Association between Stress and Diet Quality among Women of Reproductive Age from a University Population in two countries: UK and Lebanon.

Karim J. Khaled

May 2022

A thesis submitted in partial fulfilment of the requirements of Bournemouth University for the degree of Doctor of Philosophy

Bournemouth University

Copyright Statement

Abstract

Association between Stress and Diet Quality among Women of Reproductive Age from a University Population in two countries: UK and Lebanon.

Karim J. Khaled

Background and purpose – Poor diet has been linked with increased obesity-related diseases. Perceived stress has been associated with poorer dietary patterns; however, the evidence among reproductive-aged women is scarce. The objective of this PhD project was to investigate the association between stress and dietary quality/patterns in reproductive-aged women from UK and Lebanon and to explore confounding/explanatory factors that affect the stress and diet association by including a culturally diverse sample of women of reproductive age.

Methods – A systematic review and meta-analysis were conducted to review the literature on the association between stress and diet. Further, a cross-sectional study was conducted among reproductive-aged women in the UK using an online survey questionnaire to investigate the association between stress and dietary quality/patterns. In Lebanon, a similar study has been conducted after validating the European Prospective Investigation into Cancer (EPIC) food frequency questionnaire (FFQ) among Lebanese adults. Lastly, Structural Equation Modeling was performed to assess the association between stress and diet and all other variables among the whole sample.

Results – The systematic review showed contradictory results and meta-analysis demonstrated a negative association between stress and dietary quality in reproductive-aged women. The study in UK also found that stress was negatively associated with dietary quality/patterns among reproductive-aged women. After validating the EPIC FFQ in Lebanon, the next study revealed no association between stress and dietary quality/patterns among reproductive-

aged women. Structural equation modeling indicated that the country-context directly affected dietary quality and patterns, and indirectly through the mediating effect of stress. Being from Lebanon had a negative impact on diet through having increased stress levels.

Discussion –This thesis makes an original contribution to the existing knowledge by furthering our understanding of the association between stress and diet and the need to look more closely at women of childbearing age. Further, it provides evidence to support the implementation of an evidence-based stress/diet intervention to be used with childbearing-aged women, supporting their health and experiences before pregnancy.

Contents

List of Figures

List of Tables

List of Abbreviations

MD	Mediterranean Diet
EPIC	European Prospective into Cancer
FFQ	Food Frequency Questionnaire
DP	Dietary Pattern
DQ	Dietary Quality
MDS	Mediterranean Diet Score
METs	Metabolic Equivalents of tasks
PUFA	Poly-unsaturated fatty acids
MUFA	Mono-unsaturated fatty acids
PCA	Principal Component Analysis
FA	Factor Analysis
CA	Cluster Analysis
GD	Gestational Diabetes
CVD	Cardio-vascular disease
CHD	Coronary Heart Disease
MDS	Mediterranean Diet Score
BMI	Body Mass Index
PA	Physical Activity
PSS	Perceived Stress Scale
SEM	Structural Equation Modeling
aMD	Alternate Mediterranean Diet
HEI	Healthy Eating Index
DASH	Dietary Approach to Stop Hypertension
BOS	Bristol Online Survey
24-HR	24-Hour Recall
IPAQ	International Physical Activity Questionnaire

BDI-II	Beck’s Depression Inventory-II
Kg	Kilograms
MENA	Middle East and North Africa
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation
KMO	Kaiser Meyer Olkin
SE	Standard Error
g/d	Grams per day
CFI	Comparative Fit Index
$\chi 2$	Chi-square
df	Degrees of freedom
SRMR	Standardized root mean square residual
PNFI	Parsimony normed fit index
RMSEA	Root mean square error of approximation
PCFI	Parsimony comparative fit index
GFI	Goodness of fit index
AGFI	Adjusted goodness of fit index
MOOSE	Meta-analysis of Observational Studies in Epidemiology

Integrated Papers

In line with the alternate formats of thesis allowed within BU's regulations, this thesis follows an integrated format, where one or more "papers" are integrated into the thesis. The integrated papers within this thesis are listed in Table 1. The table provides details of each paper, publication status, and in which chapter of the thesis they appear. For all publications within this thesis, I am the lead/first author and confirm that I contributed over 75% of the content of each paper. A short paragraph was included before each paper in the body of the thesis to ensure that it is a coherent and continuous thesis, rather than a series of disconnected publications. Sections of the thesis which are published, submitted for publication, or ready-for-submission drafts are clearly identified in Table 1 and in text before each study.

Table 1: Table of Integrated Papers

Paper Number	Reference	Chapter	Page Number
1	Khaled, K., Tsofliou, F., Hundley, V., Helmreich, R. and Almilaji, O., 2020. Perceived stress and diet quality in women of reproductive age: a systematic review and meta-analysis. *Nutrition Journal*, 19 (1).	2	14
2	Khaled, K., Hundley, V. and Tsofliou, F., 2021. Poor Dietary Quality and Patterns Are Associated with Higher Perceived Stress among Women of Reproductive Age in the UK. *Nutrients*, 13 (8), 2588.	3	37
3	Khaled, K., Hundley, V., Bassil, M., Bazzi, M. and Tsofliou, F., 2021. Validation of the European Prospective Investigation into Cancer (EPIC) FFQ for use among adults in	4	58

	Lebanon. *Public Health Nutrition*, 24 (13), 4007-4016.		
4	Khaled, K., Hundley, V., Bassil, M., Bazzi, M. and Tsofliou, F., 2022. The Association between Psychological Stress and Dietary Quality and Patterns in Women of Childbearing Age from a University Population in Lebanon. *British Journal of Nutrition, (In Press).*	5	85
5	Khaled, K., Hundley, V. and Tsofliou, F., 2022. A Structural Equation Modeling approach to examine the influence of stress, sociodemographic, physical variables on diet quality and patterns among women of childbearing age from two countries: UK and Lebanon. *PLOS ONE*, *(completed draft for publication in PLOS ONE journal).*	6	105

Acknowledgements

A doctoral thesis is usually described as a solitary endeavour, however the following definitely proves the opposite.

I would like to acknowledge and thank my supervisors/advisors Dr Fotini Tsofliou and Professor Vanora Hundley from Bournemouth University, UK; Dr Rebecca Helmreich from the University of Texas, USA; and Dr Maya Bassil from the Lebanese American University, Lebanon, for their help, support, and patience. Their guidance helped me in all the time of research and writing of this thesis.

My family gave me nothing but continuous support, day after day, both emotionally and financially. My love and gratitude for them can hardly be expressed in words. So, I dedicate this thesis to my parents.

Lastly, and most of all, thank you to Hania. I love you and you are my world.

Chapter 1 Introduction

Nutrition is fundamentally important to reproductive health and the health of future generations (Koga et al. 2020). Much of the research to date has focused on the impact of diet on fertility or the growing fetus (Panth et al. 2018, Silvestris et al. 2019), but my area of interest is the mother and how her diet may be affected by factors such as stress. I became interested in this area since I learned psychology in one of my undergraduate courses and realized how humans change their behaviors upon stress (Meule et al. 2013). I was also very keen to investigate and research about women's nutrition, as this is crucial during the various stages of the women's life, and specifically in the reproductive years. This is because it prepares her to enter pregnancy in the best nutritional health that protects and enhances both her health and the baby's (Temel et al. 2013). For example, previous research has shown that about half of women in the UK who died during delivery were obese (Lewis et al. 2007). Moreover, obesity during pregnancy has been shown to exhibit a high insulin resistance level and leads to gestational diabetes (Kanguru et al. 2014). Other problems that result from obesity during pregnancy include stillbirth, neonatal death, increased blood pressure (preeclampsia), preterm birth, caesarean section, macrosomia (birth weight greater than 4 Kg), and congenital abnormalities (Tanentsapf et al. 2011). Bad eating habits and lack of physical activity are major reasons for these pregnancy related issues (Thangaratinam et al. 2012).

Nutrition and diet quality are important factors for both the mother's and child's health (Harnisch et al. 2012). Even though we stress the importance of a woman's health during pregnancy, there should also be emphasis on a woman's health before pregnancy and during conception. This is essential to reduce any risks and nutrition related diseases (Barfield et al. 2011). For instance, even before conception, a woman who has right nutrition and nutrition stores will achieve proper growth and will have the proper nutrition needs for pregnancy and postmenopausal (Bartley et al. 2005). Before pregnancy, it is vital that the women consume a good-quality diet which contains enough amounts of iron, calcium, iodine, Vitamins A and D, omega-3 and omega-6 fatty

acids, and folic acid (Gardiner et al. 2008, Lumley et al. 2001, Temel et al. 2013).

