dense, less expensive options high in sugars and fats (Morales and Berkowitz, 2016; Nettle and Bateson, 2019; House of Lords Library, 2023). Our findings corroborate these trends. Food insecure students reported changing their food behaviours by consuming fewer macronutrients and skipping meals due to limited resources, and they also preferred carbohydrate-rich foods over protein due to cost-effectiveness. These findings are consistent with research showing that food insecure individuals are more likely to skip breakfast (Lee and Kim, 2019; Hutchison et al., 2014) and reduce protein intake (Lee and Kim, 2019). These poor eating behaviours among our participants may be due to lower coping skills, especially after the COVID-19 lockdown, suggesting an underlying issue with accessing food or managing finances. It has been found that poor eating behaviours are often associated with ineffective coping strategies in stressful situations, particularly among food insecure individuals (Weaver and Hadley, 2009), as they often resort to borrowing money or skipping meals (Compas et al., 2001). Our participants were not different from this, as they reported lower coping skills in stressful situations such as not having enough money or the ability to budget, running out of

money most of the time, facing unaffordable food prices, and, therefore, being less confident in managing to buy healthy food, leading to borrowing money or skipping meals. These findings align with studies from Australia (Rosier, 2012) and the US (Meza et al., 2019).

The dietary change can significantly impact mental wellbeing through multiple pathways. Insufficient essential nutrient consumption and overall nutritional imbalance (Lee and Kim, 2019), such as a lack of essential macronutrients (carbohydrates, proteins, and fats) and important micronutrients (omega-3 fatty acids, B vitamins, and antioxidants), are linked to an increased risk of mental health disorders (Benton and Donohoe, 1999; Strasser et al., 2016; Freeman Rapaport, 2011; Jacka et al., 2011). These nutritional deficiencies affect mood, cognitive functions, and overall mental wellbeing (Haspula and Cui, 2023) by influencing blood sugar levels (Bergmans et al., 2018), brain reward circuits (Haspula and Cui, 2023), and neuronal and brain growth, function, and health (McGrath-Hanna et al., 2003). Moreover, they can lead to hormonal changes, such as elevated cortisol levels, which are observed in food insecure individuals (Ling et al., 2019), those who skip breakfast (Yu et al., 2023), and those with poor stress-coping strategies (Folkman and Moskowitz, 2004).

The impact of these nutritional and hormonal changes potentially extends to cognitive functions, memory, learning ability, attention (Gibson and Green, 2002; Benton and Donohoe, 1999; O'Neil et al., 2014; Davison and Kaplan 2015), and academic performance (Kudsia, 2021; Burrows et al., 2017).

Furthermore, they can increase the risk of depression and anxiety (Compas et al., 2001; Haghighatdoost et al., 2021) in both adults (Kudsia, 2021) and children (Shi et al., 2021). These factors could explain the low mental wellbeing observed in our studies. Therefore, this evidence supports the association between unhealthy or lower dietary intake (consuming fewer calories and nutrients than what is required for maintaining optimal health and wellbeing) and poor mental wellbeing. Consequently, the inability to afford healthy food and a lack of budgeting skills appear to contribute significantly to these mental health issues among university students.

However, our intervention (Chapter 5) showed that students significantly improved their food insecurity status post-intervention, positively influencing their mental wellbeing, which is consistent with previous food literacy studies (West et al., 2020; Carman and Zamarro, 2016). Also, the increased protein consumption observed among our participants post-intervention could potentially explain improved mental wellbeing. Previous evidence shows that protein improves mental health by increasing neurotransmitter production, stabilising blood sugar levels, regulating hunger, and encouraging physical activity (Benton and Donohoe, 1999; Markus et al., 2000), all of which play important roles in sustaining healthy mental wellbeing and cognitive performance (Benton and Donohoe, 1999; Markus et al., 2000), compared to decreased protein consumption (Haspula and Cui, 2023).

This supports our hypothesis that improved food access, and healthy eating behaviours positively impact students' health and wellbeing, such as how

consuming breakfast enhances cognitive functions, consistent with previous studies (Rampersaud et al., 2005; Hoyland and Lawton, 2009) and our systematic review (Chapter 2). The sufficient access to food through the food literacy intervention reflected improved mental wellbeing (Chapter 5), compared to poor dietary intake and/or lack of access to sufficient food during food insecurity and decreased mental wellbeing (Chapter 4) (Figure 6.1).

It's worth noting that while we didn't specifically investigate whether breakfast intake patterns were associated with food insecurity status, our findings collectively underscore the complex relationships between food security, dietary habits, and mental wellbeing among university students. This highlights the need for comprehensive interventions that address not only food access but also nutritional education and mental health support in university settings.

Overall, our research reveals that multiple factors influence mental wellbeing among university students, including unhealthy eating behaviours and poor financial skills (Figure 6.1). These factors contribute to food insecurity and low mental health, creating a complex, bidirectional relationship. Food insecurity increases the likelihood of mental health disorders such as depression and anxiety, creates chronic stress, and decreases cognitive function (Shankar et al., 2017; Seligman et al., 2010), while poor mental health can exacerbate food insecurity by impairing cognitive functions necessary for effective meal planning and budgeting (Whitaker et al., 2006; Leung et al., 2015), which can directly affect appetite and eating behaviours, potentially resulting in inadequate nutrition (Tester et al., 2016).

This interconnection aligns with previous findings demonstrating how poverty significantly increases the risk of mental health disorders and food insecurity (Thomson et al., 2022; Boardman et al., 2015; The Health Foundation, 2023). Those in the lowest income bracket are 4.5 times more likely to experience poor mental health compared to those with the highest income (Gutman et al., 2015), highlighting the critical role of economic factors in accessing sufficient food for mental wellbeing, with additional factors such as stressful environmental or social conditions, the COVID-19 pandemic, daily functioning, overall health, and lifestyle factors (Wolfson et al., 2021). The interplay of these various elements underscores the complexity of addressing food insecurity and mental health issues among university students.

In conclusion, our findings highlight the intricate interplay between food insecurity, mental health, and socioeconomic factors among university students. This multifaceted relationship necessitates comprehensive interventions that simultaneously address nutritional, psychological, and financial needs while considering broader socioeconomic factors. Future research and policy initiatives should focus on developing and implementing holistic programmes to better support the overall wellbeing of university students, aiming to break the cycle of poverty, food insecurity, and poor mental health outcomes.
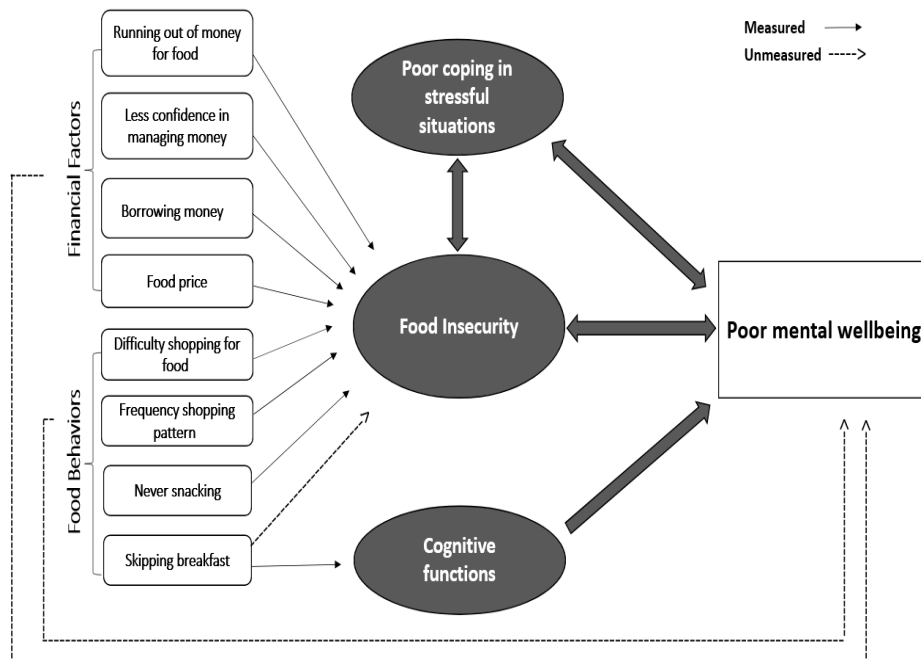
Figure 6.1: Potential drivers of low mental wellbeing among UK university students.

6.2 Main implications, limitations and future work based on the findings and insights derived from all chapters

6.2.1 Main implications

This thesis identified factors affecting university students' mental wellbeing by investigating the relationship between breakfast consumption and cognitive function, and the impact of food insecurity on mental wellbeing. It also examined how students' situations might be affected by adverse health conditions such as COVID-19. The research provides insights into addressing these issues through recommendations for university-based health promotion practitioners, potentially contributing to the development of effective dietary interventions for university students.

The findings indicate that breakfast consumption significantly improves cognitive functions compared to skipping breakfast. Encouraging breakfast

consumption among university students could enhance mental wellbeing, including cognitive functions. This could be supported through social-environmental interventions, such as those demonstrated in the BreakFAST programme (Mumm et al., 2017). Consideration should be given to factors such as timing, accessibility, and nutritional quality of breakfast options (Gratão et al., 2022). While data on breakfast programme benefits in universities is limited, recent initiatives, such as those at Okanagan University in Canada and the University of Nottingham in the UK, demonstrate potential positive impacts on student wellbeing (UBC, 2023; UoNSU, 2022). Evidence from school-based programmes suggests that such interventions can improve food security status and academic performance (Bartfeld and Ahn, 2011; Soldavini and Ammerman, 2019).

University students are particularly vulnerable to food insecurity and poor mental health, with reduced capacity to cope with stressful situations. While food assistance can mitigate these issues, long-term effects and optimal implementation strategies require further investigation (Hines et al., 2021). Strategies such as on-campus food pantries, implemented successfully in US universities, could be adapted for UK contexts (Hagedorn-Hatfield et al., 2022).

Based on our findings, we can provide some recommendations for UK universities. It would be beneficial to include implementing comprehensive breakfast programs, including the offering of free or low-cost nutritious options on campus; establishing on-campus food pantries and developing targeted food assistance programs; enhancing mental health support services and

integrating them with food security initiatives; developing educational initiatives on food literacy and financial management, particularly for first-year students; and leveraging technology to create mobile applications for food insecurity prevention and mental health support. These recommendations should be tailored to each university's specific context, considering student demographics, existing resources, and local partnerships. Potential challenges, such as funding constraints and student engagement, should be anticipated and addressed. Recent UK government initiatives, such as the March 2023 mandate for universities to provide mental wellbeing care, align with these recommendations (House of Commons Library, 2023). With food insecurity affecting up to 44% of UK university students, particularly in the Northwest of England (Armstrong et al., 2023), implementing these strategies is crucial for supporting students' academic success and overall wellbeing. In conclusion, this research underscores the need to reconsider social security measures to provide consistent support for reducing food insecurity and improving mental wellbeing among university students, both during crises and in normal circumstances. Access to adequate food should be recognized as a fundamental right, essential for students' academic and personal development.

6.2.2 Limitations

All the studies conducted through this thesis have a number of limitations. Most of the included studies (Chapters 3 and 4) were cross-sectional, which may show some bias as the sample is not enough to represent UK university students. This limitation extends to the diversity of our sample, which may not

fully represent the varied population of UK university students across different regions, socioeconomic backgrounds, and types of institutions, limiting the generalizability of our findings.

Chapters 3 and 4 were online surveys, which may limit control over the context in which respondents complete them. This may limit our ability to verify participants' status and may lead to biased outcomes due to the reliability of the data and prevent us from full authentication. The reliance on self-reported data, especially when addressing sensitive topics like mental wellbeing and food insecurity, introduces potential bias as participants may have under- or over-reported certain behaviours or experiences. Furthermore, our approach has classified variables to more clearly comprehend how they affect mental wellbeing, but this technique does not fully investigate or show the extent to which variables may compound each other. For example, a lack of financial management skills may not be a factor that influences mental health until combined with other factors, such as poor eating behaviours or vice versa, to determine whether food insecurity status may occur if there is a lack of these skills. Also, observation of poor coping skills in stressful situations may not have an impact on mental wellbeing unless food insecurity occurs (Figure 6.1). The cross-sectional nature of our main studies limits our ability to establish causal relationships between variables. While we can identify associations, we cannot definitively determine cause and effect. Additionally, this approach may not have captured seasonal variations in food insecurity and mental wellbeing, which could be significant among student populations.

In the intervention study, we were not able to distinguish the difference in the food literacy programme among the students using a control group to obtain more accurate results on the influence of education on food insecure students. This limitation, along with potential self-selection bias among participants, may have influenced the outcomes.

Moreover, the studies did not measure blood levels such as glucose tolerance level or glycaemic levels in both the breakfast and cognitive study and in the food security study, as blood level results could reveal the students' health status more accurately. Additionally, food frequency questionnaires were not employed to determine the role of breakfast composition in the association between breakfast and cognitive functions, despite the fact that evidence suggests that breakfast is connected with mental wellbeing (O'Neil et al., 2014). Breakfast was also not defined for participants because there is no globally accepted concept of breakfast (Betts et al., 2016). This lack of a standardized definition may have led to inconsistent interpretations, potentially affecting the reliability of our breakfast-related findings.

The influence of cultural factors on food habits, breakfast consumption, and perceptions of mental wellbeing may not have been fully explored in our study, potentially overlooking important cultural nuances. Additionally, while we attempted to control for various factors, there may be additional confounding variables not accounted for, such as overall diet quality, physical activity levels, or sleep patterns, which could influence the relationships we observed.

The specific tools used to assess mental wellbeing, food insecurity, and cognitive function, while validated, may have limitations in capturing the full complexity of these constructs in a student population. Thus, more validated tools to measure coping with stressful situations, financial skills, and food behaviours are needed to ensure that the students are able to cope when they have limited access to food and money.

However, despite the limitations of the studies, there are a variety of advantages that present the prevalence of food insecurity and mental wellbeing status, which have not been sufficiently carried out among university students in the UK. These studies aid in the understanding of the relationships between food insecurity and mental wellbeing, and breakfast consumption and cognitive functions, although they do not show causality, so we can only report on the results for variables that were measured and are important to consider when evaluating university student health. These studies could aid in the identification of mechanisms that can be used to assist, the development of appropriate strategies to support university students, and the development of policies to address the issues of needs assessment. Furthermore, a better understanding of the characteristics of vulnerable individuals would lay an empirical foundation for social and financial policy, enhancing the analytical content of mental wellbeing and food insecurity reduction programmes in general and at universities in particular. Thus, we encourage authorities in UK universities to initiate action to address the socioeconomic drivers of poor mental wellbeing, adopt a focused and collaborative approach to identifying

pathways out of food insecurity, guided by the expertise, enthusiasm, and commitment of those who are experts in this field.

6.2.3 Future work

The findings of this thesis suggest several potential future studies. Intervention studies that offer breakfast and measure both mental and cognitive functions are needed to determine the causation of the link between breakfast eating and cognitive functions, considering measurements of blood glucose levels and nerve receptor activity. These interventions should include longer-term studies to assess the sustained impact of breakfast consumption on cognitive function and mental wellbeing. Further research should investigate whether skipping breakfast is linked to food insecurity and low mental wellbeing. This is needed to establish causal evidence for the impact of breakfast intake on enhancing mental wellbeing through improving cognitive functions and decreasing food insecurity. It would also be advantageous to explore the influence of different breakfast types on cognitive functions and which are more beneficial for mental wellbeing. Investigating the value of macronutrients and balanced nutrition for mental health is critical, as they influence mood, cognitive performance, and overall wellbeing.

Regarding food insecurity, future studies should explore its intersectionality with other socio-economic factors and evaluate the effectiveness of different food assistance programs in university settings. Although this thesis established the potential negative impact of food insecurity on mental wellbeing and determined that food insecurity remains prevalent in the UK even after the

pandemic, it would be beneficial to organise food and financial literacy education classes for university students. Future studies should consider the use of control groups to determine how education classes could reduce food insecurity and improve mental wellbeing.

The potential of digital interventions and mobile apps for improving food literacy and mental health should also be explored. Longitudinal studies of food insecurity and mental wellbeing among university students would be beneficial to understand the longer-term impacts, considering food behaviours, financial factors, and coping with stressful situations. This could support the development and maintenance of food security and mental wellbeing through appropriate intervention and implementation, if needed. Cross-cultural comparative studies also across different countries or cultures could help understand how cultural factors influence the relationships identified in this thesis. Additionally, policy research evaluating the impact of university policies on food insecurity and mental wellbeing, as well as the cost-effectiveness of different intervention strategies, would be valuable.

Moreover, the gut-brain axis has emerged as a key area of research, with the gut microbiome, heavily influenced by diet, affecting mental health through various pathways, including the production of neurotransmitters and the regulation of inflammation (Cryan and Dinan, 2012). Future studies should explore the impact of specific dietary interventions on gut microbiome composition and mental health outcomes, as well as the interaction between food insecurity, gut health, and mental wellbeing. Measuring gut hormones,

which are responsible for creating and releasing a variety of hormones and neurotransmitters that may affect mental health including cognitive functions, would be important to consider. The bidirectional communication between the gut microbiota and the brain alters neurotransmission and behaviour, which is commonly connected with neuropsychiatric diseases (Owen and Corfe, 2017). Additionally, measuring biomarkers could provide more accurate estimates of habitual dietary patterns and mental wellbeing, offering a more comprehensive understanding of the complex relationships between diet, gut health, and mental wellbeing.

Based on the findings of this thesis, the next stages of this work may focus on two key areas for potential impact. First, implementing and evaluating a large-scale breakfast program in UK universities: This intervention will combine breakfast provision with food literacy education, targeting both immediate nutritional needs and long-term food security. The program will be designed as a randomised controlled trial, measuring cognitive function, mental wellbeing, and academic performance over an academic year. Second, developing and testing a mobile app for food insecurity prevention: This digital intervention will integrate financial management tools, meal planning assistance, and mental health resources. The app will be developed in collaboration with students and mental health professionals, and its effectiveness will be evaluated through a longitudinal study. These initiatives aim to translate our research findings into practical, scalable solutions that can significantly improve students' mental wellbeing, cognitive function, and academic success.

6.3 Conclusion

This thesis aimed to investigate the factors affecting mental wellbeing among UK university students, focusing on breakfast consumption and food insecurity. Through systematic review, cross-sectional studies, and an intervention study, we uncovered significant relationships between dietary habits, food security, and mental health. Our findings reveal that breakfast consumption positively correlates with cognitive functions, underscoring its importance for academic performance and mental wellbeing. Concurrently, we found that food insecurity is prevalent among UK university students, persisting beyond the COVID-19 pandemic, and is strongly associated with poor mental wellbeing. Students experiencing food insecurity often exhibit low stress-coping skills, potentially due to inadequate financial management and unhealthy food behaviours. Importantly, our intervention study demonstrated that improving food literacy, financial budgeting, meal preparation, and food waste reduction skills can enhance food security status and potentially contribute to better mental wellbeing. This highlights the complex interplay between dietary habits, food security, financial management, and mental health among university students.

While acknowledging the limitations of our research, including the cross-sectional nature of some studies and the focus on UK universities, this thesis contributes significantly to the existing literature. It establishes clear links between breakfast consumption, cognitive function, and mental wellbeing, while also demonstrating the prevalence and impact of food insecurity on

student mental health in the UK context. Based on our findings, we recommend that universities implement breakfast programs, integrate food literacy and financial management education into support services, and develop targeted interventions for food insecure students. Mental health services should incorporate awareness of the food insecurity-mental wellbeing link into their strategies. Future research directions should also include longitudinal studies on the long-term impacts of food insecurity and breakfast habits, investigation of culturally specific factors affecting food security and mental wellbeing, exploration of the gut-brain axis in relation to student dietary habits and mental health, and evaluation of intervention cost-effectiveness.

Finally, this thesis emphasises the critical need for comprehensive approaches to support university students' mental wellbeing, addressing food insecurity and promoting healthy dietary habits. As higher education evolves, particularly in the face of global challenges, ongoing research and adaptive interventions will be crucial in supporting student success and wellbeing.

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Appendices

1 Breakfast Consumption and Cognitive Functions

1.1 Online consent

Research Team

Afnan Aldubaybi (stxaa114@exmail.nottingham.ac.uk)
Dr Preeti Jethwa (supervisor; preeti.jethwa@nottingham.ac.uk)
Dr Lisa Coneyworth (supervisor; lisa.coneyworth@nottingham.ac.uk)

Welcome to The Breakfast and Cognition Questionnaire.
We would like to invite you to take part in our research study exploring factors affecting cognition in first-year University of Nottingham students. Please take some time to read the participant information sheet, which can be accessed via this Link before joining the survey. This research has received a favourable ethical opinion (FEO) from the School of Biosciences Research Ethics Committee, University of Nottingham, (SBREC200122FEO).

If you have any questions about the study, please contact the research team.

Consent

The following questions confirm that you consent to taking part in this online survey. Your individual identity will be anonymised prior to analysis. Your participation in this survey is voluntary, and you may withdraw at any time by simply not completing or submitting the survey.

Data will be stored in accordance with the General Data Protection Regulation (GDPR). Cookies, personal data stored by your web browser, are not used in this survey. However, as an online participant in this research, there is always a minimal risk of intrusion by outside agents and therefore the possibility of being identified.

- I confirm that I have read the participant information sheet, and I understand all information provided about the online survey.
- I understand that the questions will not ask for any information which could identify me.
- I understand that my participation in the online survey is voluntary and that I may withdraw at any time by exiting the survey.
- I understand that if I withdraw at any time any answers may still be used.
- I agree that data collected in the online survey may be used for academic publication and conference presentations.
- I understand that relevant sections of data collected in the survey may be looked at by authorized individuals from the University of Nottingham, the research group, and regulatory authorities where it is relevant to my taking part in this survey. I give permission for these individuals to have access to these records and to collect, store, analyse and publish information obtained from my participation in this survey.
- I accept that anonymous direct quotes from the survey may be used in study reports.

I CONSENT to take part in the online survey and for my answers to be used

- o   Yes
- o   No

Please write your unique code:

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Lead researcher(s) / Supervisor:

Project student: Afnan Aldubaybi (Stxaa114@exmail.nottingham.ac.uk)
Preeti Jethwa (supervisor; Preeti.jethwa@nottingham.ac.uk)
Lisa Coneyworth (supervisor; Lisa.coneyworth@nottingham.ac.uk)

Participant Information Sheet

We would like to invite you to take part in our research study. Before you decide we would like you to understand why the research is being done and what it would involve for you. One of our team can go through the information sheet with you and answer any questions you have. Feel free to talk to others about the study if you wish. Please ask us if there is anything that is not clear.

Aim of the research: Transitioning from school to university is a process characterised by a number of physiological, psychological, and social changes. Trend data suggest that this is a risky period for the development of obesity, as well as unhealthy diet and physical activity practices. The university student population is widely reported to engage in unhealthy lifestyle behaviours including unhealthy eating habits such as high consumption of snack foods, convenience foods, and fast foods, and insufficient consumption of fruit and vegetables.

Breakfast is considered to be the most valuable meal of the day. Extensive research has shown that breakfast consumption can increase cognitive performance and long-term academic achievement in children and adolescents (Tarakalakshmi et al, 2017; Taha and Rashed, 2017; Arshad and Ahmed, 2014). However, there is very little research conducted on young adults, despite this group having the greatest prevalence of breakfast omission. Interestingly, 69% of university students skip their breakfast. When asked why, 47% stated lack of time, 9% cited lack of hunger, and 3% stated it was to aid weight loss. Additionally, there is limited evidence to support the link between breakfast consumption and cognition within this age group compared to children and adolescents, despite students undergoing cognitive development. Therefore, this study investigates the possible relationship between breakfast consumption and cognitive performance among university students.

What does the study involve?
If you decide to take part, we will invite you to a face-to-face online meeting to explain what is required and to provide you with your personal unique number and web links. This number will be required for completion of the questionnaire and test and will ensure that they are completed anonymously.
Following the face-to-face meeting, we will ask you to (i) complete an online questionnaire with regarding your diet and lifestyle behaviours and (ii) complete a D2 test following a 12 hour fast (after bed) and then 30 minutes following breakfast of your choice (Figure 1). We will be asking you to note down what you have consumed, including both brands and quantities.
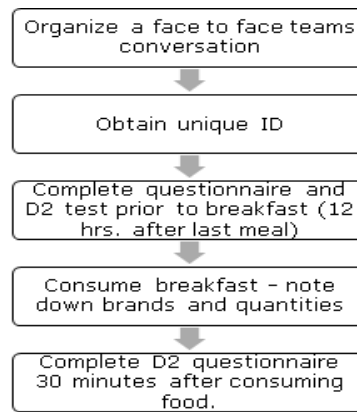
Figure 1: Process required by participants

The D2 test is a validated test, which allows us to determine concentration, attention, sustained attention, mental speed, and general performance. We will be asking you to complete this test once prior to consuming breakfast and then 30 minutes after consuming a breakfast of your choice, in your home environment. You will need access to a computer, laptop, or any device with a keyboard, as the D2 test will not work on a phone.

Taking part in the survey is **voluntary** and most of the questions we will be asking can be answered by using tick boxes. There will also be a small number of short answer questions requiring a text response. We anticipate that completing the full set of questions will take you no more than 15 minutes.

Are there any benefits in taking part?
There are no immediate benefits to you from participating in the study, but it is hoped that the findings will help to develop guidelines to improve university lifestyle and possibly reduce the number of individuals suffering from mood disorders.

Are there any risks in taking part?
There are no foreseeable risks for individuals participating in the survey, and all answers and data collected will remain anonymous and cannot be connected to the participant. We will not be asking you for your name or contact details.

The researchers have not identified any risks associated with this study. However, by completing the online survey and weight status assessment, you may be more aware of your perceptions of weight, weight stigma, and mood disorders. If you are a student at the University of Nottingham, you can seek support from any of the programs offered by the University by following the links below:

Eat Well: https://www.nottingham.ac.uk/currentstudents/healthyu/eatwell.aspx
Mental health and wellbeing: https://www.nottingham.ac.uk/currentstudents/healthyu/mental-health/bodymind.aspx
Food and Mood: https://www.mind.org.uk/information-support/tips-for-everyday-living/food-and-mood/about-food-and-mood/#.XTWVk-hKiUl
COVID-19 NHS advice: Coronavirus (COVID-19) - NHS (www.nhs.uk

Your personal data and its processing
We define personal data as information relating to a living, identifiable individual. It can also include "special categories of data", which are information about your racial or ethnic origin, religious or other beliefs, and physical or mental health, the processing of which is subject to strict requirements. Similarly, information about criminal convictions and offenses is also subject to strict requirements. "Processing" means any operation that we carry out using your personal data, e.g., obtaining, storing, transferring, and deleting.