1.1 Diet Quality and Patterns

In the past, diet quality and patterns used to be measured according to the intake of specific nutrients. However, the focus now is on the diet as a whole (Jacques et al. 2001). Dietary patterns are more important in nutritional targeting of a healthy lifestyle than just single nutrients (Hue et al. 2002). Moreover, it is hard to directly find a correlation between a disease and specific nutrients because of the way foods interact with one another, so it is absolutely hard to identify which nutrient causes what (Jacobs et al. 2003).

Maybe the best part of dietary quality/patterns analysis is that they express real life habits of food choices, and so they are used for developing nutrition advice and policies in public health as they are indicative of morbidity and mortality among the population (Kant et al. 2004).

Dietary quality/patterns are described as either “A Posteriori” or “A Priori”. The a posteriori method categorises dietary patterns by the data-reduction technique based on food intake through principal component analysis (PCA), factor analysis (FA), or cluster analysis (CA) (Quatromoni et al. 2002). While the factor analysis is technically just like the PCA (both dimension reduction techniques), it is always assumed that there are underlying trends/patterns, and factor analysis is used to uncover them. On the other hand, the “A Priori” method for assessing dietary quality relies on a dietary index that is considered protective for the health (e.g., Dietary Approach to Stop Hypertension index, Mediterranean Diet index) (Kant et al. 2004, Panagiotakos et al. 2009). The a priori is popular in epidemiological studies that examine the relation between diet (adherence to a Mediterranean diet for example) and risk of heart diseases, mortality, and non-communicable diseases (Kant et al. 2004).

1.2 Diet and Socioeconomical Status

There is a complex network of factors linked to dietary quality/patterns before and during pregnancy (Wesolowska et al. 2019). There is important evidence that shows that socioeconomic status is linked with obesity. That was first studied in a paper by Sobal et al (1989) that tested one hundred and forty-four studies with cross-sectional designs and found that as socioeconomic status/level decreased, poor dietary quality/patterns and obesity increased. The question is why do most people with low socioeconomic status tend to consume unhealthy dietary patterns? Some studies claim that this is due to the low cost of energy dense foods and the wide availability of high fat/sugar foods (Drewnowski et al. 2004). A study in Australia has studied the diet-socioeconomic status relationship from the point of view of purchasing behaviour and found that people from low educational levels with low incomes were not inclined to buy foods that are high in fibre/low in fat and sugar (Turrell et al. 2006). The author concluded that the increased healthy food cost and lack of the nutritional knowledge are major determinants of this relationship. Similarly, Murayama et al (2014) claims that low socioeconomic groups in Japan had higher concern about the cost of foods as the main barrier to eating healthy food choices, which lead to the suggestion of perhaps reducing the price of healthy foods and focusing on nutritional education to improve the public health. In women of reproductive age, the evidence in the literature is still scarce. Some studies indicated that being married (marital status), older in age, and have a high income have been linked to a healthier diet quality and patterns among women of reproductive age (Elder et al. 2008, Khaled et al. 2020, Lee et al. 2004, Si Hassen et al. 2016). On the other hand, ethnicity (African American) and greater adiposity were associated with poorer dietary quality and patterns (Hill et al. 2019, Robinson et al. 2021).

1.3 Stress and Diet Quality and Patterns

There is increasing evidence of the role of psychological stress on human health (Garfin et al. 2018). Stress is a process of perception, appraisal, and response to environmental stimuli (Fink et al. 2010). It happens when the

requirements of the surroundings exceed the adaptive capacity of the person, which affect the body's psychological and physiological processes (Cohen et al. 2007). Adults experience various stressors that come from different sources (e.g., family, studying, work, money), and each one makes up the thorough overall stress (Mimura et al. 2008). Some experiments have observed that stress affects dietary patterns, particularly among people with specific eating behaviours, such as a restrained diet (intentional caloric restriction) (Adam et al. 2007, Teegarden et al. 2008). Dietary response to stress can vary, with 40% of people consuming more food when stressed and 40% of people consuming less when stressed, while 20% of people consume the same amount of calories and do not change their eating patterns during stressful periods (Block et al. 2009, Pasquali et al. 2012, Torres et al. 2007). The variable responses might be influenced by the period of stress, kind of stressor, and the discrepancies in hunger and satiety levels at the start of the study.

It is essential to know which foods are still eaten or avoided under stress in order to explain theoretically the processes included and to talk about the health implications of stress. Most studies indicate a tendency towards eating more pleasurable foods without regard to the caloric intake during times of stress. Oliver et al (2000) and Zellner et al (2006) argue that people tend to eat hyper-palatable comfort foods like fast foods, snacks, and high caloric density foods, even if there is no hunger or bodily requirements for the calories in those foods (Rutters et al. 2009). Jastreboff et al (2012) states that these results are most noticeable in individuals with body mass index (BMI) > 25 Kg/m^2 as compared to ones with normal BMIs.

In fact, stress is related to weight gain and poor diet quality (Block et al. 2009, De Vriendt et al. 2011, Ferranti et al. 2013). It is also linked with increased energy, sugar, and saturated fat consumption (Barrington et al. 2014, Sims et al. 2008). Moreover, stress triggers physiological mechanisms that are not related to diet and dietary patterns. For example, the raised level of serum cortisol increases the metabolic production of fat inside the body (Lee et al. 2014, Rosmond et al. 2003). Furthermore, stress activates the central sympathetic nervous system and hypothalamus pituitary axis which results in

cortisol release into the bloodstream and accumulation of visceral fat (Rosmond et al. 2003). So, stress leads to adiposity in two different ways: via biological mechanisms and through diet quality/patterns.

Fowles et al (2012) showed that high perceived stress quartile was linked with the worse diet quality compared to normal one. Liu et al (2007) and Pendleton et al (2001) found out that a higher level of perceived stress is a contributing factor in binge eating, decreased consumption of fruits, and increased intake of snack foods. Previously, the link between stress and increased caloric intake was thought to be a result of lack of cognitive restraint; however, this link has been recently questioned (Lowe et al. 2006). Instead, stress might send signals to the brain and increase the longing for high fat food, snacks, and highly palatable foods (Adam et al. 2007).

In previous research, reports of severe or perceived stress among university students have become more noticeable (Bayram et al. 2008). Research has found that stress is an important factor of poor eating patterns in young adults (Wichianson et al. 2009). Most studies in young adults have concentrated on the link between stress and fat consumption. In men, studies found out that when men become more stressed, they eat more fats (McCann et al. 1990, Ng et al. 2003, Zellner et al. 2007). Results were the same in females; more fat consumption as a result of increased stress (Habhab et al. 2009, O'Connor et al. 2008, Wichianson et al. 2009). Surprisingly, one study discovered that increased release of the stress hormone cortisol after a psychological stressor and stress from serial subtraction missions and visuospatial puzzles in female individuals was linked with the intake of high fat/low sodium foods (Epel et al. 2001). However, although several studies showed increased fat consumption in highly stressed participants, a number of studies showed a decrease in fat consumption in stressed individuals as well (Torres et al. 2007). Epel et al (2001) studied dietary restraint in individuals who actively limit their food intake. The study also examined blood cortisol levels affected by stressors like speech delivery, serial subtraction tasks, and visuospatial puzzles in a sample of young women. The author summed up that high levels of cortisol are linked with higher intake of fats, but not sodium, and that stress does encourage unhealthy eating

behaviour. Meanwhile, Torres et al (2007) measured daily measures of stress and dietary habits. Results demonstrated that students, both men and women, eat less food when they are stressed. These conflicting results are probably linked to differences in the participants. That is, not everyone reacts to stress in the same pattern, and hence not everybody eats more high fat food when stressed.