We only process data for specified purposes and if it is justified in accordance with data protection law. Details of each processing purpose and its legal basis are given in each privacy notice listed below; please select the one most relevant to your relationship with the University.

Why we collect your personal data?
We collect personal data under the terms of the University's Royal Charter in our capacity as a teaching and research body to advance education and learning. The specific purpose for data collection on this occasion are to investigate the relationship between breakfast consumption and habits of attention in university students as part of a research study conducted by the Division of Food, Nutrition and Dietetics at the University of Nottingham.

Legal basis for processing your personal data under GDPR
The legal basis for processing your personal data on this occasion is Article 6(1a) consent of the data subject.

Special category personal data
In addition to the legal basis for processing your personal data, the University must meet a further basis when processing any special category data, including personal data revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and the processing of genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health, or data concerning a natural person's sex life or sexual orientation.
The basis for processing your sensitive personal data on this occasion is Article 9(2a), in which the data subject has given explicit consent to the processing.

How long will we keep your data?
The University may store your data for up to 25 years and for a period of no less than 7 years after the research project finishes. The researchers who gathered or processed the data may also store the data indefinitely and reuse it in future research. Measures to safeguard your stored data include ensuring that all information collected about you during the research will be kept strictly confidential. All questionnaire data provided will be stored in a secure, locked office and on a password protected database.

Who do we share your data with?
Extracts of your data may be disclosed in published works that are posted online for use by the scientific community. Your data may also be stored indefinitely on external data repositories (e.g., the UK Data Archive) and be further processed for archiving purposes in the public interest or for historical, scientific, or statistical purposes. It may also be transferred with the researcher who collected your data if they move to another institution in the future.

Your rights as a data subject
You have the following rights in relation to your personal data processed by us:
Right to be informed
The University will ensure you have sufficient information to ensure that you're happy about how and why we're handling your personal data and that you know how to enforce your rights. The University provides information in the form of privacy notices. Our Privacy Notices pages can be found at https://www.nottingham.ac.uk/utilities/privacy/privacy.aspx.

Right of access / right to data portability
You have a right to see all the information the University holds about you. Where data is held electronically in a structured form, such as in a database, you have a right to receive that data in a common electronic format that allows you to supply that data to a third party - this is called "data portability".
To make a request for your own information, please see the link here: https://www.nottingham.ac.uk/governance/records-and-information-management/data-protection/data-protection.aspx

To receive your information in a portable form, send an email your request to data-protection@nottingham.ac.uk

Right of rectification
If we're holding data about you that is incorrect, you have the right to have it corrected.
Please email any related requests to data-protection@nottingham.ac.uk.

Right to erasure
You can ask that we delete your data, and where this is appropriate, we will take reasonable steps to do so. Please email any related requests to data-protection@nottingham.ac.uk.

Right to restrict processing
If you think there's a problem with the accuracy of the data, we hold about you or we're using data about you unlawfully, you can request that any current processing be suspended until a resolution is agreed.
Please email any related requests to data-protection@nottingham.ac.uk.

Right to object
You have a right to opt out of direct marketing.
You have a right to object to how we use your data if we do so on the basis of "legitimate interests," "in the performance of a task in the public interest," or "exercise of official authority" (a privacy notice will clearly state to you if this is the case). Unless we can show a compelling case why our use of data is justified, we have to stop using your data in the way that you've objected to.
For direct marketing, there will be an opt-out provided at the point of receipt. To object to how we use your data, email your request to data-protection@nottingham.ac.uk.

Rights related to automated decision-making including profiling
We may use a computer program, system, or neural network to make decisions about you (for example, everyone who is on a particular course gets sent a particular letter) or to profile you. You have the right to ask for a human being to intervene on your behalf or to review a decision. Please email any related requests to data-protection@nottingham.ac.uk.

Withdrawing consent
If we are relying on your consent to process your data, you may withdraw your consent at any time.

Exercising your rights, queries and complaints
For more information on your rights, if you wish to exercise any right, for any queries you may have, or if you wish to make a complaint, please contact our Data Protection Officer.

Complaint to the Information Commissioner
You have a right to complain to the Information Commissioner's Office (ICO) about the way in which we process your personal data. You can make a complaint on the ICO's website.

Privacy notices
Please consult the privacy notice that best fits your relationship with the University.

Complaint procedure: If you wish to complain about the way in which the research is being conducted or have any concerns about the research, then in the first instance, please contact the project supervisor Dr Preeti Jethwa (tel. 0115 951 6604, email preeti.jethwa@nottingham.ac.uk). If this does not resolve the matter to your satisfaction, then please contact the Research Ethics Officer, Prof Kate Millar (tel. 0115 951 6303, email kate.millar@nottingham.ac.uk).

We would like to kindly thank you for your time and consideration

About you as a person

1. **What is your gender?**
   - ○ Male
   - ○ Female
   - ○ Prefer Not to say
   - ○ Other

   If you selected Other, please specify_____

2. **What is your age in years?** .

   [   ]

3. **Which of the following best describes your ethnic origin?**

   - ○ White British
   - ○ White Irish
   - ○ Black Caribbean
   - ○ Black African
   - ○ White and Black Caribbean
   - ○ White and Black African
   - ○ White and Asian
   - ○ Indian
   - ○ Pakistani
   - ○ Bangladeshi
   - ○ Gujarati
   - ○ Tamil
   - ○ Chinese
   - ○ Korean
   - ○ Arabic
   - ○ Other, please specify_____

4. **What degree are you studying at the university? For example: BSc Nutrition**

   [   ]

5. **What is your current weight?**

   [   ] Kg **OR** [   ] Lbs

6. **What is your height?**

   [   ] Ft [   ] In **OR** [   ] M [   ] Cm

7. **How many hours do you sleep regularly?**
   - ○ 1-3 hours
   - ○ 4-6 hours
   - ○ 7-9 hours
   - ○ 10-12 hours
   - ○ More than12 hours

8. **Do you drink alcohol every week?**
   - ○ Yes
   - ○ No

     If **Yes,** did you drink last night?
   - ○ Yes
   - ○ No

9. **Do you smoke cigarettes?**
   - ○ Yes
   - ○ No

9a. If **Yes,** did you smoke this morning?
   - ○ Yes
   - ○ No

10. In a typical week, how many occasions do you spend exercising per week?
- o None
- o Once a week
- o Twice a week
- o More than 3 times a week
- o Daily

11. How much time do you spend exercising each week?
- o None
- o 0.5-1.5 hours
- o 2-3 hours
- o 4-5 hours
- o 6-7 hours
- o More than 7 hours

12. Do you take dietary supplements?
- o Yes
- o No

12a. If **Yes,** how many types of dietary supplements do you consume each week?
- o 1-2 per week
- o 3-4 per week
- o 5-6 per week
- o More than 6 per week

Please tell us more about **ANY** dietary supplement (s) you are taking:

Dietary supplement name(s)	Dietary supplement brand(s)	Dietary supplement dose(s)	How long have you been taking this/these dietary supplement(s)? **(Please specify a number)**		Reasons for taking dietary supplement(s)
			Days		
			Weeks		
			Months		
			Years		
			Do not know		

Breakfast behaviours

13. Do you have breakfast regularly?
- o Yes
- o No

13a. If **Yes,** how often do you have breakfast?
- o 1-2 times per week
- o 3-4 times per week
- o 5-6 times per week
- o Every day

If **No,** from **1-5** check your reasons for not eating breakfast in the order of importance to you**.** Use **No 1** for the most important reason, **No 2** as the next most important, and so forth.

Reason	1	2	3	4	5	6
Not enough time						
Not hungry						
Have a heavy meal at night						
Not a daily habit						
No food in house						
Trying to lose weight						
Other						
If you selected Other, please specify:						

14. **Does breakfast consumption enhance your mood positively in the mornings?**
    - o   Yes
    - o   No

15. **Does breakfast consumption help you concentrate in lectures in the mornings?**
    - o   Yes
    - o   No

Breakfast consumption

16. **What did you eat or drink for breakfast today?**
    * For example: one small banana, 1 cup (28-42 grams) of Kellogg's cornflakes, 2 fried eggs with 1 teaspoon of olive oil.

No	Food item name(s)	Food brand(s)	Amount of consumption
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			

We would like to thank you for taking the time to complete our survey. The information that you have kindly provided may help us to understand the impact of skipping breakfast on cognitive performance in University students.

2 The Prevalence of Food Insecurity and Associated Factors

2.1 Online consent

Researchers name

Afnan Aldubaybi (stxaa114@exmail.nottingham.ac.uk)
Dr Preeti Jethwa (supervisor; preeti.jethwa@nottingham.ac.uk)
Dr Lisa Coneyworth (supervisor; lisa.coneyworth@nottingham.ac.uk)

Welcome to the Food Security and Wellbeing Questionnaire.
We would like to invite you to take part in our research study exploring food security and wellbeing of university students in the UK. First, we would like you to understand why the research is being conducted and what it would involve for you. Please take some time to read the participant information sheet, which can be accessed via this link before joining the survey.

This research has received a favourable ethical opinion (FEO) from the School of Biosciences Research Ethics Committee, University of Nottingham, (SB2021_08).

If you have any questions about the study, please contact the research team.

Consent

The following questions confirm that you consent to taking part in this online survey. Your individual identity will be anonymised prior to analysis. Your participation in this survey is voluntary, and you may withdraw at any time by simply not completing or submitting the survey.

Data will be stored in accordance with the General Data Protection Regulation (GDPR). Cookies, personal data stored by your web browser, are not used in this survey. However, as an online participant in this research, there is always a minimal risk of intrusion by outside agents and therefore the possibility of being identified.

- I confirm that I have read the participant information sheet, and I understand all information provided about the online survey.
- I understand that the questions will not ask for any information which could identify me.
- I understand that my participation in the online survey is voluntary and that I may withdraw at any time by exiting the survey.
- I understand that if I withdraw at any time, any answers I have provided may still be used.
- I agree that data collected in the online survey may be used for academic publications and conference presentations.
- I understand that relevant sections of data collected in the survey may be looked at by authorized individuals from the University of Nottingham, the research group, and regulatory authorities where it is relevant to my taking part in this survey. I give permission for these individuals to have access to these records and to collect, store, analyse and publish information obtained from my participation in this survey.
- I accept that anonymous direct quotes from the survey may be used in study reports.

I CONSENT to take part in the online survey and for my answers to be used

- Yes
- No

GDPR Privacy Notice (Version fv1)

School of Biosciences
 Lead researcher(s):
Project student: Afnan Aldubaybi (Stxaa114@exmail.nottingham.ac.uk)
Preeti Jethwa (supervisor; Preeti.jethwa@nottingham.ac.uk)
Lisa Coneyworth (supervisor; Lisa.coneyworth@nottingham.ac.uk)

We would like to invite you to take part in our research study. Before you decide we would like you to understand why the research is being done and what it would involve for you. One of our team can go through the information sheet with you and answer any questions you have. Feel free to talk to others about the study if you wish. Please ask us if there is anything that is not clear.

What is this study about?
Food security is considered a basic human right and exists when all people have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and lead a healthy and active lifestyle at all times.

Food insecurity is a growing and persistent concern in high income countries and has been shown to be associated with compromised nutrition, poor general health, and a number of chronic health conditions including poor mental wellbeing. Over 2016 to 2018, 5.6% of the UK population was estimated to have experienced food insecurity based on the Food and Agriculture organisation (FAO) globally set threshold for food insecurity. Food insecurity can be any or all of the following:

- Not having sufficient food.
- Experiencing hunger as a result of running out of food and being unable to afford more.
- Eating a poor-quality diet because of limited food options.
- Having anxiety about acquiring food.
- Having to rely on food relief.

Studies in the US and Australia have revealed that food insecurity is high in the university student population, but despite this, food insecurity among university students in the UK is unknown. However, a recent study revealed that 40% of UK students are worried about food availability due to the current Covid-19 outbreak.

Furthermore, food insecurity has been associated with poor mental wellbeing in other populations. Almost 30% of UK students suffer from poor mental wellbeing, which can impair students' academic performance and social functioning, cause significant burden at university, and potentially affect their future career opportunities. Some risk factors for poor mental health among university students include being from a poor socioeconomic background, ethnicity, being in a competitive academic environment coupled with a full academic workload, and poor cooking ability. However, it is unknown whether increasing food insecurity is related to the recent increase in mental health disorders in the university population in the UK.

Thus, the aim of this study is to determine the interconnections between food insecurity and coping mechanisms with mental wellbeing among UK university students. Findings have the potential to inform strategies and national policies to address food insecurity in higher education to improve the student experience and ultimately academic success.

What are we asking you to do?
We are asking you to complete a short online questionnaire as a university student registered to study in the UK. Taking part in the survey is voluntary, and we will seek your consent to use your responses to the rest of the questions in the survey.

With the questionnaire, we will obtain general background information, financial background, health behaviours, and cooking skills, as well as use validated scales to assess your food security status, coping strategies for stress situations, and mental health wellbeing status.

As this questionnaire is being conducted during the pandemic, we are also including questions related to it.

We anticipate that the questionnaire will take no more than 20 minutes, and the majority of the questions can be answered by ticking a box, although there are a small number of short answer questions requiring a text response.

Why have I been invited? Who is participating?
You are being invited to take part because you are a university student registered with a UK university, regardless of location. We are inviting 183 participants like you to take part.

Do I have to take part?
It is up to you to decide whether or not to take part. If you do decide to take part, you will be asked a series of questions prior to the start of the questionnaire to obtain consent. You are still free to withdraw at any time and without giving a reason. This would not affect your legal rights. Please feel free to stop answering the questionnaire at any time; however, we may use the answers already provided. All answers will be anonymous, as no identifiable information is being requested.

Who is funding this work and who are the research collaborators?
This research is being organised by the School of Biosciences, University of Nottingham. This research is not funded by the PhD student.

Expenses and payments
We are incredibly grateful to you for considering taking part in this study. However, participants will not be paid an allowance to participate in or complete the study.

What are the possible benefits of participating?
There are no direct benefits from taking part, but it is hoped that this work will help us to understand more about factors which influence health and wellbeing of university students and help identify groups which may be at risk.

What are the possible disadvantages or risks of taking part?
The researchers have not identified any risks associated with this study. However, by answering these questions, you may be more aware of your own food security and mental wellbeing. If you feel affected by the issues explored in this study, please contact student welfare at your place of study or a health professional as soon as possible. Additionally, here are some links you may visit to get more information or help.

Food security
- **Trussell Trust -**www.trusselltrust.org/get-help/emergency-food/
- **Citizen's Advice -** www.citizensadvice.org.uk/benefits/help-if-on-a-low-income/if-youre-struggling-with-living-costs/
- **The National Student Union** - www.nus.org.uk/student-advice-information

Mental health and wellbeing / coping strategies
- **NHS -** www.nhs.uk/conditions/stress-anxiety-depression/student-mental-health/
- **Student mind (National student union)** www.studentminds.org.uk/
- **Togetherall -** togetherall.com/en-gb/

Covid-19
- **NHS -** www.nhs.uk/conditions/coronavirus-covid-19/

Will my role and contribution to the study be kept confidential?
We will follow ethical and legal practice, and all information about you will be handled in confidence. If you join the study, the data collected for the study will be looked at by authorised persons from the University of Nottingham who are organising the research. They may also be looked at by authorised people to check that the study is being carried out correctly. All will have a duty of confidentiality to you as a research participant and we will do our best to meet this duty.

All information which is collected about you during the course of the research will be kept strictly confidential, secured within the University of Nottingham. We are not asking for any information which will require to be anonymised as no identifiable information is needed. However, anonymised data may be stored in data archives for future researchers interested in this area.
All identifiable research data will be kept securely for 7 years. After this time, your data will be disposed of securely. During this time, all precautions will be taken by all those involved to maintain your confidentiality; only members of the research team will have access to your personal data. For information about the University's obligations with respect to your data, who you can get in touch with, and your rights as a data subject, please visit: https://www.nottingham.ac.uk/utilities/privacy.aspx.

The questionnaire will be conducted via an Online Surveys, which is compliant with General Data Protection Regulation (GDPR). Online Surveys takes data protection responsibility seriously. For more information, please visit https://www.onlinesurveys.ac.uk/gdpr-and-online-surveys/

Who will get access to the information collected?
The answers to questionnaires will be accessible to the researchers listed on this document.

What will happen if I do not want to carry on with the study?
Your participation is voluntary, and you are free to withdraw at any time, without giving any reason, and without your legal rights being affected. If you withdraw, then the information collected so far may not be possible to extract and erase after (agreed length of time) and this information may still be used in the project analysis.

How will we use your data and what will happen to the results of the study?
The data collected will be used by Afnan Aldubaybi for her PhD thesis and will also be used to develop tools to help university students or extracts of your data may be disclosed in published works that are posted online for use by the scientific community. These will be available to participants upon request (please email Preeti.jethwa@nottingham.ac.uk). A summary of this project will be published on the Twitter page developed for this study.

Who has reviewed the study?
All research conducted at the University of Nottingham is reviewed by a group of people, called a Research Ethics Committee (REC), to protect your interests as a research participant. This study has been reviewed and received a Favourable Ethical Opinion (FEO) from the School of Biosciences Research Ethics Committee (SB REC). The FEO code for this project is: SB2021_08

Researchers contact details and contact point if any issues raised
If you have any questions, please contact Afnan Aldubaybi. If you have any concerns about the research, then in the first instance please contact Dr Preeti Jethwa (preeti.jethwa@nottingham.ac.uk). If you remain unsatisfied or wish to complain formally, then please contact the School's Research Ethics Officer, Professor Kate Millar (tel. 0115 951 6303, email kate.millar@nottingham.ac.uk).

We would like to kindly thank you for your time and consideration

About you as a person

The following questions will ask you to provide some information about yourself. Please select the appropriate answers.

1. **What is your gender?**
    o   Male
    o   Female
    o   Prefer not to say.
    o   Other_____

2. **What is your age group in years?**
    o   under 18 (skip to end of questionnaire)
    o   18- 20
    o   21- 25
    o   26- 30
    o   31- 35
    o   36- 40
    o   41- 45
    o   46- 50
    o   51- 55
    o   56- 60
    o   61 and over
    o   Prefer not to say

3. **Which of the following best describes your ethnic origin?**

o White British	o Pakistani
o White Irish	o Bangladeshi
o Black Caribbean	o Gujarati
o Black African	o Tamil
o White and Black Caribbean	o Chinese
o White and Black African	o Korean
o White and Asian	o Arabic
o Indian	o Other, please provide details _____

4. **Please state your height in one of the boxes below.**

    [   ] M   [   ] Cm   **OR**   [   ] Ft   [   ] In

5. **Please state your current weight in one of the boxes below.**

    [   ] Kg   **OR**   [   ] Stones/lbs

6. **What degree are you studying at the university?**

o Foundation	o MRes	o MA
o BSc	o MPhil	o MBA
o MSc	o PhD	o Other, please specify _____

7. **What subject area are you studying at University (e.g., Nutrition, Medicine, Business – provide exact title)**

    [   ]

8. **Please select all options that apply to you.**
    o   I am a part time student
    o   I am a full-time student

- o I am an international student (non-EU)
- o I am an EU student.
- o I am a home student (UK)

9. **What year did you enrol on/begin your current degree program?**
   - o 2014
   - o 2015
   - o 2016
   - o 2017
   - o 2018
   - o 2019
   - o 2020
   - o 2021

10. **Please select the option below that best describes your current mode of study.**
    - o Mostly face-to-face in person teaching on campus.
    - o Online leaning – mostly live lectures/workshops
    - o Online learning – mostly pre-recorded lectures/workshops
    - o Other _____
    - o Prefer not to say

11. **Which of the following best describes your current average grade band (if possible)?**
    - o N/A
    - o Less than 30%
    - o 30- 39%
    - o 40- 49%
    - o 50- 59%
    - o 60- 69%
    - o 70- 100%
    - o Prefer not to say

12. **Which of the following best describes your current term-time accommodation?**
    - o Private sector halls of residence – catered.
    - o Private sector halls of residence – not catered.
    - o University halls of residence – catered.
    - o University halls of residence – not catered.
    - o House/flat share (share with friends)
    - o Live alone in a private rented accommodation
    - o Live alone in an owned home
    - o Live with family in a private rented accommodation
    - o Live with family in an owned home
    - o Other
    - o Prefer not to say

Financial status

The next following questions describe financial status. Please select the best answers that apply to you:

13. **Do you consider yourself financially independent?** *Independent students have supported themselves financially during their studies.
    - o Yes
    - o No
    - o Prefer not to say

14. **Besides being a student, do you currently have a job?**
- Yes (full-time job)
- Yes (part-time job)
- No job
- Prefer not to say

14a. If No, are you currently trying to find a job?
- Yes
- No

15. **How much disposable income do you have each month? This is the amount of money left for you to spend after rent, bills, and food.** (drop down box)
- £0 - £50
- £51 to £100
- £101 to £150
- £151 to £200
- £20 1 to £250
- £251 to £300
- £301 to £350
- £351 and greater
- Prefer not to say

16. **How much money do you spend on food on average, per week (excluding alcohol)?**

£0- £20	£81- £100	£161- £180
£21- £40	£101- £120	£181- £200
£41- £60	£121-£140	More than £200
£61- £80	£141- £160	Prefer not to say

17. **Do your parents/guardians or other relatives offer you financial support for university?**
- Yes
- No
- Prefer not to say

18. **Do you receive financial support through grants, scholarships, or any funding source besides relatives that does not require repayment?**
- Yes
- No
- Prefer not to say

19. **Do you receive financial support through student loans or any other funding that does require repayment?**
- Yes
- No
- Prefer not to say

20. **Do you have savings to help support you if needed?**
- Yes
- No
- Prefer not to say

21. **Since you began your studies at university, have you borrowed money from family or friends in order to meet basic costs i.e., food, rent?**
- Never
- Rarely
- Sometimes

o Often
o All the time
o Prefer not to say

Your diet and eating habits during term time

The following questions will ask you about your typical diet and eating habits during term time.

Please indicate the right answers apply to you by choosing one of the following answers from each question:

22. How many main meals do you typically eat per day during term time (Do not include snacks)?
o None
o 1-2 meals/day
o 2-3 meals/day
o 4+ meals/day
o Prefer not to say

23. How often do you snack per day in the term time?
o Never
o Once
o Twice
o More than twice
o Prefer not to say

24. How would you rate your eating habits in the term time?
o Very unhealthy
o Unhealthy
o Very healthy
o Healthy
o I do not know
o Prefer not to say

25. How would you rate your eating habits outside of term time?
o Very unhealthy
o Unhealthy
o Very healthy
o Healthy
o I do not know
o Prefer not to say

No	Questions	Never	Once a week	2-4 days/week	5-6 days/ week	Everyday	Prefer not to say
26.	How often do you eat fruit?						
27.	How often do you eat vegetables?						
28.	How often do you consume alcohol?						
29.	How often do you smoke cigarettes / cigars/vape?						

The next questions are about your cooking literacy.

     30. Have you taken cooking classes?
- ○ Yes
- ○ No
- ○ Prefer not to say

How often do you do the following activities?

No	Questions	Never	Sometimes	Most of the time	Always	Prefer not to say
31.	Plan meals ahead of time					
32.	Make a list before you go shopping					
33.	Plan meals to include all food groups					
34.	Think about healthy choices when deciding to eat					
35.	Feel confident about managing money to buy healthy food choices					
36.	Use information on food labels to help make food choices					
37.	Cook meals at home using healthy ingredients					
38.	Feel confident about cooking a variety of healthy meals					
39.	Try a new recipe					
40.	Change recipes to make them heathier					
41.	Compare prices of foods to find the best prices on healthy foods					
42.	Run out of money for food					
43.	Thaw meat at room temperature					

*The Food literacy behaviours tool, factors table (Begley, A.; Paynter, E.; Dhaliwal, S.S. Evaluation Tool Development for Food Literacy Programs. Nutrients **2018**, 10, 1617).*

Your behaviour

     44. On average, how many hours do you sleep each night?
- ○ 1-3 hours
- ○ 4-6 hours
- ○ 7-9 hours
- ○ 10-12 hours
- ○ More than 12 hours
- ○ Prefer not to say

     45. Which of the following best describes your current physical activity level?
- ○ None
- ○ Light: e.g., walking, etc. for 1-3 days/ week
- ○ Moderate: e.g., brisk walking or riding a bike 3 or more days/ week
- ○ Very active: e.g., exercising at vigorous intensity 6 or more days/ week.
- ○ Ultra-active: training twice daily
- ○ Prefer not to say

Food accessibility

In the following questions, we would like to ask you about your food accessibility in the last 4 weeks.

If you have concerns about access to food or would like further support, please visit the Trussell Trust, citizen's advice and the National Student Union

46.   In the last 4 weeks were you able to go shopping for food when you need to?
- o   Never
- o   Seldom
- o   Sometimes
- o   Often
- o   Always
- o   Prefer not to say

47.   In the last 4 weeks how often do you shopped for food? E.g., supermarket
- o   Once per month
- o   Twice per month
- o   Once per week
- o   Twice per week
- o   Three times per week or more
- o   Daily
- o   Prefer not to say

48.   In the last 4 weeks which of the following options best describes how you typically purchase food?
- o   Shop in person
- o   Online for home delivery
- o   Online for click and collect
- o   Often my parents/ partner/ adult who lives with me do the food shopping in person
- o   Often my family/ friends who do not live with me do the food shopping for me
- o   Food bank or other charity organizations
- o   Prefer not to say
- o   Other_____

49.   In the last 4 weeks what kind/s of transportation have you used to do your food shopping? (Tick all methods used)
- o   Bus
- o   Tram
- o   Own Car
- o   Friend's car
- o   Relative's car
- o   Taxi
- o   Walk
- o   Bicycle
- o   None
- o   Other_____

50.   In the last 4 weeks, how difficult was it for you to get to the shops to buy food, using your normal mode of transport?
- o   Very difficult
- o   Difficult
- o   Not difficult at all
- o   Prefer not to say

51.   In the last 4 weeks, which of the following factors affect your ability to access the quality or variety of foods that you need? *MULTIPLES RESPONSES ALLOWED
- o   Distance to food shops
- o   Reliable and adequate public transport
- o   Knowledge and cooking skills to prepare healthy meals

- o   Availability of healthy foods
- o   Availability of culturally appropriate foods
- o   Food storage room and cooking equipment available at home
- o   Space to prepare food and cooking facilities (e.g., stove, oven, microwave) at home
- o   Inadequate time to shop, prepare and cook food
- o   Price of food
- o   Not applicable
- o   Other _____

Covid-19 and self-isolation status

If you would like more information on self-isolation if you or a member of your household has coronavirus symptoms, please follow this link to NHS website, which provides information on self- isolation. If you would like information on who is at VERY HIGH RISK or HIGH RISK of Coronavirus, please follow this link **to the NHS website.**

52. During COVID-19 crisis, are you currently (please tick all the apply):
- o   Self-isolating after developing symptoms within the last 7 days
- o   Self-isolating after developing symptoms within the last 14 days
- o   Self-isolating within your halls of residence following guidance from your university
- o   Self-isolating for 14 days after a member of your household developed symptoms
- o   Self-isolating for longer than 14 days after a member of your household developed symptoms and then you developed symptoms
- o   Not leaving your home because you are at very high risk of coronavirus
- o   Not leaving your home because a member of your household is at very high risk of coronavirus
- o   Not leaving your home except to get essential items such as food and medicine
- o   I am not self-isolating, but I am following government guidance on social distancing
- o   I am not self-isolating, but I am following government guidance, and I live in an area where increased restrictions have been imposed
- o   Other _____
- o   Prefer not to say

Food security

The next following questions are to assess your food security status by using HFIAS. We would like to know if you have experienced difficulties obtaining food either because you could not afford the food (lack of money) or because of issues with food availability during the last 30 days.
If you are struggling with the cost of living or are experiencing any issues with money please refer to any one of these links; Citizens advice, Red Cross **and the** Trussell Trust

No	Question	Response options
53.	In the past four weeks, did you worry that your household would not have enough food?	☐ Yes ☐ No (skip to Q54)
53a.	How often did this happen?	o Rarely (once or twice in the past four weeks) o Sometimes (three to ten times in the past four weeks) o Often (more than ten times in the past four weeks)
54.	In the past four weeks, were you or any household member not	☐ Yes ☐ No (skip to Q55)

able to eat the kinds of foods you preferred because of a lack of resources?

54a. How often did this happen?
- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)
- o Often (more than ten times in the past four weeks)

55. In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?
□ Yes   □ No (skip to Q56)

55a. How often did this happen?
- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)
- o Often (more than ten times in the past four weeks)

56. In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?
□ Yes   □ No (skip to Q57)

56a. How often did this happen?
- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)
- o Often (more than ten times in the past four weeks)

57. In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
□ Yes   □ No (skip to Q58)

57a. How often did this happen?
- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)
- o Often (more than ten times in the past four weeks)

58. In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?
□ Yes   □ No (skip to Q59)

58a. How often did this happen?
- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)
- o Often (more than ten times in the past four weeks)

59. In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?
□ Yes   □ No (skip to Q60)

59a. How often did this happen?
- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)
- o Often (more than ten times in the past four weeks)

| 60. | In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food? | □ Yes | □ No (skip to Q61) |

60a.	How often did this happen?	o	Rarely (once or twice in the past four weeks)
		o	Sometimes (three to ten times in the past four weeks)
		o	Often (more than ten times in the past four weeks)

| 61. | In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food? | □ Yes | □ No |

61a.	How often did this happen?	o	Rarely (once or twice in the past four weeks)
		o	Sometimes (three to ten times in the past four weeks)
		o	Often (more than ten times in the past four weeks)

Coates, J., Swindale, A. and Bilinsky, P. (2007) Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide Version 3. Food and Nutrition Technical Assistance Project Academy for Educational Development, Washington DC.

Health and wellbeing

The next following items assess your coping strategies when you feel stress during term time by using CFS.

Coping flexibility is generally defined as one's ability to modify one's coping strategies adaptively to meet the demands of different stressful situations. If you feel that you are not coping please find information at the NHS website or the National Student Union student mind or the together all mental health service.

Please indicate how these situations apply to you in the last 30 days by choosing one of the following for each situation:

No	Questions	Very applicable	Applicable	Somewhat applicable	Not applicable	Prefer not to say
62	When a stressful situation has not improved, I try to think of other ways to cope with it.					
63	I only use certain ways to cope with stress.					
64	When stressed, I use several ways to cope and make the situation better.					
65	When I have not coped with a stressful situation well, I use other ways to cope with that situation.					
66	If a stressful situation has not improved, I use other ways to cope with that situation.					
67	I am aware of how successful or unsuccessful my attempts to cope with stress have been.					

No	Questions						
68	I fail to notice when I have been unable to cope with stress.						
69	If I feel that I have failed to cope with stress, I change the way in which I deal with stress.						
70	After coping with stress, I think about how well my ways of coping with stress worked or did not work.						
71	If I have failed to cope with stress, I think of other ways to cope.						

Coping flexibility scale, Kato 2012, Journal of counselling psychology 59(2): 262-273.

The following statements are about feelings and thoughts . The Warwick-Edinburgh Mental Wellbeing Scales were developed to enable the measurement of mental wellbeing in the general population .**IF THE MAJORITY OF YOUR ANSWERS TO THE QUESTIONS BELOW ARE 'NONE OF THE TIME'/'RARELY', PLEASE CONTACT SOMEONE USING THESE LINKS** the NHS website or the National Student Union student mind or the together all mental health service
Please check the best statement describes your experience over the last 30 days.

No	Questions	None of the time	Rarely	Some of the time	Often	All of the time	Prefer not to say
72	I have been feeling optimistic about the future.						
73	I have been feeling useful.						
74	I have been feeling relaxed.						
75	I have been feeling interested in other people.						
76	I have had energy to spare.						
77	I have been dealing with problems well.						
78	I have been thinking clearly.						
79	I have been feeling good about myself.						
80	I have been feeling close to other people.						
81	I have been feeling confident.						
82	I have been able to make up my own mind about things.						
83	I have been feeling loved.						
84	I have been interested in new things.						
85	I have been feeling cheerful.						

NHS Health Scotland, University of Warwick and University of Edinburgh, 2006.

We would like to thank you for taking time to complete our survey.

3 Improving Food Security Status, Dietary Intake, and Mental Wellbeing

3.1 Online consent

Researchers name

Afnan Aldubaybi (stxaa114@exmail.nottingham.ac.uk)
Dr Preeti Jethwa (supervisor; preeti.jethwa@nottingham.ac.uk)
Dr Lisa Coneyworth (supervisor; lisa.coneyworth@nottingham.ac.uk)

Welcome to the Improving Food Security among University of Nottingham Students Questionnaire.
You have been invited to take part in a research study. Before you decide whether to take par t, it is important for you to understand why the research is being done and what it will involve . Please take time to read the participant information sheet, which can be accessed by following this **link** before joining the study.
This research has received a favourable ethical opinion (FEO) from the Faculty of Medicine & Health Sciences Research Ethics Committee, University of Nottingham, (**FMHS 470-0322)**. If you have any questions about the study, please contact the research team.
The following questions confirm that you consent to taking part in this online survey. Your individual identity will be anonymized prior to analysis. Your participation in this survey is voluntary, and you may withdraw at any time by simply not completing or submitting the survey.
Data will be stored in accordance with the General Data Protection Regulation (GDPR). Cookies, personal data stored by your web browser, are not used in this survey. However, as an online participant in this research, there is always a minimal risk of intrusion by outside agents and therefore the possibility of being identified.

- I confirm that I have read and understand the information sheet version number 1.0, dated 01/03/2022 for the above study and have had the opportunity to ask questions.
- I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. I understand that should I withdraw, then the information collected so far cannot be erased and that this information may still be used in the project analysis.
- I understand that relevant sections of data collected in the study may be looked at by authorised individuals from the University of Nottingham, the research group, and regulatory authorities where it is relevant to my taking part in this study. I give permission for these individuals to have access to these records and to collect, store, analyse and publish information obtained from my participation in this study.
- I understand that information about me recorded during the study will be made anonymous before it is stored. It will be uploaded into a secure database held in a secure cloud-based server. Data will be kept for 7 years after the study has ended and then destroyed.
- I voluntarily AGREE to take part in the above study.

I CONSENT to take part in the online survey and for my answers to be used

- o   Yes
- o   No

In order to check your eligibility for this study, please follow all the criteria below:

	Required	
	YES	NO
Healthy adults	○	○
Students aged 18 years old and over	○	○
Studying at the University of Nottingham	○	○
Do not have lactose intolerant, a coeliac, or have any food-based allergies	○	○
Any ethnicity, gender, or level of education	○	○
Able to access cooking facilities	◉	○

To contact you with more details about completing the study phases, please provide your email:

Research Ethics Reference: **FMHS 470-0322**
Version 1.0   Date: 01/03/2022

Study Title: Improving Food Security among University of Nottingham Students
Researchers: Afnan Aldubaybi, Dr Preeti Jethwa, Dr Lisa Coneyworth

Healthy Volunteer information sheet
You have been invited to take part in a research study. Before you decide whether to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with friends and relatives if you wish to. Ask us if there is anything that is not clear or if you would like more information. Take your time to decide whether you wish to take part or not. If you decide to take part, you may keep this leaflet. Thank you for reading this.

What is the purpose of the research?
Food insecurity is a recent concern for university students in high-income countries as it has been linked to poor public health, which can affect mental health, social health, malnutrition, and academic performance (Davis et al., 2020; Maynard et al., 2018; Gorton et al., 2010).

Food insecurity can be any or all of the following:
- Not having sufficient food.
- Experiencing hunger as a result of running out of food and being unable to afford more.
- Eating a poor-quality diet as a result of limited food options.
- Experiencing anxiety about acquiring food.
- Having to rely on food relief.

In line with this, our previous observational study revealed that 25.7-31.8% of UK university students were food insecure, and this was attributed to the inability to manage money, with large proportions being spent on purchasing food, which was associated with poorer mental wellbeing. Many studies have proposed that a healthy diet can be a protective factor against poor mental wellbeing. Indeed, in countries where the Mediterranean diet is followed, the incidence of mental health disorders such as depression, anxiety, and stress, is low; this has been attributed to the direct intake of appropriate nutrients such as omega-3 fatty acids via fish intake and B vitamins, minerals, and amino acid precursors to neurotransmitters via fruits and vegetables. Therefore, could providing students with the ability to make nutritious meals on a limited budget help with their mental wellbeing?
The aim of this project is to educate university students on preparing nutritious meals on a budget and with limited cooking facilities. We hypothesise that improving students' ability to make their money go further will improve food insecurity and, in turn, prevent the negative impacts on health and wellbeing.

What does the study involve?
Thank you for contacting us regarding this project; this document provides information about the study. If you decide to take part, we will invite you to come and meet us to discuss any concerns you may have, and we will ask you to sign a consent form. You will be assigned a unique study number, which will be used in all future correspondence. This means that all the data provided will remain anonymous, and no completed questionnaires returned to the research unit will have your address or name associated with them.
We will then ask you to complete a baseline questionnaire in which we will collect general background information, financial situation, health behaviors, cooking skills, and measure food insecurity and mental health status by using validated scales. Also, we will ask you to provide a food recall of food for three days and keep all receipts for food you may have purchased for 7 days.

Following this, we will arrange suitable times for you to attend the diet lab in the clinical skills unit at North Lab, University of Nottingham, Sutton Bonington Campus, Loughborough LE12 5RD. In the diet lab, we will be taking you through an easy recipe that can be made into more than one meal. We will discuss portion sizes and how to optimise your food to make your money go further. We will then provide you with a box of ingredients and a step-by-step guide on how to make the meals. These will be within a particular budget, and at the end, we would like to know whether this helped improve confidence in cooking, if you were surprised by how filling the meals were, and if it helped with managing your money. Following the week, we will provide you with a budget to spend on food for five dinners using the skills and resources you obtained in the last two weeks. At the end, we will ask you a variety of questions in the group to assess how you felt about this and what you have learned. Following this, we will ask you to continue to use the skills and resources for the next 3 weeks to see if you can reduce your spending on food and improve your confidence in cooking. At the end, we will ask you to complete the baseline questionnaire again for us to compare.

Why have I been invited to take part?
You have been chosen for this study because you attend the University of Nottingham. We are hoping to collect data from approximately 66 individuals (males and females) of all ages, ethnicities, socio-demographic backgrounds, and body weights. Unfortunately, you will not be able to take part in this study if

> a. You are lactose intolerant, have coeliac disease, or have any food-based allergies.
> b. You have a history of any eating disorders or mental health issues.
> c. You are pregnant or lactating.
> d. You have limited access to cooking facilities.

Do you have to take part?
It is up to you to decide whether you would like to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.
What do I have to do?
You will be required to

1. Complete a series of questionnaires which will provide information about sociodemographic information, feeding behaviors, food security status, and mental wellbeing.
2. Attend a cooking class and 2 focus group sessions at the University of Nottingham, Sutton Bonington Campus.
3. Collect all receipts of food purchases for the duration of the study.
4. Make 5 meals a week (using the ingredients provided, using a budget provided via a gift card, and following the teachings for 3 weeks).

Will food provided be to my dietary preference
The recipes and ingredients provided will be based on your dietary preference and be commercially available and food grade.

What are the disadvantages of taking part?
We appreciate that we are asking you to give up your free time to attend cookery sessions, follow a prescribed routine of shopping and cooking, attend focus groups, keep a diary, and complete questionnaires associated with the study. However, there are no risks or disadvantages associated with this study.

Are there any benefits in taking part?
The benefits of taking part are that you will learn how to plan, prepare, and portion your food in order to enhance your food behaviours. This, in turn, could help you save money.

Will my time/travel costs be reimbursed?
Participants will not receive an inconvenience allowance to participate in the study as it will be conducted at the University of Nottingham campuses.

What happens to the data provided?

We will follow ethical and legal practice, and all information about you will be handled in confidence. If you join the study, the data collected for the study will be looked at by authorised people from the University of Nottingham who are organising the research. They may also be looked at by authorised people to check that the study is being carried out correctly. All will have a duty of confidentiality to you as a research participant, and we will do our best to meet this duty.

All information which is collected about you during the course of the research will be kept strictly confidential and secured within the University of Nottingham. We are not asking for any information that will be required to be anonymised as no identifiable information is needed. However, anonymised data may be stored in data archives for future researchers interested in this area.

All identifiable research data will be kept securely for 7 years. After this time, your data will be disposed of securely. During this time, all precautions will be taken by all those involved to maintain your confidentiality. Only members of the research team will have access to your personal data. For information about the University's obligations with respect to your data, who you can get in touch with, and your rights as a data subject, please visit: https://www.nottingham.ac.uk/utilities/privacy.aspx.

The questionnaire will be conducted via Online Surveys, which is compliant with the General Data Protection Regulation (GDPR). Online Surveys takes data protection responsibilities seriously. For more information, please visit https://www.onlinesurveys.ac.uk/gdpr-and-online-surveys/

What will happen if I don't want to carry on with the study?

Your participation is voluntary, and you are free to withdraw at any time, without giving any reason, and without your legal rights being affected. If you withdraw, then the information collected so far may not be possible to extract and erase after the agreed length of time, and this information may still be used in the project analysis.

Who will know that I am taking part in this research?

Data will be used for research purposes only and in accordance with the General Data Protection Regulation. Any electronic data will be anonymised with a code as detailed above. Electronic storage devices will be encrypted while transferring and saving all sensitive data generated in the course of the research. All such data is kept on password-protected databases sitting on a restricted access computer system and would only be accessed by the research team.

Under UK Data Protection laws, the University is the Data Controller (legally responsible for the data security) and the Chief Investigator of this study (named above) is the Data Custodian (manages access to the data).

You can find out more about how we use your personal information and read our privacy notice at: https://www.nottingham.ac.uk/utilities/privacy.aspx/

Designated individuals of the University of Nottingham may be given access to data for monitoring and/or audit of the study to ensure we are complying with guidelines.

What will happen to the results of the research?

The data collected will be used by Afnan Aldubaybi for her PhD thesis and will also be used to develop tools to help university students. Extracts of your data may be disclosed both in print and online in the university archives, as well as in published works that are posted online for use by the scientific community.

Who has reviewed this study?

All research involving people is looked at by an independent group of people, called a Research Ethics Committee, to protect your interests.

Who is organising and funding the research?

This study is being organised by the University of Nottingham and funded by the Saudi Government, International Student Scholarship to Afnan Aldubaybi.

What if there is a problem?

If you have a concern about any aspect of this project, please speak to the researcher, Afnan Aldubaybi, or the principal supervisor, Dr Preeti Jethwa (preeti.jethwa@nottingham.ac.uk), who will do their best to answer your query. The researcher should acknowledge your concern and give you an indication of how she intends to deal with it. If you remain unhappy and wish to complain formally, you can do this by contacting the FMHS Research Ethics Committee Administrator, Faculty Hub, Medicine and Health Sciences, E41, E Floor, Medical School, Queen's Medical Centre Campus, Nottingham University Hospitals, Nottingham, NG7 2UH or via E-mail: FMHS-ResearchEthics@nottingham.ac.uk.

Please quote ref no: FMHS 470-0322

Contact Details

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact:

Afnan Aldubaybi (PhD Researcher)
Division of food, Nutrition, and Dietetics,
Nutritional Sciences,
School of Biosciences,
University of Nottingham, Sutton Bonington Campus
Loughborough,
LE12 5RD
Tel: 7514406707
Afnan.aldubaybi@nottingham.ac.uk

We would like to kindly thank you for your time and consideration

3.3 Questionnaire

Questions on this page will ask you to provide some information about yourself. Please select the appropriate answers.

1. **What is your gender?**
    o   Male
    o   Female
    o   Prefer not to say
    o   Other_____

2. **What is your age in years?**
    o   under 18 (skip to end of questionnaire)

o 18	o 29	o 40	o 51
o 19	o 30	o 41	o 52
o 20	o 31	o 42	o 53
o 21	o 32	o 43	o 54
o 22	o 33	o 44	o 55
o 23	o 34	o 45	o 56
o 24	o 35	o 46	o 57
o 25	o 36	o 47	o 58
o 26	o 37	o 48	o 59
o 27	o 38	o 49	o 60 +
o 28	o 39	o 50	

3. **Which of the following best describes your ethnic origin?**

o White British	o Pakistani
o White Irish	o Bangladeshi
o Black Caribbean	o Gujarati
o Black African	o Tamil
o White and Black Caribbean	o Chinese
o White and Black African	o Korean
o White and Asian	o Arabic
o Indian	o Other, please provide details_____

4. **Please state your height in one of the boxes below.**

    [   ] M [   ] Cm **OR** [   ] Ft [   ] In

5. **Please state your current weight in one of the boxes below.**

    [   ] Kg **OR** [   ] Stones/lbs

6. **What degree are you studying at the university?**

o Foundation	o MRes	o MA
o BSc	o MPhil	o MBA
o MSc	o PhD	o Other, please specify_____

7. **What subject area are you studying at University (e.g. Nutrition, Medicine, Business – provide exact title)**

    [   ]

8. **Are you:**
    - o A part time student
    - o A full-time student
    - o An international student (non-EU)
    - o AN EU student
    - o A Home student (UK)

9. **What year did you enrol on/begin your current degree program?**
    - o 2015
    - o 2016
    - o 2017
    - o 2018
    - o 2019
    - o 2020
    - o 2021
    - o 2022

10. **Which of the following best describes your current term-time accommodation?**
    - o Private sector halls of residence – catered
    - o Private sector halls of residence – not catered
    - o University halls of residence – catered
    - o University halls of residence – not catered
    - o House/flat share (share with friends)
    - o Live alone in a private rented accommodation
    - o Live alone in an owned home
    - o Live with family in a private rented accommodation
    - o Live with family in an owned home
    - o Other, please provide details_____
    - o Prefer not to say

Financial status

The next following questions describe financial status. Please select the best answers that apply to you:

11. **Do you consider yourself financially independent?** *Independent students who they have supported themselves financially for academic studying years and basic needs, married, or graduate degree, etc.*
    - o Yes
    - o No
    - o Prefer not to say

12. **Besides being a student, do you currently have a job?**
    - o Yes (part-time job)
    - o Yes (full-time job)
    - o No job
    - o Prefer not to say

  12a. If No, are you currently trying to find a job?
    - o Yes (part-time job)
    - o Yes (full-time job)
    - o No
    - o Prefer not to say

13. **How much disposable income do you have each month? This is the amount of money left for you to spend after rent, bills, and food.** (Drop down box)
    - o £0 - £50
    - o £51 to £100
    - o £101 to £150
    - o £151 to £200

- o £20 1 to £250
- o £251 to £300
- o £301 to £350
- o £351 and greater
- o Prefer not to say

14. **How much money do spend on food on average, per week (excluding alcohol)?**

o £0- £20	o £81- £100	o £161- £180
o £21- £40	o £101- £120	o £181- £200
o £41- £60	o £121-£140	o More than £200
o £61- £80	o £141- £160	o Prefer not to say

15. **Do your parents/guardians or other relatives offer you financial support for University?**
- o Yes
- o No
- o Prefer not to say

16. **Do you receive financial support through grants, scholarships, or any funding source besides relatives that does not require repayment?**
- o Yes
- o No
- o Prefer not to say

17. **Do you receive financial support through student loans or any other funding that does require repayment?**
- o Yes
- o No
- o Prefer not to say

18. **Do you have savings to help support you if needed?**
- o Yes
- o No
- o Prefer not to say

19. **Since you began your studies at university, have you borrowed money from family or friends in order to meet basic costs i.e., food, rent?**
- o Never
- o Rarely
- o Sometimes
- o Often
- o All the time
- o Prefer not to say

Your diet and eating habits during term time

The following questions will ask you about your typical diet and eating habits during term time. Please indicate the right answers apply to you by choosing one of the following answers from each question:

20. **How many main meals do you typically eat per day during term time? (Do not include snacks)**
- o None
- o 1-2 meals/day
- o 2-3 meals/day
- o 4+ meals/day
- o Prefer not to say

21. **How often do you snack per day in the term time?**
    o Never
    o Once
    o Twice
    o More than twice
    o Prefer not to say

22. **How would you rate your eating habits in the term time?**
    o Very unhealthy
    o Unhealthy
    o Very healthy
    o Healthy
    o I do not know
    o Prefer not to say

No	Questions	Never	Once a week	2-4 days/week	5-6 days / week	Everyday	Prefer not to say
23.	How often do you eat fruit?						
24.	How often do you eat vegetables?						
25.	How often do you consume alcohol?						
26.	How often do you smoke cigarettes / cigars/vape?						

27. **Are you following any specific diet?**
    o Omnivores *(a person who eats all types of food).*
    o Vegan *(foods that do not contain any animal-derived products including dairy, eggs, and honey).*
    o Vegetarian *(foods that do not contain animal products except dairy, eggs, and honey).*
    o Pescatarians (*a person who primarily eats fish and seafood, as well as vegetables and other non-animal meat foods)*
    o Other, please provide details _____

28. **How often do you shop for food? E.g., supermarket**
    o Once per week
    o Twice per week
    o Three times per week or more
    o Daily
    o Once per month
    o Twice per month
    o Prefer not to say

29. **Which of the following options best describes how you typically purchase food?**
    o Shop in person
    o Online for home delivery
    o Online for click and collect
    o Often my parents/ partner/ adult who lives with me do the food shopping in person
    o Often my family/ friends who do not live with me do the food shopping for me
    o Food bank or other charity organizations
    o Prefer not to say

o   Other, please provide details _____

30. How frequently do you prepare meals each week?
- o   No meals – takeaway, frozen meals
- o   Prepare meals once a week
- o   Prepare meals twice a week
- o   Prepare meals three times a week
- o   Prepare meals four times a week
- o   Prepare meals five times a week
- o   Prepare meals six times a week
- o   Prepare meals every day

31.   What prevents you from preparing meals?

Please provide details – e.g., could be lack of time, lack of appropriate equipment, don't know how to cook, lack of transportation, no shops nearby, lack of funds

_____

32. Are you able to go shopping for food when you need to?
- o   Yes
- o   Usually
- o   No
- o   Prefer not to say

33. Have you recently accessed food charities or organizations?
- o   Yes
- o   No
- o   Prefer not to say

Your food literacy and behaviours

The following questions will ask you about your cooking confidence and typical food behaviours during term time. Please indicate the right answers apply to you by choosing one of the following answers from each question:

34. Have you taken cooking classes?
- o   Yes
- o   No
- o   Prefer not to say

- • **Cooking confidence:**

How often do you do the following activities?

No	Activities	1 Not confident	2 Not very confident	3 Fairly confident	4 Confident	5 Extremely confident
35.	Confidence to eat the recommended servings of fruit and vegetables each day					
36.	Confidence in ability to buy healthy food on a budget					
37.	Confidence to cook from basic ingredients					
38.	Confidence in following a simple recipe					
39.	Confidence in tasting foods not eaten before					
40.	Confidence in preparing and cooking new foods and recipes					

Food Literacy. West et al.,2020; Devine et al. 2005; and Barton et al. 2011.

- **Food behaviors:**

How often do you do the following activities?

No	Activities	0 Never	1 sometimes	2 Often	3 always
41.	Look for low-salt food varieties				
42.	Choose whole meal or wholegrain bread				
43.	Read nutrition information panels when shopping				
44.	Read ingredient list when shopping				
45.	Look at price per kilo when shopping				
46.	Change recipes to make them healthier				
47.	Use a shopping list				

Food behaviors. West et al.,2020; Food Cents program 2013; and Wrieden et al.,2007.

Food security

These questions are about your food insecurity experience over the last month.

The phrase 'Lack of resources' means any factor that plays a role of <u>preventing you from accessing food</u> such as lack of money to afford food prices or travel costs. Time constraints for shopping or cooking. Lack of cooking skills.