In women of reproductive age, the nature of the association between stress and dietary quality and patterns remains unclear. Studies that have assessed this association have been limited in their methodologies. For example, Habhab et al (2009) and Barrington et al (2012) examined the stress-diet association among reproductive-aged women and found that women who were more stressed consumed more sweets, fats, and fast food. However, their sample size was small (e.g., total of 40 participants in the paper by Habhab et al (2009)), and they did not use validated tools to assess dietary intake (Barrington et al. 2012). Moreover, the authors assessed the link between stress and only specific food groups (e.g., fat intake) rather than the whole diet patterns and quality (a-priori/a-posteriori dietary approaches). Other studies have not assessed confounding factors, such as the socio-economic status and physical activity of participants, which made the results inaccurate (Richardson et al. 2015, Vidal et al. 2018). Given the limited evidence in the literature regarding the association between stress and diet among women of reproductive age and the fact that diet-related diseases have been alarmingly increasing over the past few years, it is essential to understand the factors that influence dietary quality and patterns (e.g., stress) among this population group.

The prevalence of stress among women in the UK has been rising according to the Mental Health foundation, where 35% of women had suicidal feeling because of stress in 2018 (Anon et al. 2023). In Lebanon, the numbers are no better. Several traumatic events took place in Lebanon in the past few years, starting with the Beirut Blast, which is the biggest non-nuclear explosion in the world, moving to COVID-19 pandemic, and the serious economic crisis that is still affecting the country (Farran et al. 2021). These have led to an increased

stress level among the Lebanese people where recent research found that around 78% of people reported feeling worried and stressed every day (Farran et al. 2021). Recent studies have assessed the dietary quality and pattern of women of reproductive age in the UK, and found the women had a low to medium adherence to Mediterranean diet and several dietary patterns were revealed among this age group including Vegetarian diet pattern (fruits, nuts, vegetables and legumes), dairy, sweets and starchy foods diet pattern (sweets, cereals, dairy products and potatoes), protein-rich diet pattern (eggs, seafood and meats) (Khaled et al. 2020). In Lebanon, diet patterns revealed in previous studies were Lebanese diet (high in fruits/vegetables, legumes and fibers), western diet (high in energy-dense food and sodium), and high protein diet (high in protein and fat) (Jomaa et al. 2016). To prevent morbidity and mortality caused by diet-related diseases, it is essential to understand the modifiable dietary factors. In the recent literature, studies on the association of diet quality and stress specifically focused on women of reproductive age are scarce.
The majority of these studies have included participants and data from a single country (e.g., USA (Fulkerson et al. 2004), UK (El Ansari et al. 2014), and China (Liu et al. 2007)). However, only few studies investigated stress/diet association among diverse populations. Furthermore, comparing data and findings from studies that have been conducted in single countries is complicated due to heterogeneity in the methods and tools used in each study. Previous calls in the literature have been recommending that new research targeting diet and stress should be conducted across a diverse population (Mikolajczyk et al. 2009). The current thesis bridges these literature gaps and reports key findings and data from the United Kingdom and Lebanon. This thesis included a great number of participants from two different countries (in two different continents) which warranted robust investigation of the stress and diet relationship across diverse populations with different traditional, lifestyle, and socioeconomic properties.

1.4 Research aims and objectives

The aim of this research was to examine the association between stress and diet quality and patterns among women of reproductive age from two different countries: UK and Lebanon.

The research aim was achieved through the following objectives:

- o1- To examine the association between stress and diet among women of reproductive age from UK
- o2- To investigate the association between stress and diet among women of reproductive age in Lebanon.
- o3- To use structural equation modeling of the whole dataset from UK and Lebanon to allow country comparison and derive the effects of variables on diet quality and patterns of the whole sample of women of reproductive age.

1.5 Overview of the thesis

This thesis is concerned with the association between perceived stress and dietary quality and patterns among women of childbearing age in two different countries (United Kingdom and Lebanon). The thesis uses techniques from the discipline of nutrition, and thus its main contribution is to the field of nutrition, but by bringing together reproductive health and nutrition (interdisciplinarity), it offers a broader application to maternal and public health.

The thesis is structured to reflect the progression of work over a 4-year period and has three phases (Figure 1). As an integrated thesis, the content includes published papers as well as those manuscripts that are still to be submitted or are under review.

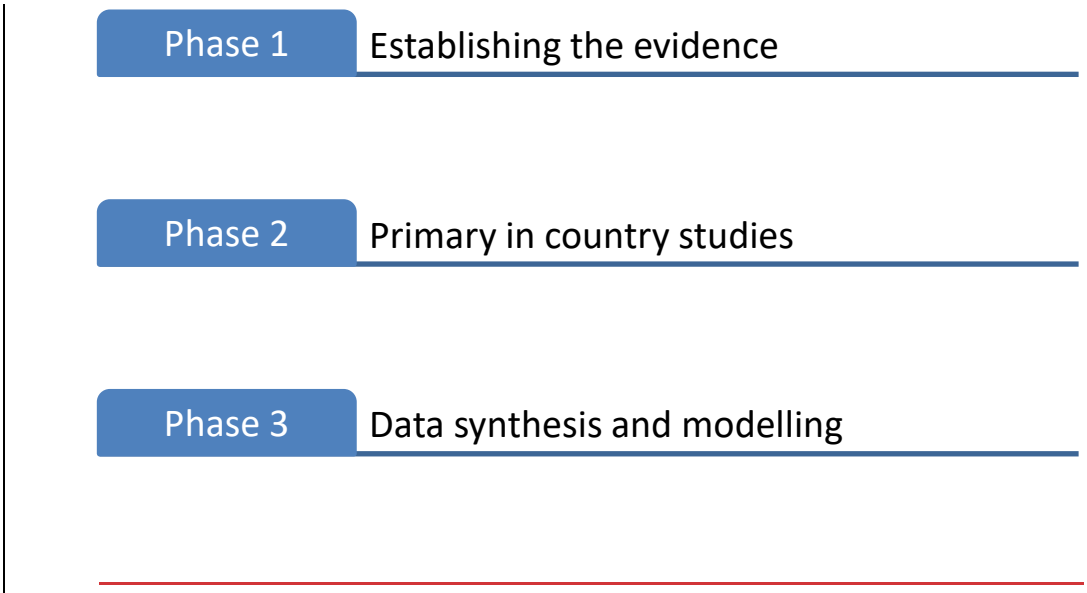


Figure 1: Outline of the empirical work in this thesis

In phase 1, a systematic review and meta-analysis study was conducted to review the literature on the association between perceived stress and dietary quality/patterns among women of childbearing age. Observational studies were included based on the PEO (population, exposure, outcome), and quality assessment and meta-analysis were performed. The gaps in the current knowledge informed the next phases of the work.

In phase 2, the original aim was to conduct three epidemiological studies to assess the association between perceived stress and dietary quality and patterns in UK, USA, and Lebanon. Due to logistic and resource constraints, this aim had to be revised and it was decided that the thesis would be based on two studies in UK and Lebanon targeting women of reproductive age. The studies focused on university populations as it was not possible to conduct the studies across the whole countries' populations due to limited resources and time constraints.

Gold standard tools and questionnaires were included in online surveys to assess dietary intake, stress levels, depression levels, socioeconomic status, physical activity, and adiposity. The tool used to assess dietary intake was the European Prospective into Cancer and Nutrition (EPIC) food frequency

questionnaire (FFQ) which is described in more detail in the studies below. However, the EPIC FFQ has not been previously validated for use in Lebanon. Therefore, it was first necessary to conduct a validation study of the EPIC FFQ against three 24-h recalls (24-HR) among adults in Lebanon.

Finally, phase 3 draws together the data from both countries. The data from UK and Lebanon about the association between perceived stress, dietary quality and patterns, physical activity, adiposity, and sociodemographic variables are modelled to provide clear insight of the factors that affect dietary quality and patterns. The use of Structural Equation Modeling to answer the research question is a relatively new approach in the nutrition field.

The structure of the thesis is outlined in figure 2 below.

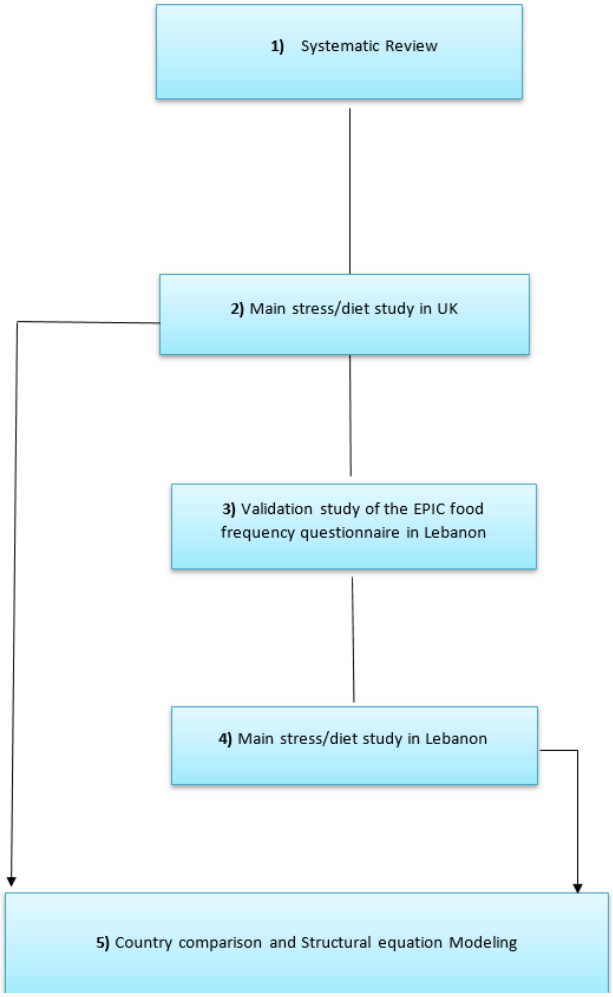


Figure 2: Thesis overview

1.6 Impact of the coronavirus pandemic on the research

In 2020, the Covid-19 pandemic affected people's lives in many ways; research is no exception. This section outlines the challenges that I faced and how my research was impacted.

Before the pandemic, participants were being recruited to the UK study through face-to-face talks and classroom visits in addition to advertising for the study through posters all over the university campuses. All of this was not possible after the closure of Bournemouth University campuses and lockdown. During the first few months of the pandemic, the data collection process of the UK cohort was hindered. My supervisory team and I thought that the best way to mitigate this impact during the lockdown is by targeting people through social media. This required an amendment to ethical approval (appendices 1 and 13), which delayed my study. Following approval, I posted descriptions about the study with links to the survey on platforms such as Twitter, WhatsApp, and Facebook. However, recruitment was significantly slower compared to the face-to-face recruitment. Unfortunately, the delay in data collection eventually led to a delay in data cleaning, data entry, and data analysis. Therefore, the research plan did not go as expected and we had to accept the impact of COVID pandemic on my research progress.

Meanwhile, I was working with my advisor in Lebanon to try and start with the Lebanese study; however, this too got delayed. Moreover, there was an inevitable delay in ethical approval and data collection from Lebanon. The Lebanese American University (LAU), as well as instructors and staff, were confused about whether the semester would start on campus or online. This made supervisors overwhelmed with paperwork and preparations for both cases. So, the Institutional Research Board (ethical committee at LAU) postponed reviewing the research protocol and hence ethical approval got delayed around 2-3 months. In addition to that, recruiting participants got harder, especially when Lebanon entered a complete lockdown for around 50 days or more. The plan was to approach participants face-to-face in the university and through classroom visits (after agreeing with the instructors of

these classes). All of this was not possible to achieve under the circumstances of the COVID-19 pandemic. In that time, I continued working on the UK data, which I finished collecting 3 months ago, and tried to stay in contact with my advisor in LAU and keep pushing for the IRB to speed up with our research especially that I have already done the paperwork for ethical approval in Lebanon. However, they were overwhelmed with work, and I was not able to do anything other than wait until the IRB agreed that I could proceed with the research. Consequently, the research in Lebanon got delayed around 2-3 months, and this was beyond my control.

On a personal level, the COVID-19 virus has strongly affected my mental health. Being previously diagnosed with severe asthma, I was overstressed and overthinking about my health especially that I read a lot about the fatal effects of getting infected with COVID for people with asthma. I took anti-depressants for a short period of time to try and stay at the same pace of work for my PhD, but then the GP said that I should gradually stop them. This caused a decreased pace of work and a delay in research plans.

During the first months of 2021, the universities all over Lebanon were closed (including LAU) and this made it extremely hard for us to recruit participants. So, data collection for the Lebanese studies got delayed. My supervisory team and I decided that the best way to mitigate this impact is by recruiting participants through social media in addition to sending them emails. Therefore, I posted about the study on social media with link to the online survey. Platforms that we targeted included Twitter, Whatsapp, Instagram and Facebook. However, recruitment went extremely slow compared to the face-to-face recruitment and this has led to massive delay in my progress, however this was totally out of my control. However, this delay in recruitment and data collection in Lebanon has eventually delayed data cleaning, data entry, and data analysis. Therefore, my research plan was obviously impacted by the COVID pandemic, and my research progress went slower.

Despite the delays and challenges, I feel that I have managed to progress well within my PhD and found proper alternative ways to maintain the pace of work and achieve my goals.

The next chapter outlines the systematic review that underpins this doctoral work.

Chapter 2 Literature Review

In phase 1, a systematic review and meta-analysis were conducted to establish the current state of knowledge regarding the association between perceived stress and dietary quality/patterns among women of reproductive age.

The decision was made to focus on observational studies because of the interest in the exposure (stress) on outcome (diet quality). The review was subsequently published in the journal BMC Nutrition Journal and this paper is replicated here.

https://doi.org/10.1186/s12937-020-00609-w

Nutrition Journal

REVIEW Open Acces

Perceived stress and diet quality in women of reproductive age: a systematic review and meta-analysis

Karim Khaled[1], Fotini Tsofliou[1,2*], Vanora Hundley[2], Rebecca Helmreich[3] and Orouba Almilaji[4]

Abstract

Background: Poor diet quality is associated with obesity-related morbidity and mortality. Psychological stress can increase unhealthy dietary choices, but evidence pertinent to women of reproductive age remains unclear. This paper systematically reviewed the literature to determine the association between psychological stress and diet quality in women of reproductive age.

Methods: Medline, CINAHL, Scopus, Cochrane Library, Web of Science, and Sciencedirect were searched. Data extraction was determined by the PEO. Inclusion criteria consisted of: English language, stress (exposure) measured in combination with diet quality (outcome), healthy women of reproductive age (18–49 years old (population)). Observational studies, due to the nature of the PEO, were included. Quality assessment used the Risk of Bias in Non-randomised Studies from the Cochrane Handbook of Systematic Reviews of Interventions. Meta-analysis was conducted using random-effect model to estimate the Fisher's z transformed correlation between stress and diet quality with 95% confidence interval (CI).

Results: From 139,552 hits, 471 papers were screened; 24 studies met the inclusion criteria and were conducted in different countries: 8 studies on diet quality and 16 on food intake and frequency of consumption. Studies of diet quality consisted of six cross-sectional and two longitudinal designs with a total of 3982 participants. Diet quality was measured with diverse indices; Alternate Healthy Eating Index (n = 2), Healthy Eating Index (n = 2), Dietary Approach to Stop Hypertension (DASH) Diet Index (n = 2), Dietary Quality Index- Pregnancy (n = 2), and Dietary Guideline Adherence Index (n = 1). Most studies used Cohen's perceived stress scale and no study measured biological stress response. After sensitivity analysis, only 5 studies (3471 participants) were included in the meta-analysis. Meta-analysis revealed a significant negative association between stress and diet quality with substantial heterogeneity between studies ($r = -0.35$, 95% CI [− 0.56; − 0.15], p value < 0.001, Cochran Q test $P < 0.0001$, $I^2 = 93\%$).
The 16 studies of food intake and frequency of consumption were very heterogeneous in the outcome measure and were not included in the meta-analysis. These studies showed that stress was significantly associated with unhealthy dietary patterns (high in fat, sweets, salt, and fast food and low in fruits, vegetables, fish, and unsaturated fats).

Conclusion: Future studies that explore diet quality/patterns should include both diet indices and factor analysis and measure biological markers of stress and dietary patterns simultaneously.