If you are struggling with the cost of living or are experiencing any issues with money please refer to any one of these links Citizens advice, Red Cross and the Trussell Trust

Please choose one of the response options of each question that applied to you for and write it down in the code column**.**

No	Question	Response options
48.	In the past four weeks, did you worry that your household would not have enough food?	□ Yes □ No (skip to Q49)
48a.	How often did this happen?	o Rarely (once or twice in the past four weeks) o Sometimes (three to ten times in the past four weeks) o Often (more than ten times in the past four weeks)
49.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	□ Yes □ No (skip to Q50)
49a.	How often did this happen?	o Rarely (once or twice in the past four weeks) o Sometimes (three to ten times in the past four weeks) o Often (more than ten times in the past four weeks)
50.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	□ Yes □ No (skip to Q51)
50a.	How often did this happen?	o Rarely (once or twice in the past four weeks) o Sometimes (three to ten times in the past four weeks) o Often (more than ten times in the past four weeks)

51.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	□ Yes □ No (skip to Q52)

51a. How often did this happen?

- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)
- o Often (more than ten times in the past four weeks)

52.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	□ Yes □ No (skip to Q53)

52a. How often did this happen?

- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)
- o Often (more than ten times in the past four weeks)

53.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	□ Yes □ No (skip to Q54)

53a. How often did this happen?

- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)
- o Often (more than ten times in the past four weeks)

54.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	□ Yes □ No (skip to Q55)

54a. How often did this happen?

- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)
- o Often (more than ten times in the past four weeks)

55.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	□ Yes □ No (skip to Q56)

55a. How often did this happen?

- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)
- o Often (more than ten times in the past four weeks)

56.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	□ Yes □ No

56a. How often did this happen?

- o Rarely (once or twice in the past four weeks)
- o Sometimes (three to ten times in the past four weeks)

Health and wellbeing

The following statements are about feelings and thoughts. The Warwick-Edinburgh Mental Wellbeing Scales were developed to enable the measurement of mental wellbeing in the general population.

IF THE MAJORITY OF YOUR ANSWERS TO THE QUESTIONS BELOW ARE 'NONE OF THE TIME'/'RARELY', PLEASE CONTACT SOMEONE USING THESE LINKS the NHS website or the National Student Union student mind or the together all mental health service

Please check the best statement describes your experience over the last 30 days.

No	Questions	None of the time	Rarely	Some of the time	Often	All of the time	Prefer not to say
57.	I have been feeling optimistic about the future.						
58.	I have been feeling useful.						
59.	I have been feeling relaxed.						
60.	I have been feeling interested in other people.						
61.	I have had energy to spare.						
62.	I have been dealing with problems well.						
63.	I have been thinking clearly.						
64.	I have been feeling good about myself.						
65.	I have been feeling close to other people.						
66.	I have been feeling confident.						
67.	I have been able to make up my own mind about things.						
68.	I have been feeling loved.						
69.	I have been interested in new things.						
70.	I have been feeling cheerful.						

NHS Health Scotland, University of Warwick and University of Edinburgh, 2006.

Three days food record

Please try to be as detailed as possible when recording the foods and beverages you consume. Please give an explanation of the preparation processes if the dish is prepared at home or in a restaurant (ex. grilled vs. fried).

• To acquire an accurate picture of your diet, keep track of your food intake for **TWO** weekdays and **ONE** weekend day (ex. Monday, Thursday, & Saturday).

No	Date/ Time	Food description	Amount	Beverage description	Amount
Food record					
Day 1					
Day 2					
Day 3					

We would like to thank you for taking the time to complete our survey.
The information that you have kindly provided may help us improve food security among University of Nottingham Students.

3.4 Intervention weeks

The following meals are super-fast and easy. You can store them well in the fridge or freezer for tasty lunches or dinners every week!

Overall, the total cost of all 5 meals in this session was £17.08, which is £3.41 per meal!
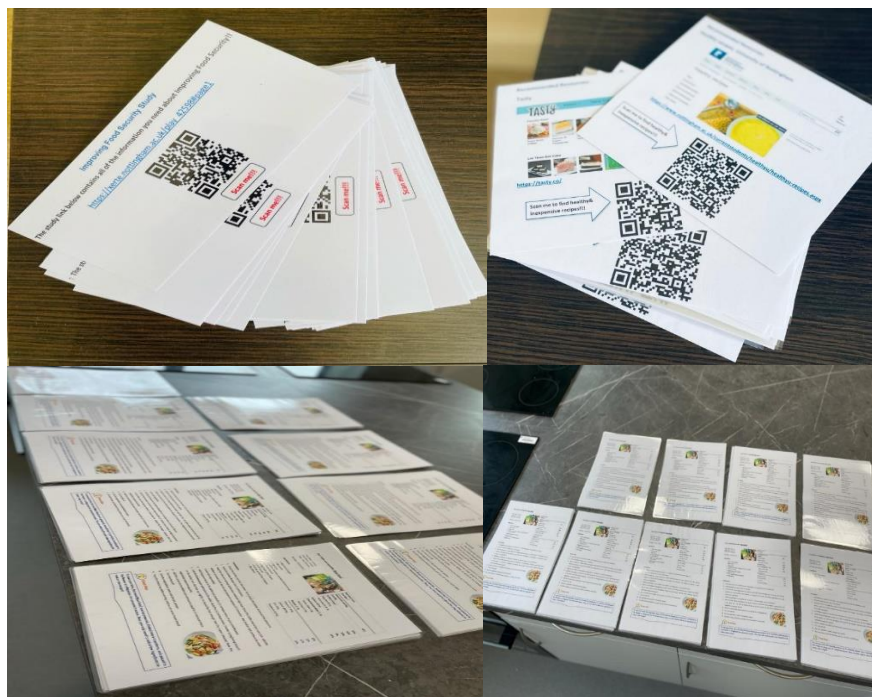
Recipes were available both online on the study website as well as in printed copies.

Easy chicken and vegetables (Base Meal)

Prep Time: 15 mins
Cook Time: 15 mins
Total Time: 30 mins
 Servings: 1 (Cost £3.41)

Nutrition Facts

Servings: 1

Amount per serving	
Calories	**433**
% Daily Value*	
Total Fat 26.1g	**33%**
Saturated Fat 8.4g	**42%**
Sodium 403mg	**18%**
Total Carbohydrate 21.3g	**8%**
Dietary Fiber 5.8g	**21%**
Total Sugars 10g	
Protein 29.7g	
Vitamin D 4mcg	18%
Calcium 283mg	22%
Iron 2mg	11%
Potassium 927mg	20%

Ingredients

- 68g frozen pepper
- 68g carrots
- 34g onion
- 0.20 lbs. boneless, skinless chicken breast
- 1 Tbsp olive oil
- 68g frozen green beans
- 0.05 tsp salt
- 0.03 tsp ground black pepper
- 30g cheese

Instructions

1. Chop the carrots and slice the onion. Try to make the pieces all around the same size.
2. Cube the chicken breasts into ½-inch pieces.
3. Heat the olive oil in a large skillet over medium-high heat. Once the skillet and oil are very hot, add the chicken and sauté until the chicken pieces are opaque (3-5 minutes – the chicken will continue to cook as you add vegetables).
4. Add the green beans to the skillet and sauté for 1-2 minutes more, or just until thawed.
5. Add the frozen pepper and onion to the skillet. Sauté for 1-2 minutes more. If water is beginning to pool in the skillet, turn the heat up slightly. It should be hot enough that the water released from the vegetables evaporates quickly.
6. Add the carrots to the skillet and continue to sauté for 2-3 minutes more.
7. Turn the heat off.
8. Give the vegetables a taste and add salt and pepper.
9. Top with cheese just before serving, and you can serve it with bread.

Club sandwich

Prep Time: 5 mins
Cook Time: 15 mins
Total Time: 20 mins
 Servings: 1 (Cost £3.41)

Nutrition Facts

Servings: 1

Amount per serving	
Calories	**558**
% Daily Value*	
Total Fat 19.5g	**25%**
Saturated Fat 3g	**15%**
Sodium 651mg	**28%**
Total Carbohydrate 65.2g	**24%**
Dietary Fiber 12.9g	**46%**
Total Sugars 12.6g	
Protein 31.6g	
Vitamin D 0mcg	0%
Calcium 173mg	13%
Iron 4mg	22%
Potassium 926mg	20%

Use the **Base Meal** ingredients and instructions as a filling for this meal.
Base meal ingredients:
- 45g frozen pepper
- 45 g carrots
- 34 g onion
- 1 tbsp olive oil
- 34 g frozen green beans
- 0.14 lbs. boneless, skinless chicken breast
- 0.03 tsp ground black pepper
- 0.05 tsp salt
- 34g Cheese (optional)

You only need to add the following ingredients:
- 4 medium Slices whole-meal bread

Instructions
1. Cook the base meal by following the instructions provided above.
2. Layer on the base meal as a filling, then top with another slice of bread. Add another filling layer. Finish with the final slice of bread and cut into quarters.
3. You may add cheese if you prefer. Serve with crisps or any sauce if you like. Enjoy!

Red Pasta with chicken and vegetables

Prep Time: 5 mins
Cook Time: 25 mins
Total Time: 30 mins
 Servings: 1 (Cost £3.41)

Nutrition Facts

Servings: 1

Amount per serving	
Calories	**583**
% Daily Value*	
Total Fat 29g	**37%**
Saturated Fat 9.4g	**47%**
Sodium 532mg	**23%**
Total Carbohydrate 46.3g	**17%**
Dietary Fiber 4.9g	**17%**
Total Sugars 9.8g	
Protein 36g	
Vitamin D 4mcg	21%
Calcium 310mg	24%
Iron 4mg	20%
Potassium 1030mg	22%

Use the **Base Meal** ingredients and instructions to add for this meal.
Base Meal Ingredients
- 45 g frozen pepper
- 68 g carrots
- 34 g onion
- 1 tbsp olive oil
- 34 g frozen green beans
- 0.20 lbs. boneless, skinless chicken breast
- 0.03 tsp ground black pepper
- 0.03 tsp salt

You only need to add the following ingredients
- 40g tomato sauce
- 50g pasta
- 2 cups of water
- 0.03 tsp salt
- 34g cheese

Instructions
1. Cook the Base Meal by following the instructions provided above.
2. Boil water until it reaches a full boil, add the pasta, and give the pasta a quick stir.
3. Replace the lid, then turn the heat down to medium-low. Let the pasta simmer over medium-low, stirring occasionally and always replacing the lid, for about 10 minutes, or until the pasta is tender.
4. Once the pasta is tender, add the pasta sauce to the pot and stir to combine.
5. Add the Base Meal to pasta.
6. Top with the cheese then place the lid back on the pot.
7. Let the pasta heat for a few minutes, or just until the cheese is melted. Serve hot! Enjoy!

Cheesy Quesadillas

Prep Time: 5 mins
Cook Time: 15 mins
Total Time: 20 mins
 Servings: 1 (Cost £3.41)

Nutrition Facts
Servings: 1

Amount per serving	
Calories	**524**
% Daily Value*	
Total Fat 28.5g	**37%**
Saturated Fat 9.4g	**47%**
Sodium 326mg	**14%**
Total Carbohydrate 38.2g	**14%**
Dietary Fiber 7.3g	**26%**
Total Sugars 8.6g	
Protein 30.6g	
Vitamin D 4mcg	21%
Calcium 335mg	26%
Iron 2mg	11%
Potassium 864mg	18%

Use the **Base Meal** ingredients to cook chicken and vegetables.
Base Meal Ingredients
- 45 g frozen pepper
- 68 g carrots
- 34 g onion
- 1 tbsp olive oil
- 34 g frozen green beans
- 0.18 lbs. boneless, skinless chicken breast
- 0.03 tsp ground black pepper
- 0.03 tsp salt

You only need to add the following ingredients
- 34g cheese
- 2 medium flour tortillas

Instructions
1. Cook the base meal by following the instructions provided above.
2. Add cheese when you turn the heat off.
3. Place a half cup of the base meal on one side of each tortilla and fold it over.
4. Cook the quesadillas in a skillet over medium heat on each side until brown and crispy and the cheesy filling has melted. Slice into triangles, then serve.
5. Serve with tomato or avocado sauce, or any sauce you like. Enjoy!

White rice with chicken and vegetables

Prep Time: 5 mins
Cook Time: 28 mins
Total Time: 33 mins
 Servings: 1 (Cost £3.41)

Nutrition Facts
Servings: 1

Amount per serving

Calories	**516**

% Daily Value*

Total Fat 17.1g	**22%**
Saturated Fat 2.2g	**11%**
Sodium 91mg	**4%**
Total Carbohydrate 59.4g	**22%**
Dietary Fiber 5.3g	**19%**
Total Sugars 6.8g	
Protein 30.4g	
Vitamin D 0mcg	0%
Calcium 70mg	5%
Iron 4mg	22%
Potassium 884mg	19%

Use the **Base Meal** ingredients to cook chicken and vegetables as a side for rice dish:
Base Meal Ingredients:
- 45 g frozen pepper
- 34 g carrots
- 34 g onion
- 1 tbsp olive oil
- 68 g frozen green beans
- 0.25 lbs. boneless, skinless chicken breast
- 0.03 tsp ground black pepper
- 0.03 tsp salt

 Then you only need to add the following ingredients:
Ingredients
- 55g rice
- 1.5 cup boiling water
- 0.08 tsp salt

Interactions
1. Cook the base meal by following the instructions provided above.
2. Cook the rice as the following instructions.

How to cook rice on the stove
3. In a saucepan, bring 55 g of rice (after rinsing!) and 1.5 cups water to a boil over medium high heat - no lid.
4. Reduce the heat to low, cover, and leave for 13 minutes.
5. Fluff with a rice paddle, rubber spatula, or fork, and marvel at the perfect fluffy rice! Enjoy.
6. Serve the rice with the base meal. You can also serve it with a fresh salad!

Oat soup

Prep Time: 5 mins
Cook Time: 20 mins
Total Time: 25 mins
 Servings: 1 (Cost £3.41)

Nutrition Facts

Servings: 1

Amount per serving

Calories	**501**

% Daily Value*

Total Fat 20.4g	**26%**
Saturated Fat 2.6g	**13%**
Sodium 263mg	**11%**
Total Carbohydrate 50.9g	**19%**
Dietary Fiber 10.4g	**37%**
Total Sugars 10.1g	
Protein 30.3g	
Vitamin D 0mcg	0%
Calcium 89mg	7%
Iron 4mg	21%
Potassium 1096mg	23%

Use the **Base Meal** ingredients to cook chicken and vegetables

Base Meal Ingredients

- 45 g frozen pepper
- 34 g carrots
- 34 g onion
- 7.3g olive oil
- 68 g frozen green beans
- 0.22 lbs. boneless, skinless chicken breast
- 0.03 tsp ground black pepper
- 0.03 tsp salt

Then you only need to add the following ingredients

- 7.3g olive oil
- 45g oats
- 34g tomato sauce
- 34g onion, chopped
- 1.5 cups water
- 0.05 tsp salt

Instructors

1. Cook the base meal by following the instructions provided above.
2. Heat a large deep saucepan over medium-low heat.
3. Pour in the oil and let it heat up.
4. In a blender or large food processor, combine the tomato sauce, onion, and 1 cup of water. Blend until smooth. Put it in the saucepan.
5. Dissolve the oats in half a cup of water; cook and stir with the sauce in the saucepan.
6. Stir in the remaining 1.5 cups of water and bring to a boil.
7. Mix in the salt and (Base Meal).
8. Cover, and simmer for 15 minutes. Serve hot or warm with homemade tortilla chips (recipe below). Enjoy.

Homemade tortilla chips

Prep Time: 3 mins
Cook Time: 10 mins
Total Time: 13 mins

Nutrition Facts

Servings: 1

Amount per serving	
Calories	**185**

% Daily Value*	
Total Fat 10.7g	**14%**
Saturated Fat 1.6g	**8%**
Cholesterol 0mg	**0%**
Sodium 22mg	**1%**
Total Carbohydrate 21.4g	**8%**
Dietary Fiber 3g	**11%**
Total Sugars 0.4g	
Protein 2.7g	
Vitamin D 0mcg	0%
Calcium 39mg	3%
Iron 1mg	3%
Potassium 89mg	2%

Ingredients

- About 2 tsp extra virgin olive oil (more or less depending on how many chips you are making)
- 2 Tortillas (each tortilla will make 6 chips)
- 0.3 tsp Salt

Instructions

1. Preheat the oven to 350°F.
2. While the oven preheats, cut the tortillas into wedges.
3. Place it on the baking sheet.
4. Spread the tortilla wedges out on a baking sheet in a single layer.
5. Bake the tortilla wedges for about 6 minutes, then use tongs to turn the wedges over.
6. Sprinkle with a little salt, and bake for another 6 to 9 minutes, until they are just beginning to color. Remove it from the oven and let it cool. Sprinkle with more salt to serve.
7. Serve with the soup. Enjoy.

What can I make with the remaining ingredients?

- You can find several recipes that you will enjoy by simply looking at the ingredients you already have.

Just visit **My Fridge Food** https://myfridgefood.com/

- We also have some suggested recipes for the leftover ingredients, as following below:
    1. **You can make <u>Pizza</u> from the ingredients left**
    2. **You can make <u>Past</u> from the ingredients left**
    3. **You can make <u>Rice pudding</u> from the ingredients left**
    4. **You can make <u>Roasted green beans and carrots</u> (a healthy snack) from the ingredients left**
    5. **You can make <u>Creamy carrot and pepper soup</u> from the ingredients left**

Easy pizza

Prep Time: 5 mins
Cook Time: 5 mins
Total Time: 10 mins

Nutrition Facts

Servings: 1

Amount per serving	
Calories	**434**
% Daily Value*	
Total Fat 13.9g	**18%**
Saturated Fat 7.2g	**36%**
Sodium 1038mg	**45%**
Total Carbohydrate 55.1g	**20%**
Dietary Fiber 9.9g	**35%**
Total Sugars 11.6g	
Protein 23.6g	
Vitamin D 4mcg	18%
Calcium 357mg	27%
Iron 4mg	22%
Potassium 626mg	13%

Ingredients

- 4 slices of bread of your choice. Toast and tortillas will all work well.
- 4 tbsp tomato sauce
- 20g Onion
- 25g Frozen pepper
- 30g Cheese
- 15g Frozen green beans (optional)

Instructions

1. Preheat the grill of your oven.
2. Place the toast or tortillas on a baking sheet and add a generous spoonful of tomato sauce. Spread with the back of the spoon to the corners.
3. Top with a handful of grated cheese followed by the toppings of your choice from frozen vegetables (pepper, or green beans) and slices of onion.
4. Place in the oven and allow to cook until the cheese has melted.
5. Remove it from the oven and allow it to cool for a few minutes before serving. Enjoy.

Vegetable pasta

Prep Time: 5 mins
Cook Time: 30 mins
Total Time: 35 mins

Nutrition Facts

Servings: 1

Amount per serving	
Calories	**449**
% Daily Value*	
Total Fat 17.5g	**22%**
Saturated Fat 6.6g	**33%**
Sodium 707mg	**31%**
Total Carbohydrate 58.9g	**21%**
Dietary Fiber 7.2g	**26%**
Total Sugars 13.8g	
Protein 17.2g	
Vitamin D 3mcg	15%
Calcium 263mg	20%
Iron 4mg	25%
Potassium 997mg	21%

Ingredients

- 60g Pasta
- 6 tbsp Tomato sauce
- 68g Frozen pepper
- 68g frozen green beans
- 68g Carrot
- 34g Onion
- 0.05 tsp ground black pepper
- 0.03 tsp salt
- 7.3g olive oil
- 25g Cheese

Interactions

1. Boil water until reaches a full boil, add the pasta, and give the pasta a quick stir. Replace the lid, then turn the heat down to medium-low. Let the pasta simmer over medium-low, stirring occasionally and always replacing the lid, for about 10 minutes, or until the pasta is tender.
2. Once the pasta is tender, add the pasta sauce, salt, ground black pepper, and olive oil to the pot and stir to combine.
3. Add the frozen vegetables (pepper, green beans), carrot, and onion, stir in the vegetables, and simmer for 5–10 minutes.
4. Place in a baking dish and top with cheese.
5. Bake for 10 minutes, or until the cheese is golden and bubbly. Enjoy.

Rice pudding

Prep Time: 5 mins
Cook Time: 35 mins
Total Time: 40 mins

Nutrition Facts

Servings: 1

Amount per serving	
Calories	**597**
% Daily Value*	
Total Fat 17.1g	**22%**
Saturated Fat 7.1g	**35%**
Sodium 1395mg	**61%**
Total Carbohydrate 94g	**34%**
Dietary Fiber 0.7g	**2%**
Total Sugars 52.1g	
Protein 19.6g	
Vitamin D 2mcg	12%
Calcium 595mg	46%
Iron 2mg	12%
Potassium 338mg	7%

Ingredients

- 2 cups milk
- 50g rice
- 7.3g olive oil
- 0.5 tsp Salt
- 30g Sugar

Instructions

1. In a large saucepan, heat milk, salt, and olive oil to a boil.
2. Add the rice and stir.
3. Let the grains expand for a few minutes.
4. Stir constantly to prevent the rice from sticking to the bottom of the pan.
5. When almost cooked, add sugar and cook for 30–40 minutes, stirring carefully so that the rice grains do not break.
6. To serve, garnish with cinnamon if you like. Enjoy.

Roasted green beans and carrots

Prep Time: 5 mins
Cook Time: 25 mins
Total Time: 30 mins

Nutrition Facts

Servings: 1

Amount per serving	
Calories	**361**

% Daily Value*	
Total Fat 28.7g	**37%**
Saturated Fat 4.3g	**21%**
Sodium 1252mg	**54%**
Total Carbohydrate 28g	**10%**
Dietary Fiber 9.6g	**34%**
Total Sugars 10g	
Protein 4g	

Vitamin D 0mcg	0%
Calcium 140mg	11%
Iron 3mg	16%
Potassium 735mg	16%

Ingredients

- 68g onion, sliced
- 113g frozen green beans, trimmed and halved*
- 113g carrots, cut into 2-inch sticks
- 2 tablespoons olive oil
- .5 tsp salt
- .25 tsp pepper
- 1 tablespoon minced fresh rosemary (optional)

Interactions

1. Preheat the oven to 400ºF.
2. Add the onion, green beans, and carrots to a large, rimmed baking sheet. Drizzle with the olive oil, rosemary, salt and pepper. Toss to combine then spread in an even layer.
3. Bake for about 25 to 30 minutes, stirring once halfway through, or until the veggies are tender to your liking.
4. Season with additional salt and pepper to taste if needed, then serve. Enjoy.

Creamy carrot and pepper soup

Prep Time: 5 mins
Cook Time: 40 mins
Total Time: 45 mins

Nutrition Facts

Servings: 1

Amount per serving

Calories	**312**

% Daily Value*

Total Fat 28.3g	**36%**
Saturated Fat 4g	**20%**
Sodium 1243mg	**54%**
Total Carbohydrate 17.1g	**6%**
Dietary Fiber 4.2g	**15%**
Total Sugars 8.3g	
Protein 1.9g	
Vitamin D 0mcg	0%
Calcium 92mg	7%
Iron 2mg	11%
Potassium 417mg	9%

Ingredients

- 2 tablespoons olive oil
- 68g onion cut into slices
- 68g carrots peeled and cut into coins approximately 1/2 inch thick
- 34g frozen pepper
- 1/2 teaspoon salt
- 1/4 teaspoon ground black pepper
- 1 teaspoon chopped fresh thyme (or 1/2 teaspoon dried)
- 4 cups water
- additional thyme, pumpkin seeds, or cream for serving

Instructions

1. In a large stockpot, warm the olive oil over medium heat. Add the onion and cook, stirring occasionally, until softened, approximately 6 minutes.
2. Add the carrots, frozen pepper, salt, and black pepper. Cook, stirring occasionally, for another 5 minutes.
3. Add the thyme and cook for approximately 1 minute.
4. Pour the water over the veggies and stir. Increase heat to high and bring mixture to a boil. Reduce heat back to medium, cover, and simmer for about 20 minutes, until the carrots are tender enough to be pierced with a fork.
5. Use an immersion blender, standard blender, or food processor to puree the soup. Taste and add more salt, if desired. Serve with fresh thyme, pumpkin seeds, or a swirl of cream, as desired. Enjoy!

3.5 Online suggested resources

- **Budget bytes**

https://www.budgetbytes.com/category/extra-bytes/budget-friendly-meal-prep/

Scan me to find healthy& inexpensive recipes!!!

- **Tasty**

/https://tasty.co
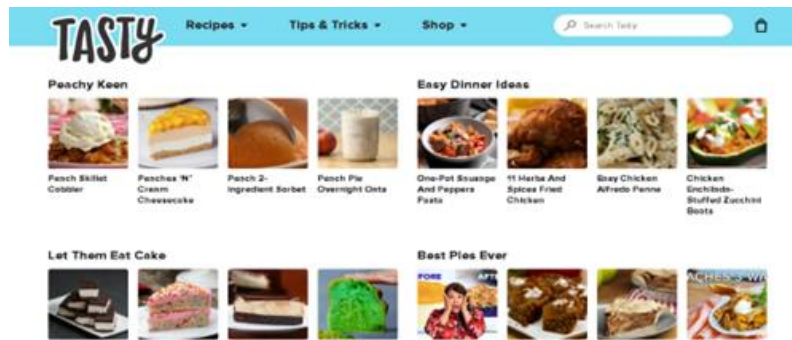
Scan me to find healthy& inexpensive recipes!!!

- **USDA. MyPlate**

https://www.myplate.gov/myplate-kitchen/recipes
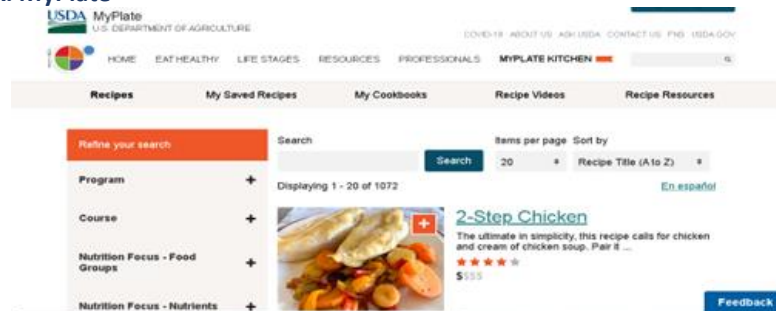
Scan me to find healthy& inexpensive recipes!!!