Keywords: Diet quality, Diet, Stress, Women, Reproductive age, Systematic review, Meta-analysis

* Correspondence: ftsofliou@bournemouth.ac.uk
[1]Department of Rehabilitation & Sport Sciences, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth BH1 3LT, UK
[2]Centre for Midwifery, Maternal & Perinatal Health, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth BH1 3LT, UK
Full list of author information is available at the end of the article

Background

The rate of obesity has increased alarmingly in the past twenty years across all age groups, especially among young adults [1]. In women of reproductive age, obesity is associated with type-2-diabetes, hypertension, decreased fertility and delayed conception, high birthweight and congenital anomalies [2–4]. These women are at increased risk of obesity related morbidity and mortality especially during pregnancy when metabolic complications might deteriorate and cause gestational diabetes, pre-eclampsia, miscarriage, and various cardiovascular disorders putting both the mother and baby at increased health risk [5]. Preventing weight gain in women of reproductive age through healthy diet is crucial and would benefit the next generation [6, 7]. Poor dietary patterns are major predictors of increased adiposity and a higher diet quality is associated with reduced risk of obesity-related metabolic disorders [6, 8]. Recently, diet patterns have been derived in nutrition epidemiological studies by measuring the whole diet instead of single nutrients [9]. Indeed, the overall food pattern is considered a more realistic approach to investigate the association between diseases and food consumption rather than single nutrients [9]. Diet patterns/quality can be estimated via a posteriori approach based on statistical methods such as factor analysis, or a priori- defined diet quality score which measures adherence to specific dietary pattern indices such as the Mediterranean Diet Index [10]. These healthy dietary patterns (e.g. Mediterranean diet) have been associated with decreased risk of cardiovascular disease, diabetes, cancer, and hypertension in women of reproductive age, and this is why they are used to measure diet patterns/quality in recent epidemiologic studies [11, 12].

There are several factors that might affect diet patterns/ quality such as adiposity, smoking, age, income, educational level, race/ ethnicity, marital status, and psychological factors [13, 14].

Particularly, there has been a growing interest in the role of stress in relation to human health [15, 16]. Stress is defined as an individual's perception, appraisal, and response to a stimulus exhibited by the surrounding environment [17], and it happens when the person's adaptive capacity is surpassed by the stimuli and demands of the environment [18]. Stress has been associated with diet patterns in young adults, and the dietary responses to stress are individualized [19, 20]. For example, some reviews and longitudinal studies investigated the effects of stress on energy intake and have found that with high levels of stress, 40% of people eat more, 40% eat less, and 20% eat the same amount of food compared to that consumed in the absence of stress [21–23]. The variance in the response to stress might be due to the duration of exposure to stress, the type of stressor, and the variation in the level of hunger and satiety at the start of the studies [24]. For example, mild/chronic stressors (such as long-term poverty, unemployment, unhappy marriage, etc.) increase the desire for food intake and binge eating, while sever/acute stressors (such as an upcoming work deadline or exam) induce restriction of food intake [24]. It is fundamental in this context to understand the types of food that are consumed and restricted under stress in order to estimate its health consequences. In general, studies have reported that highly stressed participants tend to consume hyper-palatable foods that are high caloric, low nutrient-dense (e.g. butter, cream cheese, full-fat products), and high fat foods even when there is no hunger or bodily demand for food [25–27]. The effects of stress have been found to be exacerbated in obese (BMI > 30 kg/m^2) compared to normal weight individuals because the former have higher insulin resistance than the latter and demonstrate significantly higher activation of brain reward regions when exposed to stress [24, 28].

Recent studies among young adults and university students have found that perceived stress is a serious contributor to low diet quality [29, 30]. The

majority of these studies have focused on food groups (such as fat intake) as a result of stress, rather than assessing the diet quality (a priori/ a posteriori) [30–32]. For example, there is evidence that females (18–29 years old), who report high levels of perceived stress (measured through the 14-item perceived stress scale), consume more fat than non-stressed females as assessed by the Night Eating Questionnaire [30–32]. When fruits and vegetables consumption was assessed in women of reproductive age, perceived stress was found to significantly decrease their intake [15, 16, 33–36]. Studies that have examined stress and diet have been limited in their approach. Habhab et al. [31] assessed the association between perceived stress and diet in females of reproductive age and found that participants in the high stress group (given unsolvable Sudoku) consumed more fats and sweets (measured through the Emotional Eating subscale) than individuals in the low stress group (given easy Sudoku). However, the sample size was small (40 participants), baseline hunger status was not measured, and the assignment of participants to low or high stress groups might have by chance assigned stressed individuals to the high stress group. In a study by Barrington et al. [37], higher levels of perceived stress were associated with higher fast food consumption in young women. However, the study used non validated single item scale to measure fast food intake.

In summary, the picture regarding the association between stress and diet in women of reproductive age remains unclear. This has gained attention recently, especially that diet-related diseases have been trending over the past few years among these women and studying the factors that might affect diet (such as stress) became crucial. To our knowledge, this is the first review of the association between stress and dietary patterns/quality specifically in women of reproductive age. The aim of this systematic review is to critically appraise the current literature and identify whether women who exhibit higher levels of stress have a poorer diet pattern/quality than women who exhibit lower levels of stress.

Methods

The Meta-analysis of Observational Studies in Epidemiology (MOOSE) was used to guide this systematic review [38]. The association between psychological stress and diet quality was examined using the PEO (Population, Exposure, and Outcome) model: Population (women aged 18– 49 years old), Exposure (Psychological Stress), Outcome (Diet Quality/Patterns of women of reproductive age).

Search strategy

A literature search was conducted in December 2019 in Medline complete, CINAHL Complete, Scopus, Cochrane Library, Web of Science, and Sciencedirect. These databases were searched using appropriate key words and index terms where the PEO (Population, Exposure, and Outcome) model framed the search process (Table 1 in Additional file 1). The key words were then combined by the EBSCO host operator AND/OR. The databases search was limited to human studies and English language articles published between 2000 and 2019. The search strategy (Title/Abstract) is demonstrated in Additional file 1.

Alongside title and abstract searching, Medical subject headings (MeSH) were used when searching MEDLINE and CINAHL subject headings when searching CINAHL. The key terms used were: “psychological stress” AND “Diet”. Additionally, reference lists were checked, and authors of unpublished papers were contacted by email.

Selection of studies

The reviewer (KK) screened the full texts of all potentially relevant papers, including those over which there was doubt, with excluded articles also reviewed by the second reviewer (FT) to ensure that studies are not erroneously excluded. Any

disagreements were resolved by discussion, or arbitrated if necessary, by a third reviewer (VH). Similarly, if eligibility was unclear, this was discussed across the wider team (KK, FT, and VH).

Inclusion and exclusion criteria

Studies were included in the review if they: i) enrolled healthy women aged 18–49 years old, ii) measured psychological stress (subjective and/or objective) as an exposure in combination with diet, iii) comprised observational quantitative studies looking at the association between stress and diet quality, iv) were in English language. Due to the limited resources available, it was not possible to translate non-English papers.

For studies in which the sample's age range may in part be below or over the specified age range for this review, they were included if the mean age of the sample was between the age range of 18–49 years.

Articles were excluded if they: i) used qualitative methods, ii) enrolled exclusively men or participants with mean age outside the age range of 18–49 years old; iii) did not report stress data in a format that could be extracted; iv) comprised study sample with health conditions that may confound the diet stress relationship (e.g. depression, mental disorders, heart disease, diabetes, cancer, coeliac disease, eating disorders). Abstracts and unpublished studies were not included in this systematic review.

Data extraction

Data extraction and coding stages of the review were completed by the first reviewer (KK) using structured data extraction forms. The following information was extracted from the manuscripts: first author, year of publication, location, study design, number of subjects, period of enrolment and follow-up, age, the exposure (self-reported stress measured via validated stress scales and/or via biological marker (e.g. cortisol levels in blood, hair or saliva)). A proportion of the extracted data (30%) was checked for accuracy by second reviewer (FT).