- **Healthy recipes, University of Nottingham**

https://www.nottingham.ac.uk/currentstudents/healthyu/healthyu-recipes.aspx

Scan me to find healthy& inexpensive recipes!!!

- **Good food, BBC**

https://www.bbcgoodfood.com/recipes/collection/quick-and-healthy-recipes

Scan me to find healthy& inexpensive recipes!!!

- **Healthy recipes, NHS**

https://www.nhs.uk/healthier-families/recipes/

Scan me to find healthy& inexpensive recipes!!!

- **Jamie Oliver**

https://www.jamieoliver.com/

Scan me to find healthy&
inexpensive recipes!!!
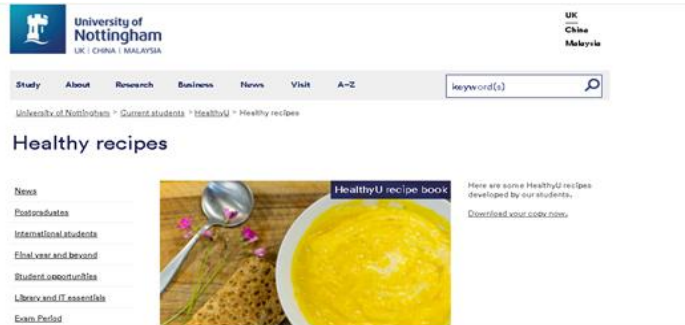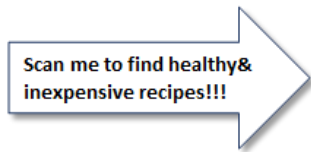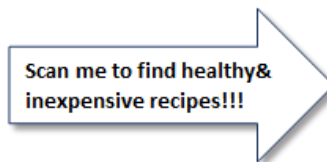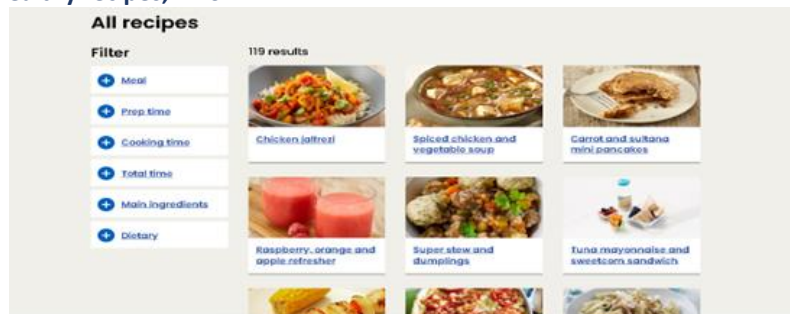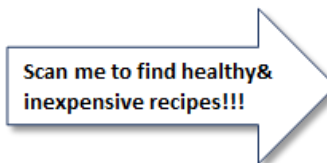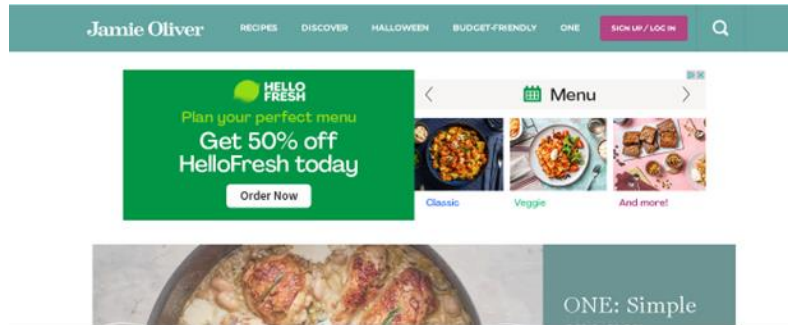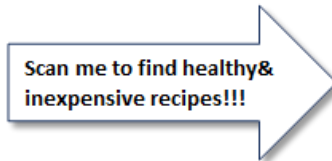
- **All information regarding the improving food security study**

The study link and QR below contains all of the information you need about improving food security!!

https://xerte.nottingham.ac.uk/play_42598#page1

Scan me!!!

3.6 Focus group discussions

Introduction

Thank you for your willingness to take part in this group discussion. The purpose of the discussion is to explore any problems you may have encountered, what you thought of the recipes, and what you have learned from the process so far.

- Your responses will be kept anonymous, and the data collected will be used for research purposes.
- Please ensure your responses will help us make decisions that will assist university students in getting a sufficient amount and variety of food, which will help improve academic life for students.

Examples of questions possibly asked in a researcher led focus group

Phase 2: Cooking week

- How did you find the cooking week session? Was it useful?
- How was it for you following the meal instructions? (Any difficulties)
- Did you use the leftover ingredients to make new meals?
- Have you developed any skills that you did not have before? What are they?
- Do you think you would be able to make these meals in your current accommodation? If not, please explain why.
- Have you ever thought about meal preparation before?
- Do you feel you would be able to continue this without help? If no, what kind of help do you think you need?
- What else would you like to learn?

Phase 3: Budget week

- How did you find the budgeted card provided? Was it useful?
- Have you bought a variety of foods in sufficient quantities and spent less money than usual?
- How many meals were you able to make with the voucher card?
- Were you expecting to be able to prepare those meals on the given budget? Why?
- Do you feel you would be able to continue this without help? If no, what kind of help do you think you need?
- Have you found any differences in your budget? Were you able to manage your money more wisely? (Please describe)
- Have you developed any skills that you did not have before? What are they?
- What else would you like to learn?

3.6.1 Focus group discussion results from the cooking week

Questions	Thems
	Categories
	Meal planning (recipes and ingredients)
How did you find the cooking week session? Was it useful?	"I felt like I was more organised, and it was good to have the food and the recipe ready to cook."
	"Just being able to know what I'm having every evening instead of having to get back and then take like half an hour to decide what I need to make from the fridge. Just quite nice knowing exactly what I was having"
	"It was like it helped me learn to plan really, and like, I know that I could use for other meals"
	"I probably say improved the planning skills"
	"In terms of like knowing what to cook, it was quite nice"
	"Having the recipes there, you know exactly what you're going to make, like you can follow it step by step. So, it's a lot easier than end up getting buying stuff that you probably shouldn't have"
	"at least I've managed to have two solid meals a day."
	"I think what I found and useful was using different ingredients which I wouldn't normally use"
	"Having the base meal means that the ingredients were there, and you could just adapt it"
	"I found that it made me a lot more like cautious with what I was eating and thinking about it earlier than maybe I normally do"
	Simplicity and quickness of recipes provided
How was it for you following the meal instructions? (Any difficulties)	"They were quite simple and easy to follow"
	"I think I found that the recipe instructions easy to follow"
	"I think they were quite easy to follow. Like they're good instructions and quite simple to go through each of them and get, you know, accurately"
	"I just have to put the same food on the rice or the spaghetti. So, I think it was pretty easy and actually I had fun doing it because it was like a new recipe for me. So, I think I just impressing like new flavors"
	"The recipes were actually quite simple"
	"The instructions were really clear to read step by step, and I thought they were quite good to follow"
	"I thought it was quite easy to follow"
	"I think it was quite good"
	"I found it easy"

	"I found it quite easy to follow"
	"Quite interesting experience for me"
	"I made the base meal twice and it literally took like 10 minutes, especially because I never thought of doing that like the frozen peppers were already cut up and stuff like that. So, all I really did to chop up was onion and garlic, and then all the other, So I kind of made it easier and it's fast"
	"With the base meal I just had like the chicken and veggies ready and then I could just cook the pasta in like 5 minutes. So, it's like it was obviously partially meal prepped, it was perfect"
Reducing food waste by using leftovers to make new meals	
Did you use the leftover ingredients to make new meals?	"We did make new meals out of any leftovers. We had the leftover base meal and used it for a fajita for lunch, and then also made vegetable Curry when we had vegetables leftover because we had no chicken. So, we did make new meals out of any leftovers"
	"I used like the leftover wraps. I just added peanut butter or jam or something like that as a snack"
	"I think I managed to sort of improvise on some of the meals. So, like with the rice one, I'm not fan of, just no sauce with rice. So, I added some leftover tomato sauce to it, and I think it was more improvising than I normally do. So, it's quite a good way of using up things that I would have probably forgotten about normally"
	"I struggled with if I buy like chicken for one meal, I don't normally have then like leftovers. Now I can realize you can actually make another meal out of that, or simply make a base meal and then have a kind of meals"
	"I've been trying to make it in a different way. For example, I use cooked spaghetti and have the sauce or in a quesadilla or base meal so I haven't thrown them away so I could have them in the fridge to have like for two more days"
	"I use the leftovers and stuff to make, like, snacks in between. So, I suppose that worked quite well"
	"I had a few leftover tortillas. So, I brought those to Uni. Obviously I had breakfast with the porridge, and I added a few ingredients to the pasta recipe and made it like one of those creamy cheesy pastas"
	"I added other stuff it wouldn't like completely disrupt it, which was nice"
	"I've used some of the leftover veg in my other meals, so like the beans and the Peppers, and then I plan to use the wraps next week for like other stuff, which is good because it's often hard to use an entire pack of wraps as one person"
	"I used it to make other pasta and rice dishes"
	"we'd have at least enough left for, like lunch the next day and maybe some other meals as well, which was quite useful"
	"I tried the club sandwich one and it worked pretty well actually"

	"I used like if I've made too big a meal at dinner, I would use it for lunch the next day, which I found really help"
	"I didn't know that you could get frozen peppers. So that is something that I know in the future I can get rather than throwing away fresh peppers"
	"Just like any small change in the recipe, like in a quesadilla or in the sandwich Club makes it like the whole like the flavor change a lot"

	Managing money and time	Improving cooking skills
Have you developed any skills that you did not have before? What are they?	**Saving money** "I think knowing what meal I have when I get back like it helps me kind of resist walking in, like on my walk home from the Union. I always walk pass like a Sainsbury's when I get off the bus, and even if I know I do not need anything I like often just go in there anyway and let's see what they have. I think knowing definitely like what I'm going to have at home kind of makes me be like Oh no, I don't actually need to go in and display something randomly that I probably don't really need that much" "That's something that I do as well, I passed by like the local Tesco and I just end up like buying something that's awful, but because I had the meals planned out and like, I knew how much like, nutritional things that I need for the day that really helped" "I found that it really made me think about what I was going to eat rather than kind of waiting until I was quite hungry in evening and then like ending up just buying something that was more convenient, whereas like thought about things a bit more in advance, which I guess isn't maybe like a physical skill in the sense of like shopping or meal prep or anything like that. But I found that it made me a lot more like cautious with what I was eating and thinking about it earlier than maybe I normally do" "I probably say improved the budgeting because I usually would go to the shops a few times a week, whereas now I've realized you can actually just go once and have enough ingredients if you plan ahead"	"I've done more cooked lunches than I normally would like. I would normally just have a sandwich, but I actually cook food, which I suppose is a bit more nutritious" "I think I managed to sort of improvise on some of the meals. I think it was more improvising than I normally do" "I actually learned a new way to cook rice, and I quite like the new way of cooking rice, I thought it was much better than my old way of doing it" "I added some spices and things to the recipes, so I guess I developed my spicing skills and like adding flavors to things" "I didn't do that much cooking at home, but obviously this did teach me like a few other things that I could, like, consider" "I think having the base meal in front of you and like you can see all the different ways that you can change one meal, you can just literally add another thing and it's completely different so kind of mixes it up. So, you're not having the same thing" "I like the idea of using the base meal for like to make it different meals because I do get very bored of food, so it's quite I hadn't thought to do that before" "I hadn't thought about all the different things I could do with it" "I would like make too big of a thing, and then I don't like have the same meal again, but mix it up a bit and

	"I think it gave me a bit more motivation because I feel normally when it comes to dinner, I don't even know what I'm going to make and all this you just get lazy and end up getting buying stuff that you probably shouldn't have"

"I found that it really made me think about what I was going to eat rather than kind of waiting until I was quite hungry in an evening and then like ending up just buying something that was more convenient"

"I know one of my biggest things is picking up other stuff. But, if I stick to my meal plans that well, generally, I think I'd have to be a bit more restrained than planned."

Saving time
"I actually spent quite a lot of time in the library. It really helped me manage time and like I had in my head that I had to eat those two main meals. So, it just helped me improve my time skills, basically time management skills"

"Generally, I go to the shop like a few times a week, it was quite good to see that actually you can go to the shop once"

"I found the whole thing quite useful. Just being able to know what I am having every evening instead of having to get back and then take half an hour to decide what I need to make from the fridge. Just quite nice knowing exactly what I was having every night"

"With the meal prep I did at the weekend, I had lunches for the next two days." | make some changes, so I was able to use it and also use it to like change between like lunch and dinner depending on how hungry I was" |
| | **Food storage space (fridges and freezers)** | **Teaching the first-year students cooking skills** |
| **Do you think you would be able to make these meals in your current accommodation? * If not, please explain why.** | "We have like enough space to cook, and I had enough equipment. But it was really hard storing leftovers because I have very little space in the fridge and the freezer. I feel like that's the hardest thing for me like I would be if I could prep more and freeze more things and like one day to have them ready, but in student | "I think especially I got I was kind of helping my family cooking stuff before I came to Uni, but there were quite a few people that I met in first year that had clearly never cooked themselves before. I think maybe if the Union could send round like some videos" |

	accommodation is quite hard to find the space to do that"	"I think I came from a slightly different situation where I didn't do that much cooking at home because my dad did most of it and it was kind of, he liked to but obviously this did teach me like a few other things that I could, like, consider"
	"I think the thing that limits you most is the amount of fridge and freezer space. Especially in halls like I'm thinking about last year because obviously, I am in a private house now, you don't get very much space in either, we don't really have an option to keep it anywhere else. So, I think that's probably the biggest limitation"	"If I compare it to like in first year, I think my cooking skills were a lot more questionable and so I think doing something like this in fast year would have really helped with those Uin"
	"I think that actually really applies to me and my housemate, because our house has like no fridge space, like absolutely zero fridge space"	"I wouldn't have known to do it in the first year. So, I think if I'd been taught about this in first year, this would have been mind-blowing for me"
	"I think that was a similar issue with the meal prepping and then sort of putting it in freezer to get it out. I could not do that, which is another reason I had it for three days like meals and then two lunches so I could actually use it all before it went bad in the fridge. So that was another limitation where I'd probably similarly"	
	"The only limitation I think to having big bags of frozen veg is in student accommodation. Usually, you only have like 1 freezer shelf and one fridge shelf. So, there is not that much room to sort of stock up. So that's the only thing I struggled with is like fit in the beans and the peppers into my freezer"	
	"I thought the same. The freezer space was an issue and needed quite a big pan to cook the entire base meal at once. So that's another thing to consider"	
	"I think the same as my housemate, like the freezer space was a bit of an issue, but in terms of actually cooking the meals, that was completely fine because we had like the hub and the kettle and stuff. That's just the freezer space I struggle with"	
	"I think the one thing that is like still limiting is obviously kind of like fridge freezer space. But obviously that is not much you can do about that. What you	

	are living in a student house is like, yeah, more space to store things. So, you can, like, freeze meals and make them last longer, but obviously cannot. There's not much that we could really do about that."
Food prep experience	
Have you ever thought about meal preparation before?	"I feel like I I've always used meal prep before, but I kind of just have one meal that was the same for like several days. But I had not really thought before about making a base meal and then using and like prepping that all in advance and then just using that to make different meals. So, I guess that was like a bit different from what I've done before"

"I think that's really helpful because I did find when I did meal prep before that having the same meal all the time was quite boring and I felt like obviously learned that this is a good way to have different meals, but obviously with a bit of prep before so you don't have to do the full whole cooking process in one evening"

"I was trying to do this before this study, but with the study it was like a bit easier with the experience. You still have the same recipes because I didn't have any ideas. I think that's what made it difficult for me to find what to eat, but with this new idea, like the recipe that you gave us and the ideas that you do with the leftovers, it kind of helps me. So, I think it will be better from now"

"I've been meal prepping for quite a few years"

"I started to meal prep quite recently and cause we're busy at Uni"

"During this week, I kind of thought about meal prepping just because the idea of cooking every day is just a bit tiring for me because I just feel like busy from UNI work in that kind of thing. So, meal prepping would be ideal because it would just be like 3 hours, like maybe once in like 3-4 days"

"I think for me, I've always sort of meal prep anyways, but it was not really meal prep more of like batch cooked, but I didn't actually. What I learned was that I could plan what I would use that those specific ingredients for different things about the week, whereas what I used to do was like maybe back look like two or three different meals and then just ultimate within the week"

"I'd always thought about meal prepping, but I never really got to it because it's like I think the organization is what I was lacking, like organizing recipes, ingredients and everything, but like having the peppers like pre chopped you can just whack them in the pan and the same with the green beans. So, it's a lot quicker. So, I could have that for quite a few meals, and it's just like it saves like when you're getting back from Uni, you just can quickly pop it in the microwave and then you can eat, and it saves you a bit of time"

"The thought of meal prepping like meal prepping, how it's portrayed on social media, it's always like you have all these varied meals ready and they're all like in the freezer, you just popped them out and stuff like that. I feel like that's a little bit unrealistic because it's costly and also just generally space wise, I couldn't prepare meal for like a whole week. But with the base meal I just had like the chicken and veggies ready and then I could just cook |

	the pasta in like 5 minutes. So, it's like I it was obviously partially prepped meal, but it was perfect because then I was also able to like, create new meals at the same time instead of having like 3 portions of the same thing. I could have like pasta and then I could make like rice with it"
	"I've kind of done batch cooking before, but not the meal prepping in terms of the base meal and then doing different ones I think it's really useful"
	"I think since being a fourth year, I've actually started meal prepping a lot more specially lunches. it's very useful as a tool for being university in everyday and working as well"
	"I've always sort of meal prep anyways, but it was not really meal prep more of like batch cooked. but I didn't actually learned sort of plan what I would use that those specific ingredients for different things about the week"
	"I think I found it quite useful with the meal prep because I did it at the weekend. So, then I prepared, like my lunches for the next two days"
	"I think I've learned making meal prep in a different way that hadn't before"
	"I was able to like, create new meals at the same time instead of having like 3 portions of the same thing. I could have like pasta and then I could make rice with it and then have wraps"
	"I have very little like space in the fridge and the freezer. I feel like that's the hardest thing for me like I would be if I could prep more and freeze more"
	Tools and references for recipes
Do you feel you would be able to continue this without help? If no, what kind of help do you think you need?	**Using tools provided** "I think I will be able to continue without the help because all the sources like for all the tools that you gave to us. Like look for recipes or maybe what can I do with the ingredients that I have? What can I buy? So, I think that is really helpful. So, I think that I should be able to continue without help. Just thanks to all the tools that you gave to us and everything." "I think you gave us some good resources this week. I used BBC good food, so I definitely use them again in the future and so I think I'll be able to continue without help." "It would take some effort to stay consistent with the meal prepping, but I would try with the resources. I think it provides variety to help keep meals interesting " "with the web page that you gave to us that we can use and put the ingredients we have and then it gives like a recipe. I think that will be easier as well." **Another research** "I think if I did some research on some different recipes for different base meals, I could probably still do this without help" "I feel like I'd be able to continue what I was doing without help. I guess one thing that I probably do first is maybe like try and like research different recipes to get other ideas of like what I could use as like different base meal and what other meals I could make out of that"

"I think I'd like to continue to use different recipes and shop based on those recipes because it does make it a bit easier."

"Finding some other recipes, I think would be good as well"

"I think it made me think a bit more about doing extra research myself. Like if I was thinking about what to cook, I'll actually go and have a look and look at recipes more than I used to."

"The only thing is I'm trying to figure out ways to change up the base meal, so I even Googled it yesterday because I was trying to figure it out as I don't want it to get boring. So, I was just trying to figure out like other base meal basically that I could use with like similar ingredients that I still have, and maybe something instead of like fake chicken"

"I think it definitely takes some thinking, sort of like a said planning what to do. but I think my plan is to use a meal that I've made normally and then sort of think of what I usually have leftovers and go from there. So, I think it'll just take a bit of thinking"

"I think I would say more help, that would just be me being lazy and asking for more recipes or more types of other things I could do and so I think if I was sort of left on my own, I could potentially look for. I guess it's just looking for recipes that have the same ingredients and then you know being able to transfer them over and across. But, I mean, it's always nice for someone to just give you a bunch of different recipes that you can use"

"I probably struggle most with coming up with another base meal that's different to what I've had this week and what combination of food I could use and probably I'd want to go for a different protein source rather than chicken because I wouldn't want it to have chicken every week and what else I could use instead would probably be my challenge"

"I think I could continue to use the base meal and then edit it kind of daily to make it a bit different. But I think I would get bored of having the same flavor every day even if the ingredients are the same. I think I'd change it up to be maybe a creamy dish and then tomatoey dish to use the same ingredients to make a different flavor"

	Nutrition knowledge	Using spices to make different dishes
What else would you like to learn?	"Maybe things like what you could substitute. So rather than chicken how much, I don't know, like chickpeas, you might want to use and then how that alters the nutritional values, and then like other things that you may have, you know cupboards like stock items that you could. So maybe like learning about all that alternative ingredients you could choose" " I think maybe suggestions for alternatives if you run out of chicken but you still want to use some kind of protein if you have like chickpeas you can use this or if you have like these things this would be like a similar nutritional value or exposing you	"Maybe using sort of like a base number of spices that you have. Then you can make the meals a bit different. So, it's the same veg, same everything. But then one day it's sort of like Italian dish with some mixed herbs or another dates, got soy sauce. It's like to make them a bit more different in a cheap way because you can have herbs for ages" "The spices thing, because I think when you go to the shops, there's like 50 lined up or whatever and like I know a few from home, but there's a lot more that I like haven't tried

	wanted to adapt to the meal if you wanted to make it for someone that was also a vegetarian or had different diet requirements like how could you change them and how would it affect the nutritional value I think would be useful" "I think one of the things that I always find quite difficult and could do with like help with this working at how long food can last and so like in terms of if you're wanting to meal prep, if you wanted to buy chicken, how long could your meal prep? If you cooked at home for many days, could that then be eaten for after or before you cooked it? That sort of thing to work out" "Planning and stuff like anything to that, how long? Roughly? These things" "Knowing that like the protein percentages of like different stuff" "I was thinking, just like learning as a student is good that you're actually eating, but also figuring out how to eat healthy. Like what healthy means? That's good. it was this week was really good though." "I guess figuring out how to plan healthy meals because I can, like, plan meals, but I don't know how healthy they were. but then the study obviously gave like an in depth like coverage of the calories and the fiber and that kind of thing, which would be really helpful to know if I'm if I'm supposed to be eating healthy" "I think the quantity for one person who could be also healthy" "Educate students on how to eat properly, it's just good to give them parameters of like you should have five different vegetables a day and you should not have more than like 20 grams of added sugars and stuff like that"	before. So, I don't really know what they would go with" "Some like suggested combinations that go with the vegetables and like that go different combinations of vegetables so you can mix it up every day with different flavors that you add in, but then you can, like, prep that ahead sort of thing"

3.6.2 Focus group discussion results from the budgeting week

Questions	Thems
	Categories
	More cautious and stricter with the budget
How did you find the budgeted card provided? Was it useful?	"Because I knew I only had £20, I was really careful on what I did pick up to buy and at the end when I came to scanning at all, I kind of listed it in priority and have some items which I couldn't have because it would have gone over £20.00. So, then I had a look at my recipes and saw what I could substitute instead. So rather than buying like other vegetables, I would use some leftovers from the ones I've already purchased" "I was more careful while I was actually shopping to make sure I wasn't spending unnecessary amounts because I guess if you're just buying it normally. You haven't really set a certain amount that you can spend. It's really easy to be like oh, just buy that. It's like a couple of pounds more but the difference will that make whereas when you're a bit more careful with that, meaning overall. If every time I thought about it, I buy something cheaper than probably make quite a big difference." "I think the limit really helped for me as well because I knew how much I could spend" "I think it helped me to be just like a bit stricter of myself with what I was picking up and like what I was buying and comparing. I think before I just did that oh looks nice, I'll just get that. But, with being I think that would be a bit straight to it and the stick to like what I've actually planned." "I find it really useful. I thought it was good because I literally went through as I was shopping taking note of everything I bought, and it made me much more aware of how much things cost and what things I could afford or what things were better price for money especially." "I quite liked having like a set amount that we had to stick to because usually I just kind of get things as and when I need them, and I don't really look at the amount until the end when I've put in all my list that I've created through the week." "It made me think more about what I was buying and rather than just getting everything, I wanted sort of realized all that's over budget. So, I should probably cut out some of the less important things that are sort of like treats not actually needed." "I think because we were given the limit of £20, I was kind of the mindset that I wanted to maximize those £20, which I think was quite good. So, I just tried to get as much as I could in that budget, which was useful" "I thought the budget amount was good because, I usually just like buy what I need and then take stuff off at the end. The only thing I struggled with was in store, adding it up as I was going, and then I ended up sort of going back on myself quite a lot, realizing that I could afford more than I initially got. so, perhaps in the future, I would like budget a bit more looking at the prices before I went in the store"

	"I think having the set limit to like work towards definitely helps you like stick to your budget, and it's kind of almost like a challenge you want to get it in that £20.00. So, I think that was good." "I think this is the amount of money I spent. It made like I think I was able to make food that like lasted for more meals than what I normally do." "I found the card budget a little hard because I couldn't go above the budget it meant that I had to remove some items that I would have liked to buy for prioritization."
	Spending less money and eating enough
Have you bought a variety of foods in sufficient quantities and spent less money than usual?	**Sufficient food** "I definitely spent a lot less money and I think I did have sufficient quantities" "I would definitely say I spent less money than I would usually, definitely" "I definitely had enough food and probably have spent less money because it was far more controlled than usual" "I think I definitely had sufficient food quantities." "I think I bought quite a lot of large quantities like lots of carrots to make soup and stuff, so I did spend the whole amount, but then normally I probably spend about 12 to 15, maybe a week if I don't need to stock up on more expensive items." "I definitely bought a lot of food and because I was able to make some like healthy snacks rather than just relying on pre bought stuff which can actually be quite expensive." "I bought a lot of different stuff and I feel like I bought more cheaper stuff than I normally do" "Definitely. I think I feel like the food that I bought is healthier than what I might buy normally. and I think the meals that I made were healthy and I felt it was sufficient. So, like, I didn't feel hungry at all after like the meals that I made." "I was able to make some like healthy snacks rather than just relying on pre bought stuff which can actually be quite expensive." "I feel like the food I bought could last me about 1 week because I eat quite big portion sizes" **Variety of food** "I think the only thing I struggled with was the variety because it was easier to buy, like bigger packs at the same thing for cheaper that would last me longer. So, I'd end up with quite similar meals and even though they were changed slightly, they were still relatively similar. But other than that, was still nice and everything a lot." "I was using lots of the same vegetables and the same bases at least probably less variety because as using kind of similar base ingredients. So, I was able to buy things in bigger packs because it was more economical but actually probably less variety of foods." "I guess I didn't have some of my foods I could have made more effort to be a bit have a wider variety, but I think I often a kind of I made one big meal and then had like the leftover portions that I probably could have changed those a bit more. But I did like the food that I made. So, I didn't mind having I guess a

	similar one for a few days in a row, but I definitely had a kind of quantity of food."
	"I've I bought quite a variety of different foods. I've bought vegetables, meat, and carbohydrates, and obviously I use like, some of the stuff that was leftovers from the week before, which I found quite useful"
	"I definitely bought a lot of food and because I was able to make some like healthy snacks rather than just relying on pre bought stuff which can actually be quite expensive."
	"I don't think I bought food it was out at any point. I actually had breakfast, lunch and dinner like every day. So, three meals, this week. So that's really good."
	"Definitely. I think I feel like the food that I bought is healthier than what I might buy normally. and I think the meals that I made were healthy and I felt it was sufficient. So, like, I didn't feel hungry at all after like the meals that I made."
	"I was able to make some healthy snacks rather than just relying on pre bought stuff which can actually be quite expensive."
	"I didn't buy as much of a variety that could create a larger meal or to last longer"
	"I think I got quite a few different meat groups like some and some sausages, and there were really cheap to get because they already are frozen"
	"I definitely bought a lot of food and because I was able to make some like healthy snacks rather than just relying on pre bought stuff which can actually be quite expensive."
	"I didn't expect to make the meals that I did because it contained meat, and for me that was something like kind of expensive"
	"I think I was trying to buy fish this week to get protein which I don't always do. So, I think that I spend all the budget this week, whereas on a normal shop, I'd generally spend a bit less because I don't have the fish."
	"I would say that I spent more like price per meal this week because I was able to buy more expensive ingredients and like I bought meat, which I never buy meat for the week, whereas normally I'd probably be able to do my lunches and dinner for around £15."
	"I guess it comes down to money and especially having meat or fish for lunch feels like an extravagance. So, I could have vegetarian meals instead. But I think definitely this study has taught me that I can like include a lot more protein in my lunches and feel fuller for longer, for actually not that much more money than I thought."
	Eating generous amounts of meals with £20
How many meals were you able to make with the voucher card?	"I had enough food for five separate recipes, but each of those I probably had at least two servings, so which I had father for another dinner or lunch. I'd say probably 10 to 11 meals from £20. " "I found that I could make sort of 5 meals and most of them were like sort 2 portions"

	"I think I was able to make 10 meals. Well, I made really big serving sizes. Like, if I'd make one meal, I'd like to make it two or three times. So, I think that really fed me over a bunch of meals. Also, I use some of the ingredients from the previous week, like the frozen beans and the frozen peppers. So, it really liked helped me"
	"I've made about 10 portions of meals so far and then I have enough because I only went shopping on Saturday. I have enough that I think I'll probably make about four more as well, and from the £20 services kind of lasted a long time."
	"I made at least six meals and then obviously I have like some things leftover as well"
	"I was able to make 5 meals. I also make breakfast and eat some snacks during the day and well this is without counting like the leftovers from the last week, but I think that I was able to like for five days perfectly with the £20."
	"I've still got quite a few foods leftover, but I think so far, I've made about 6 meals and then I've made quite a few lunches, I'd say like. You know close to maybe 15."
	"I made breakfast, lunch and dinner for every day and I think I still have loads of the base meal and I still have one last lunch left and I still have one breakfast left, so that's good about 18 meals."
	"I made 20 meals because I planned for four different meals with 5 portions of each"
	"I made about 9 portions of main meal and then probably 10 to 15 portions of snacks, and then five days of breakfasts."
	"I made 10 main meals and then four days' worth of breakfast, and then a couple of snacks as well."
	"I have made 11 sorts of like main meal, so dinner and lunch, and then for breakfast out of the money."
	"I think 6 meals was probably pretty good for the money we were given."
	"I kind of understood. How many is like would be able to use, especially with the leftovers from what we had before, and I think 6 meals was probably pretty good for the money we would give"
	Inspiring and confident
Were you expecting to be able to prepare those meals on the given budget? Why?	"I was kind of inspired, I guess from the previous week because I knew that shop was £17.00. So, I thought that I would be able to make the meals."
	"I didn't expect to make the meals that I did because it contained meat, and for me that was something like kind of expensive. But when I kind of organized what I was going to buy I was able to buy ingredients for a specific meal. So, I just think it was just organization what I needed."
	"Not really. When I was buying the food, I kind of planned the meals, but I'd planned on like to last a week. I didn't think they'd last further, but I think once you make it, you kind of realize there's actually quite a few portions you can get out of 1. So, like some of the portions I made that I thought would last like two nights. So, it spreads a lot further, which is good"

"I think so technically out of the £20.00 and making more than the meals that I prepared. That's crazy."

"I was surprised by using cheaper ingredients like carrots or broccoli for soup. You can make a lot of quantity for not much money."

"I think I made more than I expected because usually I would make these sorts of things like I'd prepare breakfast or meal prep lunches or dinners, but not in one week. So, I think the fact that I was able to do it all in one week. It was quite a lot of food"

"I think I kind of knew that I was going to make quite a few meals, but I hadn't really thought about it. like, added it up. So, I think when you do it this way and then you add it up the end, you kind of reflect and realize actually you've made those of food."

"I would say that I was surprised. I sort of like the calorie content of the meals that I could make, and which is meant that I haven't snacked and really at all this week and which is good"

"I think I did better than I expected"

"I think because from the previous week when we've been given a bag and we knew it only cost around like £17. I made a lot of meals from that, and I had some food leftovers. I think after that I felt confident that I could make enough meals within the £20. But I guess before that I would have thought maybe I couldn't have made so many."

"The fresh vegetables and meat and things I would spend about £25.00. So, I kind of understood how many is like would be able to use, especially with the leftovers from what we had before, and I think 6 meals was probably pretty good for the money we were given."

"I think I'd like to continue to use different recipes and shop based on those recipes because it does make it a bit easier."

"I think I did better than I expected, like going to the shop, cause normally I buy stuff I don't need. But I feel like I was based on the food you gave us the week before. I felt like I stuck to that. Quite good"

	Lack of planning in budget	Motivation
Do you feel you would be able to continue this without help? If no, what kind of help do you think you need?	"I think causing quite a bad habit of like popping to the shops every few days. But now I've realized that some extra time planning meals and thinking about what you're going to purchase and what you've already got in, like your store covered at home. You can probably make more than five meals on the budget given. And I can do that probably going forward now as well. There's always undisciplined with not going to the shops, and, planning in advance" "I think I just realized that if I do take time to plan in advance, then I can make it last longer. I think, this would be good if I could set it aside. Sometimes you just plan for the week ahead,	"I think it would be hard to maintain motivation I think is the only thing I struggle with because sometimes you want to cook a set of meals and try to make It work around that maybe. So, I think probably being all the motivation than anything that I'd struggle with." "I think the only problem is that I just need to have the motivation to continue to do it,

	whereas before I think I wouldn't plan as much and then it would end up being more expensive because I'd be buying things that I didn't need or didn't kind of fit within the meal, but I think now from this like I think I'll be able to continue without much extra help"	but not if I actually put myself to it, then, definitely"
	"The thing that would like to stop me is deciding what meals to make for the week because I just can't predict what I would be in the mood for something or what I'd feel like eating or how much time I'd have to cook. just like deciding which I struggle with a bit, but I think with that tools I don't require more help"	
	"I feel like I was based on the food you gave us the week before. I felt like I stuck to that quite good. So, I think I'd be able to continue without help"	
	"I'm not sure I'd do it to this extent because it took up a lot of time meal prepping, but I definitely will use all of the like ideas and sort of implement it."	
	"I think like more organization before I just wing and just buy whatever food like I thought I might need. But like before we went, I was thinking about like recipes and what I'd like to do. So, I thought I planned before that I was going to do the base recipe, so I knew what I needed. So, I think that's a skill I had more organization and more planning."	
	"How do I say I got better? basically organizations really good and just generally just like food shopping or like shopping smart. Which is good definitely. But I mean it's not actually just like oh let's have a budget. It's the sticking to it. That make a difference."	

Managing money more wisely

Have you found any differences in your budget? Were you able to manage your money more wisely? (Please describe)	"I think having the card definitely helped with budgeting because there were some things in the recipes that only needed a whole 3 tablespoons of peanuts for example and a whole bag was £1.60 which out of 20 pounds is quite a considerable percentage. So, I ended up kind of substituting that was something I could use for another meal instead. So, without the budget I probably would have just bought them and not really thought about. So, what else could I have used them for and do actually have the money to do that. So, I would say I probably have managed my money more wisely"

"I think having the plan of like my meal plan has helped me to manage my budget more, so I think before, I didn't have a plan of what I was going to eat so I walk pass the shop on my way home every day, then it is easy to just kind of go in there, be like see what I feel like, and I think you do end up spending more when you do that. But now when I knew I already had a plan and a meal ready that I did it, I didn't feel like I need just to kind of go in the shop for no reason. So, I |

think that helped stick to the budget and spend less than like what I would normally do"

"I did find myself like getting more, like on offer items when I was at the shops at to really kind of extend how much food I could get within the budget and I found it really useful to make me more aware of how much I could get within the budget because I was really thinking when I went shopping, you know, how to make the most of the money I have, especially when it came to like buying frozen items which I thought. Well, obviously cheaper than the fresh items and could last longer. So, I think it did make me use manage my money more wisely. Definitely"

"I think having the fact that it was a £20 budget, so if I saw like a certain food like I saw the sausages but like the fresher sausages. Umm, I would like to wait to see if I could get a better price, whereas normally, I just pick them up, but I feel like the differences in the budget I was able to get a lot more for less. Actually, like looking at the price per kilo for everything"

"To be fair, in my weekly budget, I didn't realize how much money I was spending on silly food. So, I wasn't eating properly, and I would like to go to Tesco and buy whatever. It just wasn't working. Definitely. I didn't realize how much money I was actually spending but having only the £20.00 this week how to buy that or to spend that money was just really helpful."

"I think by planning the kind of specific meals I'm going to make with my food, it helps you to manage the budget a bit better because sometimes I kind of just add lots of things to my basket and then don't really think about what I'm going to make with them. So, planning it does definitely make you use it better. "

"I think I'll give myself like a top budget from now on because I do think it cuts down on me buying things that aren't really necessary so. I think I will probably end up spending less just because I won't buy stupid things and whatever I do buy is actually useful. I also want to end up utilizing my covered a lot more because with a budget, I knew that I couldn't just buy extra things that might not be needed. So instead, I was like oh, I've already got rice. I've already got past the there's no point getting something else to go with a meal because that's just extra money when I've already got stuff."

"I think having the set limit to like work towards definitely helps stick to your budget. it's kind of almost a challenge like you want to get it in that £20.00. So, I think that was good."

"I was probably managed my money a bit better having that set limit to work to."

"I do more of a bulk shop to last me longer, but I don't necessarily meal plan and buy according to what I am going to make - I think going forward, having my meals in mind will help me to reduce how much I spend. also trying not to buy little things when walking into Tesco but I think this helps by eating 3 times a day so that I'm not hungry and therefore impulse buying"

	Shopping skills	Improving cooking skills
Have you developed any skills that you did not have before?	"I used to like looking in the cupboard before going shopping and making sure. I took a paper and pen with me. So, if I was thinking about the stuff I needed. I wasn't just buying off the top of my head, but also was aware of like things I had	"I think I would say I developed some skills of, like, adapting meals. I like how you can add things whatever your base meal is to completely change it

| **What are they?** | in the store covered already, so I wasn't purchasing them twice."

"I used the scan and go handset in Asda for the first time which was really useful for keeping to my budget. I was able to see how much I was spending as I was going, which I found really helpful, and I hadn't used this before. I think being better at planning ahead before my shop is a skill I have improved"

"I'm not always would have considered myself quite good at budgeting, but I do think the skill of making sure I have a list every time I go shopping and not always picking up the like the first item I want, but also checking other brands and different produce that could be cheaper. I think it's definitely a skill I've learned"

"Before I just wing and just buy whatever food like I thought I might need, and I wasn't thinking about like recipes and like what I'd like to do. So, I think I plan before that I am going to do like the base recipe, so I knew what I needed. So, I think that's a skill. I have more organization and more planning."

"Basically, organizations are really good and generally just like food shopping or shopping smart. I mean it's not just like let's have a budget, it's sticking to it. That make a difference."

"Having written a list especially beforehand was really helpful. So, I knew which food I could actually get to have a variety of different foods"

"I think also kind of like making shopping lists and things will be helpful"

"I quite liked having a set amount that we had to stick to because usually I just kind of get things when I need them, and I don't really look at the amount until the end when I've put in all my list that I've created through the week."

"It made me think more about what I was buying and rather than just getting everything, I wanted sort of realized all that's over budget. So, I should probably cut out some of the less important things that are sort of like treats not actually needed."

"I think because we were given the limit of £20, I was kind of the mindset that I wanted to maximise that £20, which I think was quite good. | or to change it quite a lot. So even though you may be eating the same sort of food. It's doesn't taste the same, and so it's a bit more interesting"

"It was more like I can cook for maybe one day. I can repeat with different presentations. For example. I was like there was that you gave to us with the chicken and the vegetables. One day I had it with spaghetti in the next day I had it with rice. The next day I had it like Qussidia and it tastes really different. So, with that I learned that if I make something or maybe for four days and I can reduce with different complements and it's just totally different the flavor. So, I will not get four of the same things."

"I searched for more recipes and tried to follow them and cause a lot of the time before. I just kind of make pasta or noodles or rice and just kind of throw everything together and following the recipes makes you make more kind of variety of food and stick to the budget as well."

"Cooking a variety of different meals and having different meals that I can eat throughout the day. learned how to transfer food from one meal to another - e.g., turning leftover pasta sauce into a wrap."

"I found myself improvising with leftovers. I think it's challenged me to actually look at what I've got leftovers. So, I made French onion soup from the onions last week because it actually requires like minimal ingredients, and I found I actually had everything else in the pantry and I probably wouldn't normally think to do that. I'd just sort of leave them |
|---|---|---|

|	So, I just tried to get as much as I could in that budget, which was useful."	in the fridge and then eventually I'll use bits, but they probably won't end up using them all. So, it has made me more aware of, like how to use them wisely."
	"I thought the budget amount was good because I usually just buy what I need and then take stuff off at the end. The only thing I struggled with was in store, adding it up as I was going, and then I ended up sort of going back on myself quite a lot, realizing that I couldn't afford more than I initially got. So, perhaps in the future, I would like budget a bit more looking at the prices before I went in the store"	"I learned better how to use my leftovers and like, improvised new things like, planning meals and stuff. It's good practice this week."
	"I think the skill I learned this week was calculating the cost of the food as I went along"	
	"I learned that I could buy frozen food that I had never thought about it - having frozen veg I think will last so much longer for me, especially because I normally shop for 2weeks worth of food "	
	"I feel like the differences in the budget I was able to get a lot more for less. Properly looking at like the price per kilo for everything"	
	"I was shopping taking note of everything I bought, and it made me much more aware of how much things cost and what things I could afford or what things were better price for money especially."	
	"I Improved like the budgeting because I usually would go to the shops a few times a week, whereas now I've realized you can actually just go once and have enough ingredients"	
	"I bought cheaper stuff than I normally do, like when normally I'm on campus and I'd, you know, be tempted to buy like meal deals and stuff. I was thinking more about like oh no, I have nice food at home, like I'd rather go home and have that food. So, I thought that was good"	
Long-term budget for food	
What else would you like to learn?	"I did think maybe it would be good if we could do some like. To that big meal, prep things and whether we can include like a long-term budget. So, for things for example earlier when I was talking about like if I bought a huge bag of pasta that would last me a month and I don't know how I would incorporate that into my budget because obviously I wouldn't have to buy past, but then I'd have to buy other things. So, kind of incorporating the kind of the produce that lasts longer into a budget"	

3.7 Photos of some meals made by students during the intervention weeks

3.7.1 Meals were made by students during the cooking week.
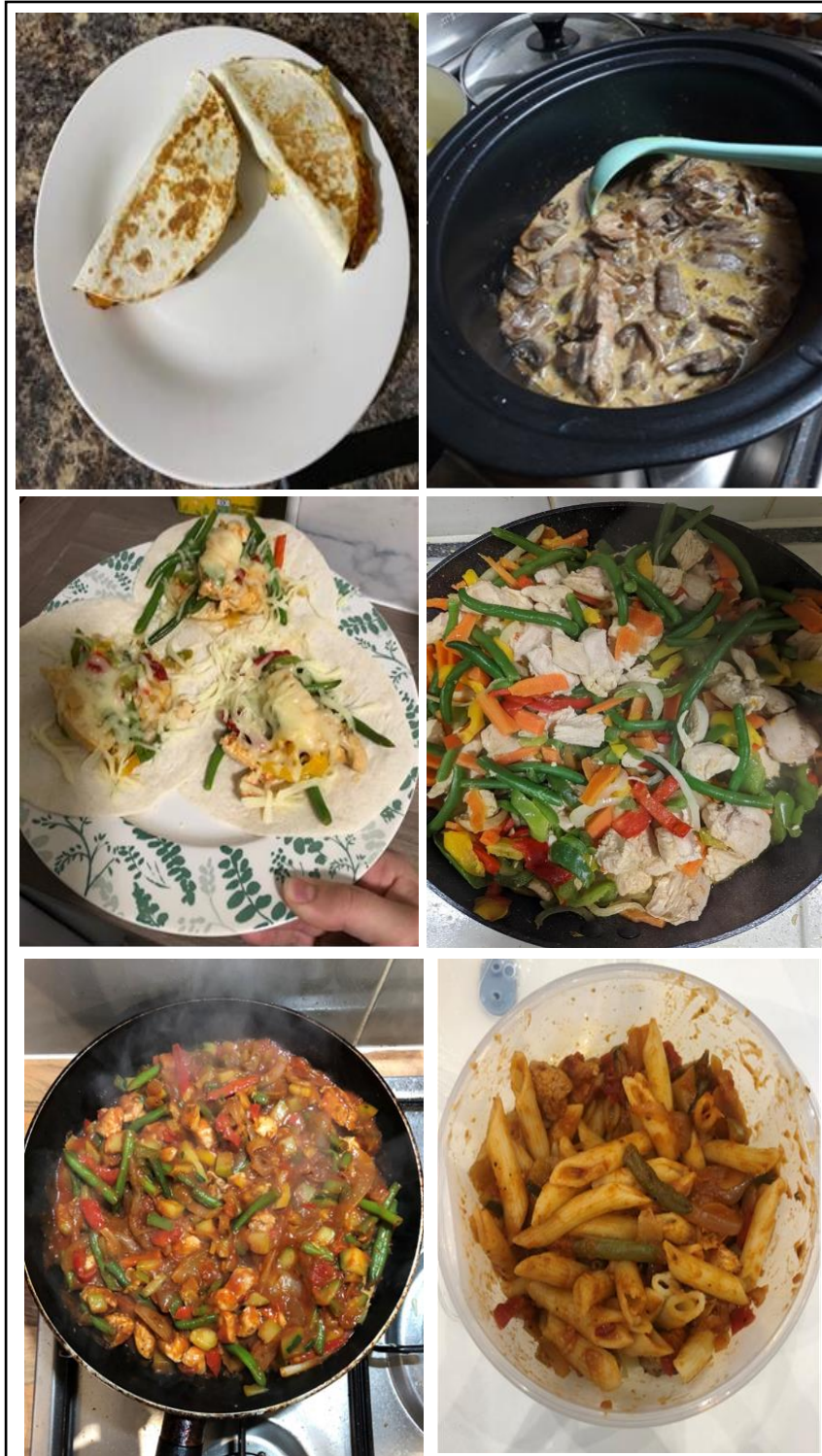
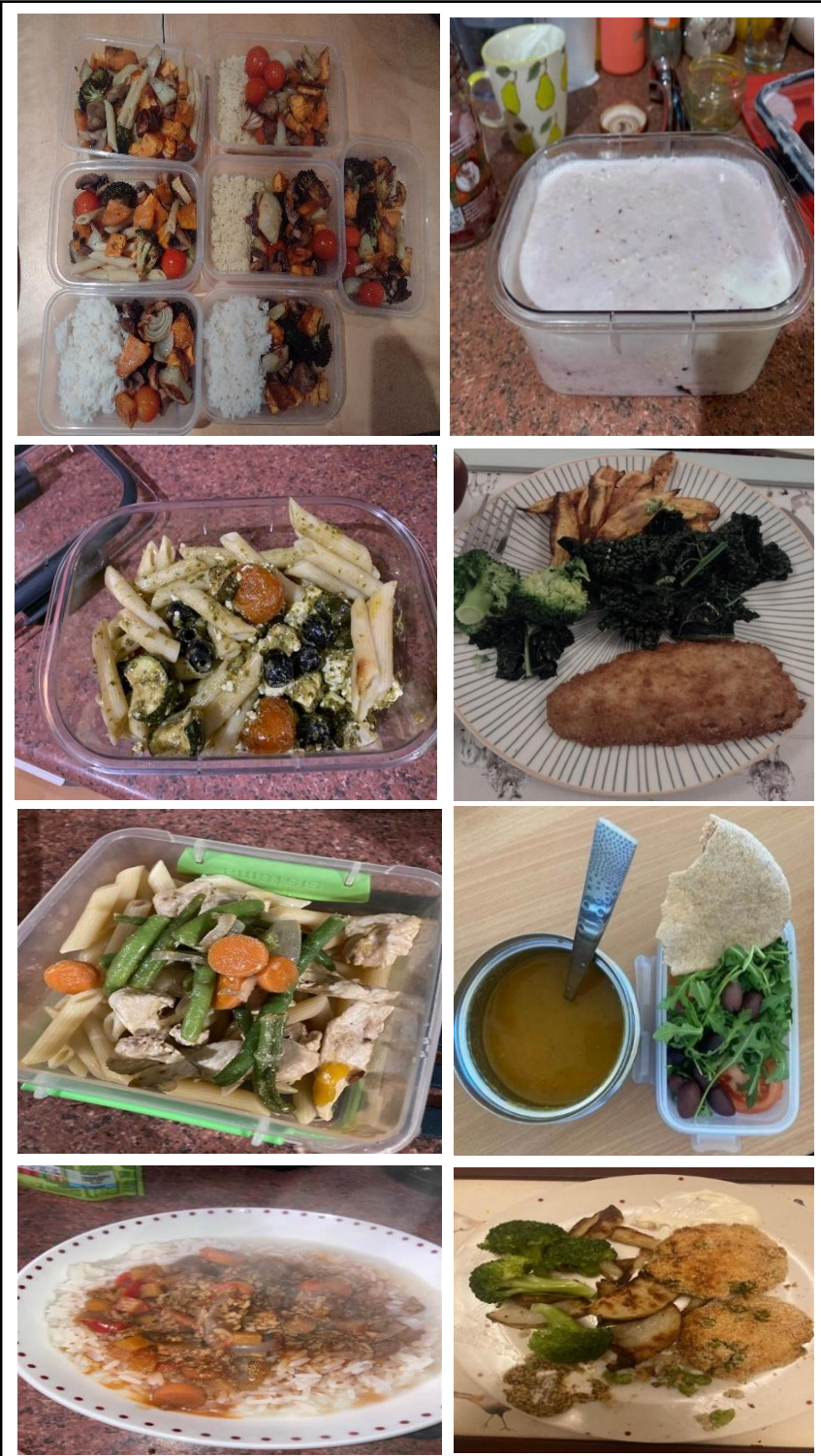**3.7.2 Meals were made by students during the budgeting week.**
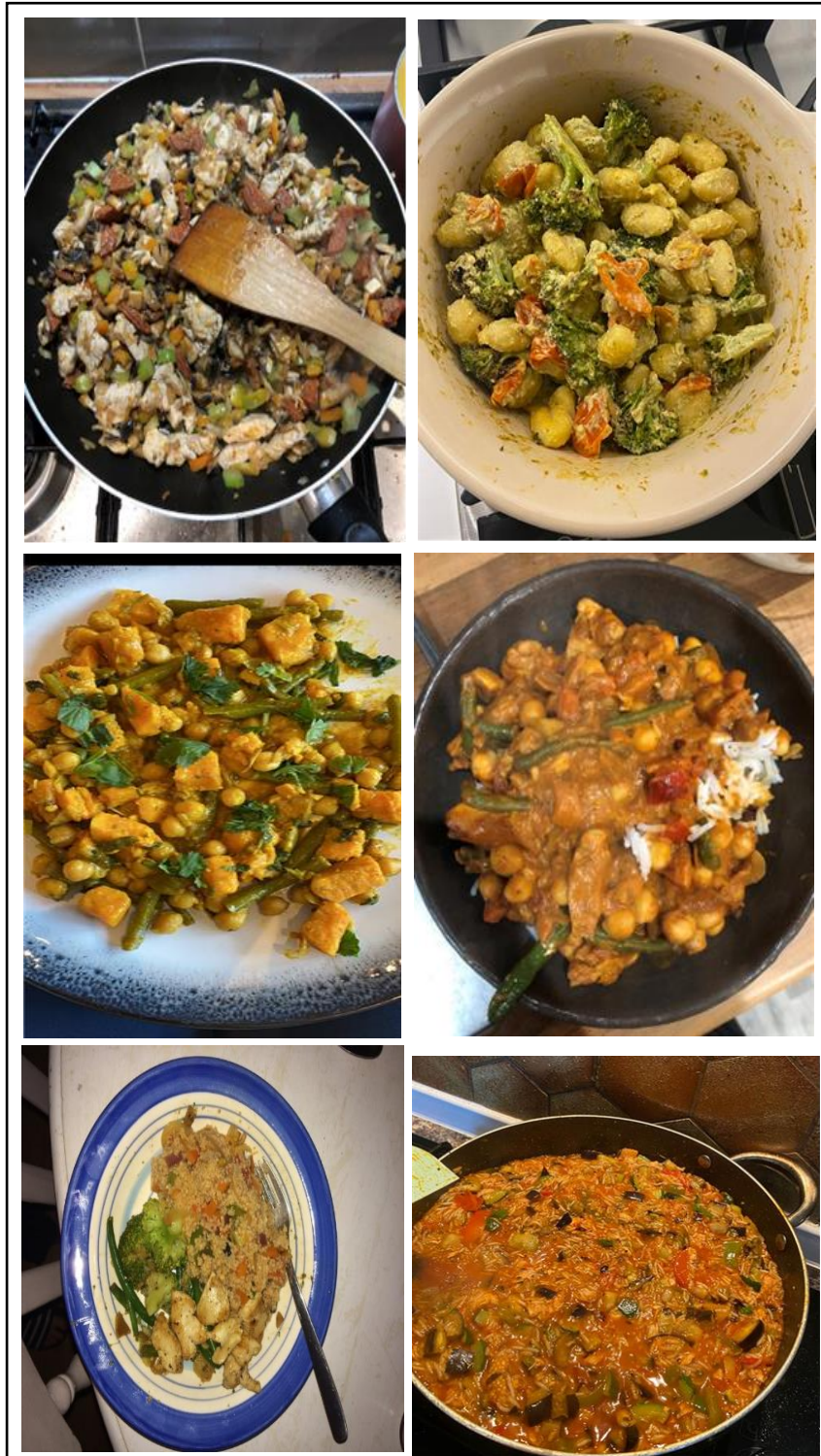
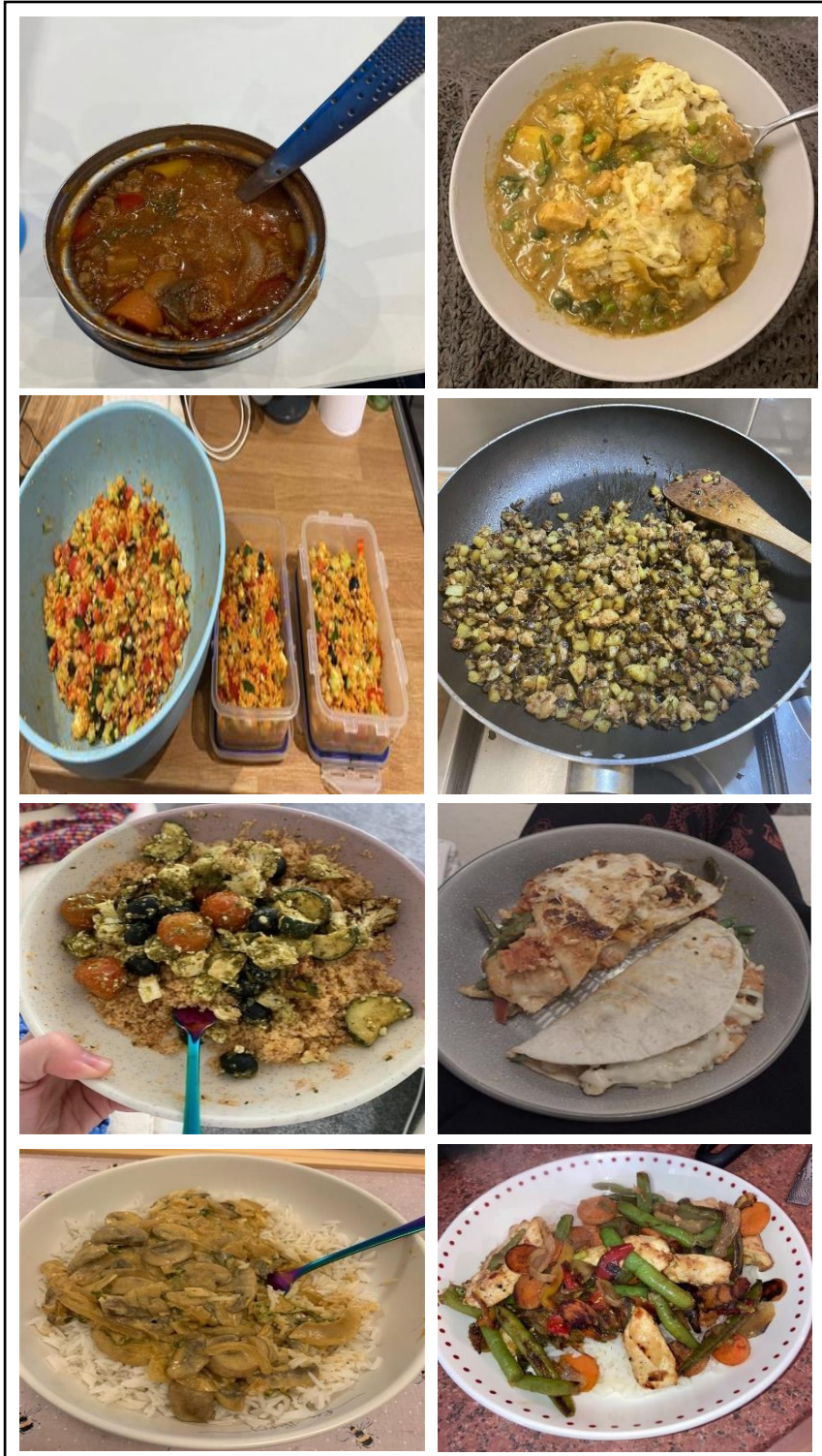### 3.7.3 Meals were made by students during the practising weeks.