For the purpose of meta-analysis, a dataset containing the 7 studies [39–45] that initially qualified for metaanalysis was built. Ferranti et al. [10] was not among these studies as it did not report any effect size and hence should not be qualified for meta-analysis. The dataset was developed with the help of reviewer (OA) and included the following information from the studies: effect size, number of participants, first author surname, and year of publication. When only β coefficient was reported in any study, a proper conversion was carried out to transform β coefficient to correlation coefficient "r". This was undertaken using the formula of imputing r value from β [54]: $r = 0.98\,\beta + 0.05\,\lambda$ (restricted only to linear models and β values between ±0.5), where λ is an indicator variable that equals 1 when β is nonnegative and 0 when β is negative [54]. In the study by Richardson et al. [39]: $r = 0.98\,(-0.18) + 0.05\,(0) = -0.1764$. The β coefficient in Isasi et al. [40] is not within the exact range (± 0.5), however due to the large sample size in the study and the proximity of its β coefficient value to the range in the formula of imputing r from β, the formula was applied as follows: $r = 0.98\,(-0.61) + 0.05\,(0) = -0.5978$. The formula was not applied to Valipour et al. [42] as it is based on categorical dependent variable model, so this study was also excluded from the meta-analysis.

Study outcomes

Study outcomes included: dietary components (e.g. fat intake, alcohol intake, healthy versus unhealthy diet patterns) or adherence to diet indices (e.g. Alternate Healthy Eating Index (AHEI), the Dietary Approaches to

Table 1

Table 2: (Chapter 2, Table 1) - Characteristics extracted from the 24 included studies: BS (Breakfast skippers), BE (Breakfast eaters), CS (Cross-Sectional), LG (Longitudinal), y (years), m (months), FFQ (Food Frequency Questionnaire), WFR (Weigh food record), SES (Socioeconomic status), PA (Physical Activity), AM (Anthropometric measures), − (not reported)

Author, Year	Country	Age and Number of Participants	Study Design	Participants in Study	Dietary Assessment Tool	Confounding Factors Identified
			8 studies on Diet Quality			
Richardson et al. 2015 [39]	USA	18–44 y, N = 101	CS	Women who had a child up to age 5	24-h Dietary recalls	SES, AM
Ferranti et al. 2013 [10]	USA	Mean age 48 y, N = 433	LG (5 y follow up)	University and health center employees	FFQ	SES, PA, AM,
Isasi et al. 2015 [40]	USA	18–74 y, N = 3141	LG (9 m follow up)	Hispanic/Latino males and females	24-h Dietary recalls	SES, PA, AM
El Ansari et al. 2015 [41]	Egypt	16–30 y, N = 1483	CS	Undergraduate students males and females	FFQ	SES, PA, AM
Valipour et al. 2017 [42]	Iran	28–45 years old, N = 2134	CS	General Adults	FFQ	SES, PA, AM
Fowles et al. 2012 [43]	USA	Mean age 24.7 y, N = 71	CS	Low income pregnant women	24-h Dietary recalls	SES, AM
Fowles et al. 2011 [44]	USA	Mean age 25 y, N = 118	CS	Low income pregnant women	24-h Dietary recalls	SES, AM
Widaman et al. 2016 [45]	USA	Mean Age 25.1, N = 35 (BS) Mean Age 24.1, N = 40 (BE)	CS	Female habitual breakfast eaters and breakfast skippers	24-h Dietary recalls	PA, AM
			16 studies on Food Intake and Frequency of Consumption			
Vidal et al. 2018 [1]	Peru	Mean Age: 19 y, N = 272	CS	Undergraduate students	Block fat screener	SES
Nastaskin et al. 2015 [46]	Canada	Mean age: 20 y, N = 113	CS	Students	Block fat screener/ Block sodium screener	SES, AM
Pettit et al. 2011 [47]	USA	18–24 y, N = 78	CS	Undergraduate students	Energy drink intake questions	SES
Mikolajczyk et al. 2009 [34]	Germany, Poland, Bulgaria	Mean age: 20 y, N = 1201	CS	Fist year undergraduate students	FFQ	–
Errisuriz et al. 2016 [48]	USA	Mean age: 18.9 y, N = 433	CS	Freshman students	Food and beverage frequency questions	SES, AM
El Ansari et al. 2014 [15]	UK	Mean age: 24.9 y, N = 2699	CS	Students	FFQ	–
Ng et al. 2003 [49]	USA	Mean age: 40 y, N = 6620	CS	Working adults	Block Fat Screener/ Alcohol frequency questions	SES, PA

Barrington et al. 2012 [37]	USA	18–65 y, N = 357	CS	Working adults	Single-item question for fast food intake/ 5-A-Day fruit & vegetable assessment tool	SES, PA, AM
Grossniklaus et al. 2010 [50]	USA	Mean age: 41.3 y, N = 64	CS	Working adults	3-day WFR	SES, AM
Papier et al. 2015 [16]	Australia	Mean Age 21.2 y, N = 397	CS	Students	FFQ	SES, PA, AM
Roohafza et al. 2013	Iran	Mean age: 38.4–39.5 y, N =	CS	General adults	FFQ	SES, PA, AM

Table 1 Characteristics extracted from the 24 included studies: BS (Breakfast skippers), BE (Breakfast eaters), CS (Cross-Sectional), LG
(Longitudinal), y (years), m (months), FFQ (Food Frequency Questionnaire), WFR (Weigh food record), SES (Socioeconomic status), PA (Physical Activity), AM (Anthropometric measures), – (not reported) (Continued)

Author, Year	Country	Age and Number of Participants	Study Design	Participants in Study	Dietary Assessment Tool	Confounding Factors Identified
[35]		9549				
Gonzalez et al. 2013 [51]	Puerto Rico	21–30 y, N = 186	CS	First and second year students	Alcohol frequency questions	SES
Tseng et al. 2011 [36]	USA	Mean age 43.9 y, N = 426	CS	Premenopausal women	48- h Dietary recalls	SES
Hinote et al. 2009 [33]	8 post-Soviet republics	> 18 y, N = 10, 454	CS	General adults	Questions about frequency of consumption	SES
Hwang et al. [52]	Korea 2010	Mean age: 23.7 y, N = 570	CS	Vietnamese female marriage immigrants	1-day Dietary recalls	SES, PA, AM
Wardle et al. [53]	UK 2000	Mean Age: 36.29 y, N = 58	CS	Staff of a store	24-h Dietary recalls	SES, AM

Stopping Hypertension (DASH), and the Mediterranean Diet Score (MDS)).

Quality evaluation

The first and second reviewers (KK, FT) assessed bias in all eligible studies using the Risk of Bias in Nonrandomised Studies [55], which is recommended by the Cochrane Handbook of Systematic Reviews of Interventions [56]. The bias domains included in the quality assessments were bias due to confounding, bias in selection of participants, bias in classification of interventions, bias due to deviations from intended interventions, bias due to missing data, bias in measurement of outcome, bias in selection of the reported results.

Any conflicting opinion of quality of studies was discussed with the third reviewer (VH).

Meta-analysis

Meta-analysis was performed based on the Cochrane Handbook for Systematic Reviews of Interventions and Borenstein book on meta-analysis [57, 58]. Fisher's z transformation of correlation was used as a summary measure of the association between diet quality and stress, whereby correlation coefficients were converted to Fisher's z scale. Due to heterogeneity of the studies, particularly with respect to studies' participants and the methods of measuring the exposure and the outcome, a random effect model has been applied for the metaanalysis. Higgin's & Thompson's I^2 and

Cochran's Q measures were used to assess the between-study heterogeneity [58]. Outliers and influential studies were detected by identifying any study with a confidence interval that did not overlap with the confidence interval of the pooled effect through Baujat plot [57]. Publication bias was assessed through a Funnel plot. Sensitivity analysis was performed by applying trim and fill method [57, 58]. Following the Cochrane Handbook recommendations, a risk-of-bias assessment was performed for all included studies by creating a "weighted bar" which plots the distribution of risk-of-bias judgements within each bias domain. The figure was formatted according to the risk-of-bias assessment tool (ROBINS-I).

Results

The databases identified 139,552 hits; only 471 had a relevant title (Fig. 1; (MOOSE Checklist in Additional file 2). The titles and abstracts of these articles were screened further and 382 were deemed not relevant which yielded 89 articles for fulltext screening. A further 65 studies were subsequently excluded as they did not meet the criteria. Three studies were eliminated after quality assessment for the following reasons: one study did not have a methods section [59] and two studies measured the emotional/psychological domain of eating as an outcome (disordered eating/emotional eating) [60, 61]. A total of 24 studies were included in the review: 8 studies on diet quality (measured the adherence to specific dietary indices as outcome) and 16 studies on food intake and frequency of consumption which reported consumption of different food components and nutrients as proxy measure for dietary patterns (Tables 1, 2, and 3 in Additional files 3, 4 and 5 respectively).