4 Publications

4.1 Paper publication

ORIGINAL RESEARCH

Nutrition Bulletin

Assessing the prevalence and potential drivers of food insecurity and the relationship with mental wellbeing in UK university students: A cross-sectional study

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Abstract

Food insecurity (FI) among university students in the United States has been associated with poor mental wellbeing, but very little is known about the relationship between FI and mental wellbeing in the UK university population. Here we examined the prevalence of FI, determined potential drivers for it and its relationship with mental wellbeing and coping ability. Students studying at UK universities ($n = 289$) completed an online self-reported questionnaire to obtain socio-economic characteristics including financial status, FI status (Household Food Insecurity Access scale), mental wellbeing (Warwick-Edinburgh Mental Wellbeing Scale) and coping ability (coping flexibility scale). FI was observed in 28% of the participants and was associated with financial independence, running out of money, borrowing money and lacking confidence to purchase healthy foods ($p < 0.05$). Although we cannot determine directionality, logistic regression analysis revealed those who were judged as FI were more likely to shop often (OR = 3.139 95% CI 1.533–6.429), never snacked between meals (OR = 4.261 95% CI 1.309–13.875) and the amount of food purchased was affected by perceptions of the price of food in general (OR = 2.954 95% CI 1.675–5.210). Financial instability and the inability to access nutritious food may contribute to the decrease in mental wellbeing ($p < 0.01$) and lower ability to cope with stressful situations ($p < 0.01$) in food-insecure students although the direction of these relationships cannot be determined from this cross-sectional study. This study has identified that there is a need to develop appropriate strategies to combat FI in university students and to improve mental health.

KEYWORDS
coping strategies, food insecurity, food security, mental health, university students, wellbeing

INTRODUCTION

Food insecurity (FI) is defined as "a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life" and has become a serious global public health concern (FAO, IFAD, UNICEF, WFP & WHO, 2022). The UK Food Security report revealed that approximately 7%–8% of the United Kingdom (UK) population were regarded as food insecure in the 2019–2021 financial year (Francis-Devine et al., 2023; GovUK, 2021). The doubling in the prevalence of FI (The Food Foundation, 2023) to around 17% since then is reinforced by the upsurge in the use of food banks in the United Kingdom with 600 000 more people using them in 2020–2021 compared to the previous year (Trust TT, 2022). COVID-19, the increase in the cost

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of living and limited financial resources are factors contributing to this rise in food bank use (The Food Foundation, 2021).

Although many population sub-groups are at increased risk of FI, observational studies conducted across the globe, particularly in the United States, Australia, Malaysia, Canada and Greece, have shown an increase in the prevalence of FI in those attending university (Ahmad et al., 2021; El Zein et al., 2019; Hughes et al., 2011; Oh et al., 2022; Riddle et al., 2020; Shi et al., 2021; Sprake et al., 2018; Ukegbu et al., 2019; Weaver et al., 2020). Globally, the prevalence of FI among university students is variable ranging from 12.5% to 84% (Bruening et al., 2017). However, factors associated with the development of FI among the university student population are not fully understood, although the limited studies conducted so far have outlined financial hardship, socio-economic status, race, sexual orientation, cooking ability and unemployment as the biggest predictors (Ahmad et al., 2021; El Zein et al., 2019; Hughes et al., 2011; Oh et al., 2022; Reeder et al., 2020; Riddle et al., 2020; Shi et al., 2021; Sprake et al., 2018; Ukegbu et al., 2019; Weaver et al., 2020; Wolfson et al., 2022, 2023). The increased financial burden of university study along with the lack of funds to consistently access affordable and nutritious food and unhealthy eating habits, may in turn negatively affect student academic performance, physical health and mental health including depression, stress and anxiety (Ahmad et al., 2021; El Zein et al., 2019; Hughes et al., 2011; Oh et al., 2022; Riddle et al., 2020; Shi et al., 2021; Sprake et al., 2018; Ukegbu et al., 2019; Weaver et al., 2020).

A recent study conducted for the Food Standards Agency in 2022 reported that four out of ten university students in England were classified as food insecure with the highest levels noted among students at universities based in the North West of England (Armstrong et al., 2023). Furthermore, one in ten UK university students were reported to have used a food bank during the 2021/2022 academic year (Brown, 2022). This could potentially be due to the 14% increase in living costs since 2021 related to increased tuition fees and the 61% increase in rent observed over the last decade (Unipol, 2021). Furthermore, 82% of students worry about making ends meet, while four out of five students thought of dropping out of university, with 52% of these thinking of dropping out because of money worries (Brown, 2022). Furthermore, a survey of 3500 UK university students in 2022 reported that 96% of students had reduced their spending, with some only having £50 a month to purchase food and other personal items after essential bills were paid. Of those who had reduced their spending, 92% reported that this had affected their mental wellbeing (NUS, 2022), although only one in five had had help with this.

There are currently over two million university students in the United Kingdom. These are the future global citizens, leaders and innovators, but very little is known about the prevalence or potential drivers of FI in those studying in the United Kingdom nor do we know the potential implications of FI on mental wellbeing. The evidence cited above shows that FI in UK university students is higher than the UK national average and may be associated with poor mental wellbeing and ability to cope in stressful situations. Here we aimed to examine the prevalence of FI in students studying at UK universities and determine the potential drivers and its relationship with mental wellbeing and coping ability.

MATERIALS AND METHODS

Ethical standard

This study was conducted according to the guidelines laid down in the School of Biosciences Research Ethics Committee at the University of Nottingham (SBREC2021_08). Completion of the questionnaire was taken as informed consent from all participants.

Participants

Students at universities across the United Kingdom were invited to complete an online questionnaire disseminated via email to the Nottingham universities and disseminated to the wider population via social media sites such as Twitter, Facebook and Instagram and a dedicated website. The use of social media enabled us to reach students at various locations in the United Kingdom, of different ethnicities and socio-economic status. All those over the age of 18 years old and currently studying at a UK university were eligible to participate to ensure equality and diversity.

Study design

A newly designed questionnaire consisting of 48 questions, taking no more than 20 minutes to complete was developed for completion online via mobile devices or computers hosted by online surveys (JISC, Bristol, UK). The questionnaire collected sociodemographic characteristics alongside food security prevalence, feeding behaviours including cooking skills, ability to cope and adapt to different situations, and health and mental wellbeing. These were assessed using validated tools that included the Household Food Insecurity Access Scale (HFIAS; Coates et al., 2007), the Coping Flexibility Scale (CFS; Kato, 2012), and the Warwick-Edinburgh Mental

Wellbeing Scale (WEMWBS; Marmara et al., 2022; Tennant et al., 2007). The survey was conducted from February to December 2021.

Measures

Sociodemographic and student characteristics

Sociodemographic data included age, gender, ethnicity, marital status, living situation and sources of financial support (family/parent, government/federal grants, scholarships, loans and/or other sources), employment and disposable income (income remaining following payment of essential bills). Student characteristics data included anthropometric measurements (self-reported height, weight, hip and waist circumference), type of university degree (undergraduate, postgraduate [research or taught]), degree subject, type of study (full time or part-time) and current grade band. We also acquired information on health behaviours including eating habits, consumption of alcohol, smoking and food shopping patterns.

Household food insecurity

FI was measured by the Household Food Insecurity Access Scale (HFIAS). The HFIAS is composed of a set of nine questions called "occurrence questions" and each question is followed by a frequency-of-occurrence question to determine how frequently the condition occurs. The participants were asked to choose the best answer that described their experience over the past 4 weeks. The responses to the occurrence questions are coded as No with 0 and Yes with 1, while the frequency-of-occurrence questions are coded as Rarely 1, Sometimes 2, and Often 3. The HFIAS scores are calculated for each student by summing the codes for each frequency-of-occurrence question. The maximum score is 27, and the minimum score is 0. Higher scores indicate more FI, while lower scores indicate less FI. We further categorised the data as food secure, mildly food insecure, moderately food insecure or severely food insecure following the guidelines published by Coates et al. (2007). This scale has been used in several countries with a wide range of populations including university/college students (Abu et al., 2023; Abu & Oldewage-Theron, 2019; Celik et al., 2023; Rizk et al., 2023; Theodoridis et al., 2018; Wagner et al., 2021), as this tool can distinguish household food security status across different cultural contexts. Furthermore, in the current study, the HFIAS showed strong internal consistency, with a Cronbach's alpha value of 0.805 in the sample. The information generated by the HFIAS can be used to assess the prevalence of household FI (access component) and to detect changes in the FI situation of a population over time.

Coping strategies

The ability to cope with stressful situations was assessed using the Coping Flexibility Scale (CFS). Coping Flexibility is defined as "the ability to discontinue an ineffective coping strategy and produce and implement an alternative coping strategy." (Kato, 2012). This scale has been used in several studies within adult populations, demonstrating that it is a valid and reliable approach. The CFS contains 10 questions divided into two subscales based on dual process theory; evaluation coping (e.g. I only use certain ways to cope with stress) and adaptive coping (e.g. when a stressful situation has not improved, I try to think of other ways to cope with it); each subscale has five items rated on a 4-point scale. Participants ranked how much each item applied to them over the last 4 weeks: not applicable 0, somewhat applicable 1, applicable 2, and very applicable 3 (Kato, 2012). The scale was calculated by summing the student scores, then presenting the results as a mean and standard deviation. Higher scores indicate more effective coping with stressful situations.

Mental wellbeing

Mental health and wellbeing were assessed by the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS; NHS Health Scotland, University of Warwick and University of Edinburgh, 2006). The scale was developed to assess the mental wellbeing of the general population and the evaluation of projects, programmes and policies that aim to improve mental health and not to diagnose disorders (Marmara et al., 2022; Tennant et al., 2007). The scale is a short and robust tool for monitoring mental health in populations since it can distinguish between different population groups in a way that is consistent with other population surveys and is relatively unsusceptible to bias (Marmara et al., 2022; Tennant et al., 2007). It has been validated for use in the United Kingdom with a large population sample over the age of 16 years, including university students, the general population and focus groups (Maheswaran et al., 2012; Tennant et al., 2007). The scale contains 14 items, and participants were asked to choose the best answers that reflected their experience with each statement over the last 4 weeks. The statements, worded positively, cover individual wellbeing and psychological functioning. The score is calculated by summing responses to each item answered on a 1 to 5 Likert scale, None of the time 1, Rarely 2, Some of the time 3, Often 4 and All of the time 5 and

then presenting the results as a mean and standard deviation. The minimum score is 14, and the maximum is 70. A high score is indicative of better wellbeing. The students' scores were classified by following the cut points approach of WEMWBS, where the top 15% of scores range from 60–70 and the bottom 15%, 14–42. However, we combined high-level scores with medium scores since there were fewer than five students in the high-level score category and most statistical tests, particularly Chi Square, require five or more observations in a group (Yates, 1934).

Data and statistical analysis

Only data from students who completed all questions were included in the data analysis. The food security questions were coded using HFIAS instructions that required summing the question codes, and students were classified into four groups: food secure, mild insecurity, moderate insecurity and severe insecurity (Coates et al., 2007). The CFS and WEMWBS were analysed by summing each individual item score using ranking orders and presenting them as means and standard deviations. The Statistical Package for Social Sciences (SPSS version 27; IBM, Hampshire, United Kingdom) was used to analyse the data. Descriptive statistics were used to summarise the sociodemographic characteristics. A chi-square (χ^2) test was used to examine the associations between FI and other variables such as sociodemographic, socio-economic and food and health behaviours. To determine any significant differences in correlations between HFIAS, WEMWBS and CFS, the independent T-Test was used. Binary logistic regression was used to assess the likelihood of a variable to be predictive factor for the development of FI; these included those associated with finance and access to food. The results were expressed as odds ratios with 95% confidence intervals (CIs). A p value of ≤0.05 was considered statistically significant.

RESULTS

Participants

A total of 289 students studying in UK universities completed a self-reported online questionnaire. Participant characteristics are presented in Table 1. The largest proportion of participants were between the age of 21–25 years old (45.7%), of normal body mass index (BMI; between 18.5–24.9 kg/m^2 [53.6%]), female (72.7%), of white British ethnicity (42.6%), studying full-time (91.3%), classed as an undergraduate student (63.2%) and living in shared housing (49.3%). Interestingly, most students classed themselves as financially dependent (62.7%), supported by their parents (70.5%) and not working (62.6%) or looking for work (60.8%). Furthermore, most participants had a student loan, which required repayment (67.9%). Most students reported a disposable income greater than £200 per month (43.3%).

Prevalence of food insecurity among UK university students

The HFIAS revealed that almost a third of the participants were food insecure (28%; Figure 1a). Further classification of those who were food insecure revealed that a third were mildly food insecure (32.1%), a third were moderately food insecure (34.6%) and a third were as being severely food insecure (33.3%; Figure 1b).

Sociodemographic characteristics based on food security status

There were no significant differences between participant characteristics, including sex, ethnicity, age, BMI status, accommodation type and degree level and food security status (Table 1). Our findings revealed that food insecure students were more likely to consider themselves financially independent (46.3%) compared to food secure students (33.8%; $\chi^2 = 3.793$, $p = 0.05$). Those who were evaluated as food insecure were more likely to be looking for employment (51.1%; $\chi^2 = 3.732$, $p = 0.05$) alongside their studies when compared to food secure students. In addition, there was a trend for food insecure students to have less disposable income, with 39.5% having less than £100 per month compared to the 46.1% of food secure students who reported having more than £200 per month although this did not reach statistical significance ($\chi^2 = 5.164$, $p = 0.08$). Moreover, food insecure students were significantly less confident in managing money to purchase healthy foods, with only 12.8% always having confidence compared to 25.6% of food secure students ($\chi^2 = 11.049$, $p < 0.05$). Food insecure students were less likely to have savings (53.2%; $\chi^2 = 5.240$, $p < 0.05$), and tended to borrow money often (21.3%, $\chi^2 = 12.699$, $p < 0.005$) compared to food secure students (67.9% and 12.3%, respectively). Overall, food insecure students were more likely to run out of money to spend on food (38.2%) compared to food secure students (11.7%; $\chi^2 = 34.061$, $p < 0.001$; Table 1).

Food behaviours, accessibility pattern and food security status

We observed that food insecure students were significantly less likely to eat three meals per day (42.0%) compared to food secure students (59.4%; $\chi^2 = 7.145$,

TABLE 1 Sociodemographic characteristics of the UK university students based on food security status.

| | HFIAS score | | | |
| | FS | FI | Total participants | |
Variable	$n = 208$ (72%)	$n = 81$ (28%)	$n = 289$ (100%)	p
Gender				
Male	53 (25.6)	25 (31.6)	78 (27.3)	ns
Female	154 (74.4)	54 (68.4)	208 (72.7)	
Age (Years)				
18–20	78 (37.5)	36 (44.4)	114 (39.4)	ns
21–25	100 (48.1)	32 (39.5)	132 (45.7)	
26 and above	30 (14.4)	13 (16.0)	43 (14.9)	
Ethnicity				
White British	88 (42.3)	35 (43.2)	123 (42.6)	ns
Black	32 (15.4)	12 (14.8)	44 (15.2)	
Asia	68 (32.7)	27 (33.3)	95 (32.9)	
Mixed	8 (3.8)	3 (3.7)	11 (3.8)	
Other White	12 (5.8)	4 (4.9)	16 (5.5)	
BMI				
$<18.5 \, \text{kg/m}^2$	19 (9.6)	9 (11.8)	28 (10.2)	ns
$18.5–24.9 \, \text{kg/m}^2$	113 (57.1)	34 (44.7)	147 (53.6)	
$25–30 \, \text{kg/m}^2$	34 (17.2)	20 (26.3)	54 (19.7)	
$30 \, \text{kg/m}^2$ and above	32 (16.2)	13 (17.1)	45 (16.4)	
Studying status				
Undergraduate	126 (60.9)	56 (69.1)	182 (63.2)	ns
Postgraduate	81 (39.1)	25 (30.9)	106 (36.8)	
Full-time student	193 (92.8)	71 (87.7)	264 (91.3)	
Faculty				
Science	92 (44.4)	34 (42.5)	126 (43.9)	ns
Social Sciences	64 (30.9)	18 (22.5)	82 (28.6)	
Engineering	27 (13.0)	14 (17.5)	41 (14.3)	
Arts	24 (11.6)	14 (17.5)	38 (13.2)	
Average grade				
N/A	40 (21.3)	12 (15.4)	52 (19.5)	ns
59% and less	24 (12.8)	12 (15.4)	36 (13.5)	
60% and above	124 (66.0)	54 (69.2)	178 (66.9)	
Accommodation				
Shared house	98 (47.6)	43 (53.8)	141 (49.3)	ns
Private sector (university halls/catered/ not catered)	53 (25.7)	19 (23.8)	72 (25.2)	
Live with family	39 (18.9)	9 (11.3)	48 (16.8)	
Live alone	16 (7.8)	9 (11.3)	25 (8.7)	
Financially independent				
Yes	69 (33.8)	37 (46.3)	106 (37.3)	0.05
No	135 (66.2)	43 (53.8)	178 (62.7)	
Job				
Yes	74 (35.6)	34 (42.0)	108 (37.4)	ns
No	134 (64.4)	47 (58.0)	181 (62.6)	

(Continues)

TABLE 1 (Continued)

Variable	HFIAS score		Total participants	p
	FS	FI		
	n = 208 (72%)	n = 81 (28%)	n = 289 (100%)	
Trying to find a job				
Yes	47 (35.1)	24 (51.1)	71 (39.2)	0.05
No	87 (64.9)	23 (48.9)	110 (60.8)	
Disposable income/month				
£0–100	45 (25.3)	30 (39.5)	75 (29.5)	0.08
£101–200	51 (28.7)	18 (23.7)	69 (27.2)	
£201 and greater	82 (46.1)	28 (36.8)	110 (43.3)	
Money spent on food/week				
£0–60	162 (80.6)	61 (76.3)	223 (79.4)	ns
£61 and more	39 (19.4)	19 (23.8)	58 (20.6)	
Financial support				
Parental	146 (72.6)	52 (65.0)	198 (70.5)	ns
Grants/scholarships	63 (30.9)	32 (40.0)	95 (33.5)	ns
Student loans	140 (68.0)	55 (67.9)	195 (67.9)	ns
Savings	131 (67.9)	42 (53.2)	173 (63.6)	0.02
Borrowed money				
Never	143 (70.1)	38 (47.5)	181 (63.7)	0.002
Sometimes	36 (17.6)	25 (31.3)	61 (21.5)	
Often	25 (12.3)	17 (21.3)	42 (14.8)	
Feel confident in managing money to buy healthy foods				
Never	12 (5.8)	12 (15.4)	24 (8.4)	0.01
Sometimes	65 (31.4)	29 (37.2)	94 (33.0)	
Most of the time	77 (37.2)	27 (34.6)	104 (36.5)	
Always	53 (25.6)	10 (12.8)	63 (22.1)	
Run out of money for food				
Never	130 (63.4)	22 (28.9)	152 (54.1)	0.01
Sometimes	51 (24.9)	25 (32.9)	76 (27.0)	
Most of the time	24 (11.7)	29 (38.2)	53 (18.9)	

Note: $p \leq 0.05$ deemed as statistically significant.

Abbreviations: FI, food insecurity; FS, food security; HFIAS, Household Food Insecurity Access Scale.

$p < 0.01$; Table 2), as well as being more likely to never have a snack between meals (12.3% vs. 3.9% food secure; $\chi^2 = 8.187$, $p < 0.05$). However, food insecure students were more likely to drink alcohol more than 2 days a week (42.5% vs. 30% food secure; $\chi^2 = 7.262$, $p < 0.05$) and smoke at least 1–4 days a week (22.8% vs. 11.6% food secure; $\chi^2 = 6.004$, $p = 0.05$). Furthermore, only 31.3% of food insecure students were always able to shop for food compared to 65.7% of food secure students ($\chi^2 = 32.811$, $p < 0.001$), while 24.1% of food insecure students reported that they had difficulties acquiring a variety of nutritious foods compared to only 6.9% of food secure students ($\chi^2 = 16.332$, $p < 0.001$; Table 2) potentially due to the distance to food shops (46.9%; $\chi^2 = 7.538$, $p < 0.005$), the price of food (46.9%; $\chi^2 = 16.605$, $p < 0.001$), and the availability

of food storage rooms and cooking equipment (28.4%; $\chi^2 = 4.411$, $p < 0.05$; Table 3). However, no significant differences were found between food insecure and food secure students in the frequency of fruit and vegetable consumption.