Characteristics of included studies

Two out of the eight studies that assessed diet quality were longitudinal cohort studies: [10] included 5 years of follow-up (n = 429), while [40] followed participants for 9 months (n = 3141) (Table 1). Both studies investigated psychological stress via the Perceived Stress Scale (PSS) at baseline; however, diet quality was investigated through different methods: [10] used food frequency questionnaire at baseline while [40] used two 24-h dietary recalls. The other six studies were cross-sectional, published between 2011 and 2017, and included a total

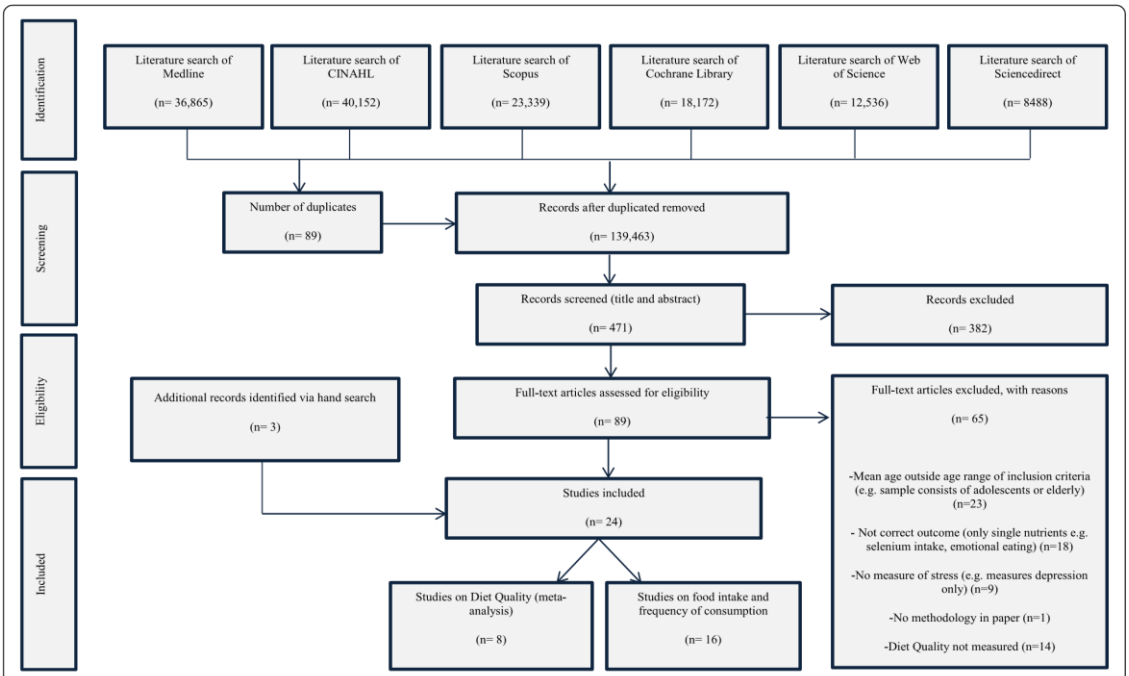


Fig. 1 Meta-analysis of Observational Studies in Epidemiology (MOOSE) flow chart

Figure 3: (Chapter 2, fig 1) – Meta-analysis of Observational Studies in Epidemiology (MOOSE) flowchart

Table 3: (Chapter 2, Table 2) - Data values extracted from the included eight studies on Diet Quality: β (Beta coefficients), r (correlation coefficient), OR (Odd Ratio), ↑ (increase), ↓ (decrease), <= > (no association)

Author, Year	Stress Assessment Tool	Diet Quality Index	Association between Stress and Diet Quality	β coefficient, r, or OR
Richardson et al. 2015 [39]	- 14-item Perceived Stress Scale	- Healthy Eating Index 2010	<=>	β = − 0.18 (S.E 0.10, p = 0.08)
Ferranti et al. 2013 [10]	- 14-item Perceived Stress Scale - Beck Depression Inventory II	- Alternate Healthy Eating Index - Mediterranean Diet Index - Dietary Approach to Stop Hypertension Index	<=>	Not reported
Isasi et al. 2015 [40]	- 10-item Perceived Stress Scale - 8-item Chronic stress burden	- Alternate Healthy Eating Index 2010	↓	β = − 0.61 (− 1.18 to − 0.03)
El Ansari et al. 2015 [41]	- 4-item Perceived Stress Scale	- Dietary Guideline Adherence Index	<=>	r = 0.00, p = 0.98 β = 0.00 (− 0.13 to 0.13)
Valipour et al. 2017 [42]	- 12-item General Health Questionnaire	- Dietary Approach to Stop Hypertension Index	<=>	OR: 1.02 (0.78–1.33)

Fowles et al. 2012 [43]	- Edinburgh Postnatal Depression Scale - Prenatal Psychosocial Profilestress subscale	- Dietary Quality IndexPregnancy	↓	r = −0.35, p is not reported
Fowles et al. 2011 [44]	- Edinburgh Postnatal Depression Scale - Prenatal Psychosocial Profilestress subscale	- Dietary Quality IndexPregnancy	↓	r = − 0.293, p < 0.01
Widaman et al. 2016 [45]	- Wheaton Chronic Stress Inventory	- Healthy Eating Index 2010	↓ in breakfast skippers <= > in breakfast eaters	Empty calories (r = − 0.392, p = 0.027) Empty calories (r = − 0.104, p = 0.53)

Table 3 Data values extracted from the included studies on food intake and frequency of consumption: ↑ (increase), ↓ (decrease),
<= > (no association)

Author, Year	Stress Assessment Tool	Association between Stress and the measured Food intake and frequency of consumption	Values
Vidal et al. 2018 [1]	14-item Perceived Stress Scale	↑ Fat intake	p = 0.005
Nastaskin et al. 2015 [46]	14-item Perceived Stress Scale	↑ Fat intake	r=. 35, p < 0.01
		↑Sodium intake	r=. 23, p = 0.07
Pettit et al. 2011 [47]	14-item Perceived Stress Scale	↑ Energy Drink intake	r=. 235, p < 0.01
Mikolajczyk et al. 2009 [34]	14-item Perceived Stress Scale	↑ Sweets, cookies, snacks, fast food	p = 0.03
		↓ Fruits/vegetables	p < 0.01
Errisuriz et al. 2016 [48]	Perceived stress single item scale (0–10)	↑ Soda, coffee, energy drink, salty snack, sweet snack, frozen food, and fast food consumption	p < 0.05
El Ansari et al. 2014 [15]	4-item Perceived Stress Scale	↑ Sweets, cookies, snacks, fast food	P = 0.017
		↓ Fruits and vegetables	P = 0.002
Ng et al. 2003 [49]	4-item Perceived Stress Scale	↑ High Fat diet	p < 0.01
		<= > Alcohol intake	p = 0.4
Barrington et al. 2012 [37]	10-item Perceived Stress Scale	↑ Fast food intake	z = 3.00, P = .003
		↓ Fruits and vegetables intake	z = − 3.01, P = .003
Grossniklaus et al. 2010 [50]	Perceived Stress Scale	<= > food and beverage intake	p > 0.05
Papier et al. 2015 [16]	Depression Anxiety Stress Scale (DASS)	↑ processed foods	p < 0.01
		↓ meat alternatives	p < 0.05
		↓vegetables and fruits	p < 0.01
Roohafza et al. 2013 [35]	-A12-item General Health Questionnaire (GHQ-12)	↑ Saturated oils	p < 0.01
		↓ Unsaturated oils	p < 0.01
		↓ Fruits	p < 0.01
		↓ Vegetables	p = 0.02
		↓ Meat	p = 0.03
		↓ dairy products	p < 0.01