Effect of food security on mental wellbeing and coping flexibility

The WEMWBS revealed that a higher proportion of food insecure students had lower mental wellbeing (55.5%) compared to food secure students (44.5%, $\chi^2 = 4.398$, $p < 0.05$). The average WEMWBS score for food insecure students is categorised as being low mental wellbeing (WEMWBS score 14–42)
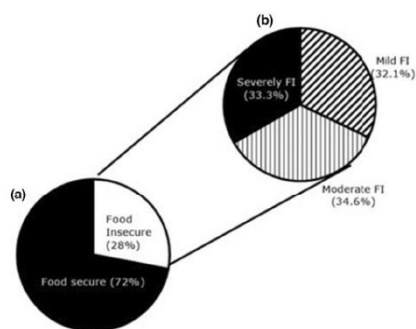
FIGURE 1 Prevalence of food insecurity in UK university students. Students were classified according to their household indicator access scale (HFIAS) score (Coates et al., 2007). Pie chart to show prevalence in (a) total population ($n = 289$) and (b) food insecure population ($n = 81$). FI, food insecure.

compared to food secure students being categorised as medium-high wellbeing (WEMWBS score 43–60; WEMWBS score (mean ± SEM): food secure 45.6 ± 0.86; food insecure 39.6 ± 1.5; t(df) = 3.496, $p < 0.001$, Figure 2a). Furthermore, we observed that those classed as food insecure had significantly lower evaluation coping compared to the food secure students (Evaluation [mean ± SEM]: food secure 12.06 ± 0.19; food insecure 11.27 ± 0.34; t[df] = 2.516, $p < 0.05$; Figure 2b), suggesting an inability to abandon any ineffective coping strategies. No difference was observed in the willingness to consider alternative coping strategies between the FS and FI groups (Adaptive [mean ± SEM]: food secure 12.27 ± 0.23; food insecure $12.04 \pm 0.0.35$; t[df] = 0.5169, p = n.s.; Figure 2b).

Potential predictors of food insecurity in students

Logistic regression revealed that the factors that remained significantly associated with FI were running out of money for food, less confidence in managing money to purchase healthy food, difficulty going shopping for food, ability to go shopping, dietary patterns including less snacking and perceptions of the price of food in general (Table 4). Those who shopped sometimes or often were three to seven times more likely to be food insecure (Sometimes: OR 6.564 95% CI 3.238, 13.303; Often: OR 3.139 96% CI 1.533, 6.429; $p < 0.005$), while those who never consumed snacks were four times more likely to be food insecure (OR 4.261 95% CI 1.309, 13.875; $p < 0.02$). Price of food was also a predictor of being food insecure with those

who found food expensive being three times more likely to be food insecure (OR 2.954 95% CI 1.675, 5.210). Financially independent students were more likely to be food insecure although this failed to reach significance (OR: 1.654 95% CI 0.912, 3.00; $p = 0.09$).

DISCUSSION

The purpose of this study was to examine the prevalence of FI in UK university students and determine the associated drivers and to explore the potential influence of FI on mental health outcomes, particularly mental wellbeing and the ability to cope in stressful situations. We found that in 2021, approximately 28% of the respondents were evaluated as being food insecure and although this is similar to the prevalence reported by Sackey et al. (2021) in the United States (28.5%), it is lower than that observed by Armstrong et al. (2023) who found that 44% of university students in the United Kingdom reported FI in 2022. This 1.5-fold increase in just 1 year indicates the need to understand the potential drivers of FI in university students in order to develop effective interventions.

Similar to studies conducted in the United States (Ryan et al., 2020), Australia (DeBate et al., 2021), and Malaysia (Ahmad et al., 2021; Bruening et al., 2018; Davitt et al., 2021), we found no significant differences in food security status according to demographics such as gender, ethnicity, accommodation, type of degree or subject. Although some studies have shown that FI impacts students' academic performance (Martinez et al., 2018; Ryan et al., 2020), and affects their ability to meet academic responsibilities (Ashley et al., 2018), and eventually to be less successful in completing their degrees (Britt et al., 2017; Wolfson et al., 2022), we found no significant differences between the two groups in terms of academic performance. A potential reason for this difference could be that we did not distinguish between undergraduate and postgraduate students since Bruening et al. (2018) found that FI only negatively affected the academic performance of first year university students.

According to the studies conducted across the globe, FI is higher in those having financial difficulties due to inadequate finance, loans/scholarship and high living expenses (Bruening et al., 2017; Martinez et al., 2018; Mialki et al., 2021; Owens et al., 2020; Payne-Sturges et al., 2018) and our results were no different. We have observed that food insecure students were more likely to be financially independent with no parental help, with less disposable income, which could, in part, explain the higher number of food insecure students trying to find a job. Regression analysis showed that these factors were twice as likely to predict the potential of developing FI. Furthermore, poor financial management can also lead to FI due to the lack of funds to buy food. In

TABLE 2 Food behaviours and accessibility patterns of the UK university students based on food security status.

Variable	HFIAS score		Total participants	p
	FS $n = 289$ (100%)	FI $n = 81$ (28%)	$n = 208$ (72%)	
Main meal/day				
1–2 meals	84 (40.6)	47 (58.0)	131 (45.5)	0.008
3+ meals	123 (59.4)	34 (42.0)	157 (54.5)	
Snack/day				
Never	8 (3.9)	10 (12.3)	18 (6.3)	0.04
Once	66 (31.9)	28 (34.6)	94 (32.6)	
Twice	70 (33.8)	21 (25.9)	91 (31.6)	
More than twice	63 (30.4)	22 (27.2)	85 (29.5)	
Eating fruit				
0–1 day/week	31 (15.0)	17 (21.5)	48 (16.8)	ns
2–4 days/week	73 (35.3)	34 (43.0)	107 (37.4)	
5–6 days/week	43 (20.8)	15 (19.0)	58 (20.3)	
Everyday	60 (29.0)	13 (16.5)	73 (25.5)	
Eating vegetables				
0–1 day/week	20 (9.7)	11 (13.8)	31 (10.8)	ns
2–4 days/week	56 (27.1)	27 (33.8)	83 (28.9)	
5–6 days/week	40 (19.3)	13 (16.3)	53 (18.5)	
Everyday	91 (44.0)	29 (36.3)	120 (41.8)	
Consuming alcohol				
Never	73 (36.0)	31 (38.8)	104 (36.7)	0.03
Once a week	69 (34.0)	15 (18.8)	84 (29.7)	
More than 2 days/week	61 (30.0)	34 (42.5)	95 (33.6)	
Smoking				
Never	161 (77.8)	52 (65.8)	213 (74.5)	0.05
1–4 days/week	24 (11.6)	18 (22.8)	42 (14.7)	
More than 5 days/week	22 (10.6)	9 (11.4)	31 (10.8)	
Able to shop for food				
Sometimes	31 (15.0)	34 (42.5)	65 (22.6)	0.001
Often	40 (19.3)	21 (26.3)	61 (21.3)	
Always	136 (65.7)	25 (31.3)	161 (56.1)	
Difficulty shopping				
Difficult	14 (6.9)	19 (24.1)	33 (11.7)	0.001
Not difficult at all	190 (93.1)	60 (75.9)	250 (88.3)	

Note: $p \leq 0.05$ deemed as statistically significant.

Abbreviations: FI, food insecurity; FS, food security; HFIAS, Household Food Insecurity Access Scale.

line with this, we observed a trend towards food insecure students having less disposable income, although Silva et al. (2017) showed that students who have extra money tended to spend it on other items such as clothes, mobile phones and alcohol than food. Our findings support this with a higher proportion of food insecure students consuming alcohol more than 2 days a week. This lack of ability to budget could be a potential reason behind why food insecure students were significantly more likely to run out of money to purchase food and borrowed money more often compared to food secure students (Gundersen & Garasky, 2012; Hiller et al., 2021). Furthermore, these students lacked confidence in purchasing cheaper healthier foods, which could restrict their access to adequate food, ultimately contributing to consuming fewer meals and snack observed by us and others (Coates et al., 2007; Gundersen & Seligman, 2017; Gundersen & Ziliak, 2015).

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TABLE 3 Factors affecting UK university student to access a variety/high quality food based on food security status.

Variable	HFIAS score		Total participants	p-value
	FS	FI		
	n = 208 (72%)	n = 81 (28%)	n = 289 (100%)	p-value
Distance to food shops	62 (29.8)	38 (46.9)	100 (34.6)	0.006
Reliable and adequate public transport	10 (4.8)	4 (4.9)	14 (4.8)	ns
Knowledge and cooking skills to prepare healthy meals	37 (17.8)	12 (14.8)	49 (17.0)	ns
Availability of healthy foods	26 (12.5)	15 (18.5)	41 (14.2)	ns
Availability of culturally appropriate foods		9 (11.3)	33 (11.5)	ns
Food storage rooms and cooking equipment available at home	36 (17.3)	23 (28.4)	59 (20.4)	0.036
Space to prepare food and cooking facilities	22 (10.6)	12 (14.8)	42 (11.8)	ns
Inadequate time to shop, prepare and cook food	61 (29.3)	27 (33.3)	34 (11.8)	ns
Price of food	47 (22.6)	38 (46.9)	88 (30.4)	0.001

Abbreviations: FI, food insecure; FS, food secure; HFIAS, Household Food Insecurity Access Scale.
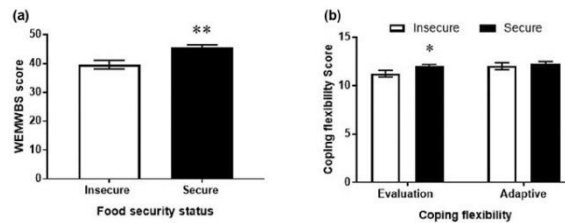
FIGURE 2 Food insecure students have lower mental wellbeing and ability to cope with stressful situations. Mental wellbeing score according to (a) the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS; Tennant et al., 2007) and (b) coping flexibility scale (Kato, 2012) associated with their household indicator access scale (HFIAS) score (Coates et al., 2007). Data presented as mean ± SEM, $*p < 0.05$, $**p < 0.01$.

TABLE 4 Logistic regression analysis of food insecurity (FI) by financial status and food behaviours.

Characteristics	Beta	OR (95%CI)	p value
Financial independence	0.503	1.654 (0.912–3.00)	0.09
Running out of money for food	−1.356	0.258 (0.134–0.494)	<0.001
Less confidence in managing money to purchase healthy food	−1.314	0.269 (0.099–7.30)	0.010
Borrowing money	−0.642	0.526 (0.281–0.986)	0.05
Difficulty shopping for food	−1.383	0.251 (0.116–0.544)	<0.001
Able to shop			
Sometimes	1.882	6.564 (3.238–13.303)	<0.001
Often	1.144	3.139 (1.533–6.429)	0.002
Snack			
Never	1.450	4.261 (1.309–13.875)	0.02
Price	1.083	2.954 (1.675–5.210)	<0.001
Food storage	0.540	1.716 (0.904–3.257)	0.09

Abbreviations: CI, confidence intervals; OR, odds ratio.

We also found that those who were food insecure were three times more likely to shop for food more often than those who were food secure. This may be due to lack of storage facilities for larger amounts of food, difficulty in shopping and transporting food, and distance to food shops alongside poor culinary knowledge as

observed by Davitt et al. (2021). Additionally, they found that lower cooking self-efficacy increased the risk of FI in university students during the COVID-19 pandemic (Davitt et al., 2021).

It has been well established that the lack of good nutrition can interfere with the wellbeing of individuals. A recent meta-analysis suggested that FI has a significant effect on the likelihood of being stressed or depressed (Pourmotabbed et al., 2020), supporting the results in this study with food insecure students having a lower mental wellbeing score. Furthermore, this was associated with a lower ability to cope with stressful situations leading to the employment of ineffective strategies such as changing eating habits for the worse (Broton & Goldrick-Rab, 2016). We observed that food insecure students changed their food intake by consuming fewer than three meals per day and snacking less and were more likely to smoke and consume more alcohol, factors associated with appetite suppression (Perkins et al., 1996; Yeomans, 2010). However, whether these students made unhealthy food choices as a result of low coping abilities cannot be determined in a cross-sectional study such as this one, although many studies have shown that food insecure individuals are more likely to have unhealthy dietary practices (Becerra et al., 2017; Ranjit et al., 2020; Shi et al., 2021).

Limitations of the study

There are a number of limitations in this study; firstly, the participants were largely female suggesting that the findings may not be generalised to the entire UK student population. A potential reason for this may be that women are more likely to participant in survey studies when compared to men (Curtin et al., 2000). Indeed many have shown this including (Armstrong et al., 2021) who investigated the effects of COVID-19 on FI, reporting that 63% of participants were female and 39% were food insecure. However, it is also known that women are more likely to suffer from FI than men as suggested by a systematic review by Jung et al. (2017) which found that female-led households were 75% more likely to be food insecure than male-led families. Furthermore, while the study included students across the United Kingdom, we are unable to identify geographical locations and therefore are unable to state where the prevalence of FI would be higher. We are also aware that the number of students who completed the questionnaire is low considering there were approximately two million students studying at higher education providers in 2021–2022. However, in the current culture, university students are surveyed about multiple topics by universities and therefore may have survey fatigue which may have been a hindrance in obtaining larger numbers. Another limitation is the self-reporting nature of the study which may

result in social desirability bias although all participants were informed that the questionnaire was only intended for research use and was confidential with no personal information obtained. Finally, the cross-sectional nature of this study means that the direction of the relationships between FI, coping ability and mental wellbeing cannot be determined.

Significance

Despite these limitations and the low numbers responding, this study found that FI is common among UK university students, and although an inability to manage money well may be a predictor for FI, it is unknown whether this is the reason behind the decrease in mental wellbeing and needs to be further investigated. But it is probable that students' poor financial management of limited resources may put them in a precarious financial situation, and there is the potential for higher education settings to provide advice on financial management, on developing resource management skills, including improved cooking skills based on the facilities available to the students, good decision-making and prioritisation of spending, and practical education on food variety.

AUTHOR CONTRIBUTIONS
AAA, LJC and PHJ contributed to the conception, interpretation of the data and reviewing of the drafts. AA contributed to writing the original draft, acquisition, and analysis of the data, LJC and PHJ contributed to the revising and contributing intellectual content writing. PHJ had final approval of the version to be published.

CONFLICT OF INTEREST STATEMENT
The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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4.2 Conferences

4.2.1 Summer Conference 2023

Improving the food security status, dietary intake, and mental health among university students

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We previously reported that 28% of UK university students were food insecure, which is double the national average[1]. Factors including poor access to nutritious food and low financial stability were significantly associated with increased food insecurity and poorer wellbeing (under submission). This pilot study aimed to conduct a short intervention to enhance food insecure university students' nutritious meal preparation skills when faced with limited finance and cooking facilities and to assess whether this improves mental wellbeing.

Food insecure UK university students, identified using the Household Food Insecurity Access Scale, were invited to take part in a 5-week study approved by the Faculty of Medicine and Health Sciences Ethics Committee at the University of Nottingham (FMHS 470-0322). During phase one of the study (two weeks), students engaged with resources to enhance financial budgeting, meal preparation, and food waste reduction skills. Phase two of the study (3 weeks) required students to practice the obtained skills using online resources. Participants completed a newly designed questionnaire prior to and post intervention to obtain sociodemographic information and assess food insecurity status, habitual food intake (3-day food diary), food literacy (Food Confidence and Behaviours Scale), and mental wellbeing (Warwick-Edinburgh Mental Wellbeing Scale). The online questionnaire was supported by focus group discussions. A paired T-test and thematic analysis were used to analyse quantitative and qualitative data respectfully.

Sixteen female food insecure UK University students participated in this study. Food security status improved in 62.5% of the participants from baseline to post-intervention. Mental wellbeing of the participants also improved significantly post-intervention compared to baseline ($p < 0.05$). Participants reported significant improvements in food literacy in both their abilities to cook nutritious food confidently and food preparation behaviours ($p < 0.001$). A significant increase in energy, protein, and fat intake was also reported post-intervention ($p \leq 0.001$). Baseline focus groups revealed that although inability to cook, lack of storage space, and lack of time were attributed to the development of food insecurity, the most common theme was lack of money or inability to budget. Interestingly, post-intervention students reported that having the ability to plan their meals during the intervention enabled them to stick to a budget without compromising the nutritional content.

This study confirmed that enhancing participants financial budgeting, meal preparation, and food waste reduction skills improves food security status and, in turn, may contribute to the improvement in mental wellbeing. Further studies are required to explore the long-term impact of this intervention.

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Improving the food security status, dietary intake, and mental health among university students

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INTRODUCTION

In 2022, one in ten UK university students reported using a food bank, and 47% admitted that "money worries" had negatively impacted their meals[1]. It was also revealed that 62% of students reported spending less on food and other needs in response to rising costs and relying more on credit cards to cover daily expenses[2], which have been linked to a variety of negative impacts on their mental health[3].

AIM

To evaluate the impact of a 5 week nutrition and culinary education intervention on food insecurity, dietary intake and mental wellbeing in university students.

RESULTS

Participant characteristics
Based on the screening week using the HFIAS, a total of 16 female food insecure UK University students participated in this study.
 Key participant characteristics included:
• Average age of 23 ± 2.88 years old.
• Average BMI 22.1 ± 2.28.
• 50% of undergraduate students, all studied full-time.
• 81.3% lived in shared accommodation.
• The majority was 68.8% white British.
• Only 37.5% were financially independent.

METHOD

Participants completed a newly designed questionnaire prior to and post intervention to obtain:
• Sociodemographic information
• Food security status using the Household Food Insecurity Access Scale (HFIAS).
• Mental wellbeing status using the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS).
• Food literacy using the Cooking Confidence and Food Preparation Behaviours Scale (CCFPB).
• Habitual food intake using a 3-day food diary.
The online questionnaire was supported by focus group discussions. A paired T-test and thematic analysis were used to analyse quantitative and qualitative data respectfully.
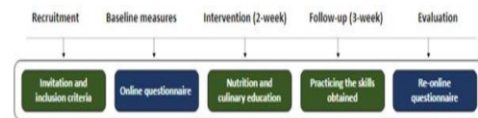

Figure 1: Summary of the study design and timeline.

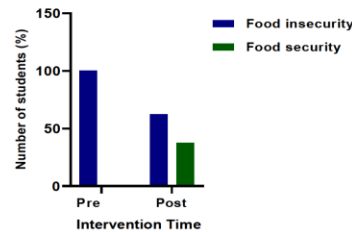### 1) Our intervention improved food insecurity in 62.5% of the participants

Figure 2: The prevalence of food security among the university students' pre- and post-intervention 5-week

2) Our intervention significantly improved the mental wellbeing score

The mean mental wellbeing score significantly increased between pre- and post-intervention (pre, 47.68 ± 6.23: post, 51.93 ± 8.08, $P < 0.05$), suggesting improvement in participants' mental wellbeing status from pre- to post-intervention, despite being at a medium level at both intervention times.
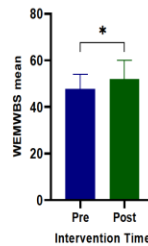

Figure 3: The WEMWBS status among the university students pre- and post-intervention 5-week

3) Our intervention increased overall daily energy intake via increase in protein, carbohydrates and fat potentially due to improved food literacy.

A) Habitual food intake
The average daily intake increased significantly from pre- to post-intervention in energy ($p=0.001$), protein ($p<0.001$), fat ($p=0.001$), and carbohydrates ($p=0.055$).
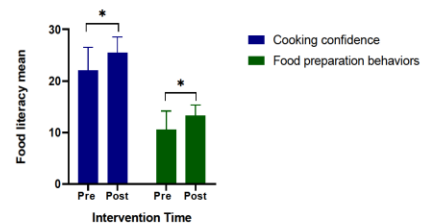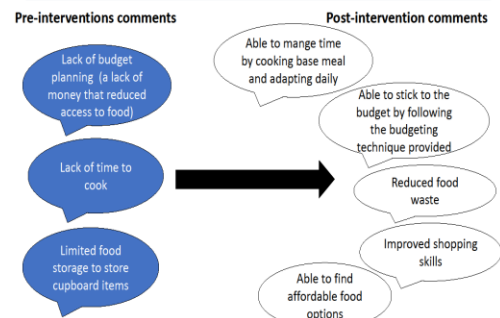
B) Improvements in food literacy

Figure 4: Food literacy average pre- and post-intervention 5-week

4) Reasons from focus groups pre- and post- interventions

CONCLUSION

In this small group of university students, we found that engaging students with nutrition and culinary education resources significantly improved self-reported food insecurity scores post-intervention compared to baseline, which in turn may have a positive impact on their mental wellbeing. This could be because the students felt more settled and organised during the intervention. However, given that poverty is an underlying cause of food insecurity[4], this data supports the need to explore in a larger group with a control group the long-term impact of this intervention.

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4.2.2 Summer Conference 2022

The prevalence of food insecurity among UK university students

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Food insecurity may be defined as the unreliable access to a sufficient quantity of safe, affordable and nutritious food. Food insecurity is associated with a variety of negative health outcomes, impacting physical and mental health as well as social and emotional well-being. In 2020, 8% of UK households regarded themselves as food insecure, a number which has doubled since 2018. A recent systematic review on college/university students in the United States revealed that 14% to 59% of them had undergone food insecurity, which exceeded the national prevalence (12.3%)[1]. However, very little is known about university students studying in the UK, thus the aim of this study was to examine the prevalence of food insecurity and associated drivers in UK university students and explore the potential for food insecurity to influence health, particularly mental wellbeing and ability to cope in stressful situations. Students studying at a UK university (n = 289) completed an online questionnaire combining the Household Food Insecurity Access scale with the Warwick-Edinburgh Mental Wellbeing Scale and the Coping Flexibility Scale with demographic and financial questions. We observed that 28% of the student population reported themselves as food insecure, a figure that doubles the national average of 8–10% in 2021[2]. Although insignificant, we observed that male students (32.1%) were more likely to report food insecurity compared to female students (26%, p = ns). We observed no significant difference between the prevalence of financial independence between food insecure (34.9%) and secure students (65.1%), those who deemed themselves food insecure stated they had with less savings (P < 0.05) and were more likely to borrow money from friends and family (P < 0.005). Furthermore only 15.9% of food insecure students felt confident about managing money to purchase food (P < 0.01) and were more likely to have no money to spend on food (P < 0.001) compared to food secure students. Furthermore, food insecure students stated that they had difficulties in acquiring a variety of nutritious foods due to the price of healthy nutritious foods (P < 0.001) and the distance to food shops as they lacked their own transportation (P < 0.01). Lack of both financial stability and access to nutritious food may contribute to the observed significant negative correlation between mental wellbeing and food insecurity status (r = -.209**, P < 0.001) which may be due to the inability to cope with stressful situations (P < 0.01).Food insecurity is common among UK university students in line with other countries, however whether the financial burden of managing money or the lack of nutritious food leads to a decline in mental wellbeing is unknown and requires further investigation.

References

1. Ahmad NSS, Sulaiman N, Sabri MF, *et al.*. (2021) *Int J Environ Res Public Health* **18**(11), 5627.
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Proceedings of the Nutrition Society

The Prevalence of Food Insecurity among UK University Students

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INTRODUCTION

Food insecurity may be defined as the unreliable access to a sufficient quantity of safe, affordable, and nutritious food. Food insecurity is associated with a variety of negative health outcomes, impacting physical and mental health as well as social and emotional wellbeing. In 2020, 8% of UK households regarded themselves as food insecure, a number which has doubled since 2018[1].

A recent systematic review on college/university students in the United States revealed that 14% to 59% of them had experienced food insecurity, which exceeded the national prevalence (12.3%)[2].

AIM

To examine the prevalence of food insecurity and associated drivers in UK university students and explore the potential for food insecurity to influence health, particularly mental wellbeing and ability to cope in stressful situations.

METHOD

A cross-sectional study was designed to investigate food insecurity, health and wellbeing, and coping mechanisms among UK university students via an online questionnaire using a number of validated tools, including the Household Food Insecurity Access Scale (HFIAS), The Warwick-Edinburgh mental wellbeing Scale (WEMWBS), and the Coping Flexibility Scale (CFS) with demographic and financial questions.

Data was analyzed using SPSS and regression analysis was conducted.

RESULTS

Participant characteristics:

A total of 289 UK university students participated in this study.

Key participant characteristics included:

•Average age of 22.16 ± 3.06 years old.
•63.2% undergraduate students.
•93.1% studied fulltime.
•49.3% lived in shared accommodation.
•A mix of ethnicities, 42.6% of white British and 57.4% of other ethnicities.

Prevalence:

28% of the participants deemed themselves as food insecure, with males more likely to be insecure than females.
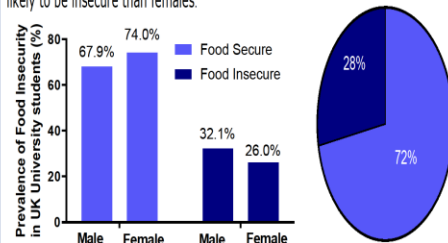

Figure 1: The distribution of the prevalence of food security status among UK university students

RESULTS

Financial capability

No difference in financial independence, but in comparison to the food secure students, food insecure students were significantly more likely to:
•Have less savings (P< 0.05).
•Have lower confidence in managing money (P<0.01).
•Have no money to spend on food (P<0.001).

Mental wellbeing

In comparison to the food secure student, food insecure students were significantly more likely to have poor mental health (r = -0.209**, P<0.001).

Ability to cope with different situation

In comparison to the food secure students, food insecure students had lower capacity to cope with stressful situations (P< 0.01).

RESULTS

Regression analysis identified that those who experienced difficulty shopping, eating fewer meals, having low confidence in managing money were significantly more likely to be food insecure compared to those who did not experience these factors.
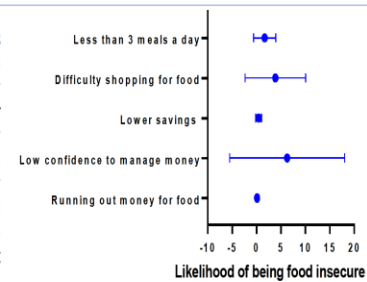

Figure 2: Factors associated with increasing risk of food insecurity (mean, CI)

CONCLUSION

This study found that food insecurity is common amongst UK university students in line with other countries. Data suggests that poor mental health is more common in students experiencing food insecurity. This study has begun to explore and identify possible factors that may contribute to food insecurity although further research is required.
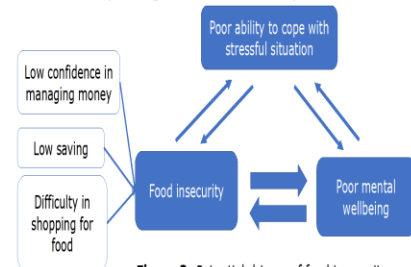

Figure 3: Potential drivers of food insecurity

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