Gonzalez et al. 2013 [51]	Cognitivist Systemic Model Academic Stress scale	↑ Alcohol intake	p < 0.05
Tseng et al. 2011 [36]	Migration–Acculturation Stressor Scale	↑ Energy density	-(β = 0.002, p = 0.04)
		↑ % energy from fat	-(β = 0.06, p = 0.05)
		↓ total grams of grains	-(β = −11.3, p < 0.0001)
		↓ Overall grain intake	-(β = −0.18, p = 0.03)
Hinote et al. 2009 [33]	12-item distress scale	↓ Meat, fish, vegetables, fruits, animal fat	p < 0.001
Hwang et al. 2010 [52]	Psychological Well-Being Index	↓ energy intake	-p = 0.011
		↓ carbohydrates	-p = 0.004
		↓ protein	-p = 0.021
		↓ fat	-p = 0.021
		↓ calcium	-p = 0.042
		↓ vitamin A -p = 0.039 ↓ zinc -p = 0.005	
		↓ thiamine	-p = 0.006

Table 3 Data values extracted from the included studies on food intake and frequency of consumption: ↑ (increase), ↓ (decrease), <= > (no association) (Continued)

Author, Year	Stress Assessment Tool	Association between Stress and the measured Food intake and frequency of consumption	Values
		↓ riboflavin	-p = 0.013
		↓ folate	-p = 0.004
Wardle et al. 2000 [53]	10-item Perceived Stress Scale	↑ energy intake, ↑ saturated fats intake, ↑ fat intake	p < 0.05, p < 0.01, p < 0.05

of 3982 participants [39, 41–45]. Only two out of the eight studies were conducted outside of the USA [41, 42]. Two studies included pregnant women of reproductive age who fall in the age range 19–49 years old [43, 44]. Four studies recruited females only (18–45 years old) [39, 43–45] while the other four recruited both males and females (16– 74 years old) [10, 40–42].

The 16 studies on food intake and frequency of consumption did not assess diet quality, but instead measured the different food components and nutrients. As a result, the studies were very heterogeneous. Studies were all of a cross sectional design and published between 2000 and 2018. Six studies were conducted in USA, two in UK, and the remaining eight were conducted in other countries. Two studies took place in more than one country: Mikolajczyk et al. [34] was done in three European countries (Germany, Poland, Bulgaria) and Hinote et al. [33] was done in eight post-Soviet republics. In only two studies, participants were 100% females; the rest had both males and females with more than half of the participants were females in all of these studies. One study did not specify the percentage of females in its sample [35]. Mean age of participants was between 18.9 and 43.9 years and the number of female participants ranged from 52 to 10,454 per study.

Findings of the studies

In four of the eight studies on diet quality, stress was not associated with diet quality [10, 39, 41, 42], while in another three studies; stress was significantly associated with poorer diet quality [42.40.41] (Table 2). Interestingly, one study found that stress was significantly associated with lower diet quality in breakfast skippers only while no association was found in breakfast eaters [45].

The three studies that reported β coefficients indicated mixed results; two found no association [10, 41] and one found poorer diet quality when individuals were stressed [40]. Studies that reported correlation coefficient "r" found negative association between stress and diet quality [43, 44], no association [41], and mixed results (negative association in breakfast skippers/no association in breakfast eaters) [45] as shown in Table 2.

The outcomes of the 16 studies on food intake and frequency of consumption were very heterogeneous and thus it was not possible to perform a meta-analysis (Table 3). All studies that assessed fat intake found that perceived stress was significantly associated with increased fat consumption [1, 36, 46, 49, 53]. Only Hwang et al. [52] reported a significant decrease in fat intake, along with decreased intake of energy, carbohydrates, protein, calcium, vitamin A, zinc, thiamine, riboflavin, and folate, as a result of high stress ($p < 0.05$). The intake of fruits, vegetables, and grains was found to be significantly lower in individuals with higher stress ($p < 0.02$) [15, 16, 33–37]. Some studies assessed the intake of fast food, sweets, snacks, and energy drinks and found a direct association between these foods and perceived stress ($p < 0.05$) [15, 34, 37, 47, 48]. The consumption of meat and meat alternatives was measured in three studies and was inversely correlated with stress ($p < 0.05$) [16, 33, 35]. Mixed results were found in two studies that assessed alcohol intake: Gonzalez et al. [51] found that perceived stress was significantly associated with greater consumption of alcohol ($p < 0.05$) whereas Ng et al. [49] found no significant association ($p = 0.4$).

Meta-analysis

Using the aforementioned methods for meta-analysis, 6 studies on diet quality were eligible for the meta-analysis [39–41, 43–45].

Assessment of heterogeneity

Outliers and influential analysis identified one outlier study [41]. Before removing this study from the analysis, the pooled effect was r = − 0.28 (95% CI [− 0.45; − 0.08], p value< 0.01). The overall effect size estimate (pooled correlation) was recalculated after removing this study and revealed a medium, negative, and very significant correlation (r = − 0.34, 95% CI [− 0.51; − 0.15], p value < 0.001) with 95% prediction interval of [− 0.80; 0.37]. These results (Fig. 2) suggest that a higher stress level was associated with poorer diet quality, and vice versa. The I^2 heterogeneity measure in this analysis was substantial (93%), indicating significant variability across the studies (heterogeneity) and supporting the use of a random-effects model. Additionally, this conclusion was supported by Cochran's Q test of heterogeneity which showed a very significant P value (< 0.0001).

Given the broad prediction interval in Fig. 2, which stretched well above zero, we cannot be 100%

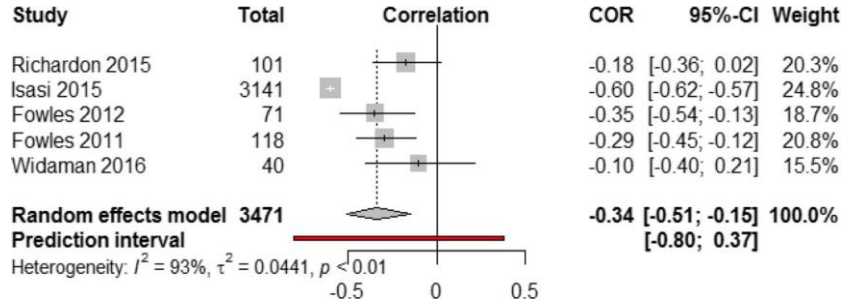


Fig. 2 Association between stress and diet quality (five studies based on correlation coefficient "r" and converted β coefficients to "r")

Figure 4: (Chapter 2, fig 2) – Association between stress and diet quality (five studies based on correlation coefficient "r" and converted β coefficients to "r")

confident that the negative correlation between stress and diet quality found in this meta-analysis will be robust in every context.

Publication Bias

The funnel plot created was asymmetrical (Additional file 6). The asymmetry was mainly driven by one small size study [45] that has a large standard error and was shown in the bottom-right corner of the plot. This resembles a publication bias. Although this might occur due to chance, it might have also been comprised as a result of heterogeneity. The number of studies included in the meta-analysis was too small (5 studies) to test for significance of funnel plot asymmetry.

Sensitivity analysis

Trim-and-fill procedure identifiedthree studies(Additional file7) and assumed that initial results were underestimated due to publication bias. The true effect might be r=−0.57 (95% CI [− 0.75; −0.31], p value<0.01) rather than r= −0.34. Due to the assumed missing studies (small size studies reporting large effect sizes) and the small number of studies in this metaanalysis, the result of sensitivity analysis (r=−0.57) is not considered a more valid estimate of the pooled correlation.

Quality assessment

Using "robvis" package, a weighed bar plot of the distribution of risk-of-bias judgments within each bias domain (Fig. 3) was generated to visualize the quality assessment performed for the 24 studies that were included in this systematic review.

Fig. 3 shows that most studies scored moderate with regards to bias in measurement of outcomes, selection of the reported results, and the overall risk of bias. More than 75% of studies had a critical risk of bias due to missing data. When it came to the bias due to confounding and selection of participants, around 90% of studies had a low risk, and most studies scored not available (NA) risk with regards to bias due to classification of interventions and deviations from intended interventions.

Recruitment procedure

Recruitment procedures were very different among studies. In the eight studies on diet quality, three used data from participants enrolled in large cohorts from previous projects [10, 40, 42] while Fowles et al. [43, 44] recruited low income pregnant women in clinics using recruitment cards and forms (Table 1). The staff of a nutrition program helped Richardson et al. [39] identify women eligible for the study and the study staff asked them for their interest. Widaman et al. [45] recruited participants through advertisements on local newspapers, websites, and posted flyers while university students were recruited by distributing questionnaires during lectures [41]. Ethical approval was granted in seven studies and one study [40] did not give information regarding the ethical approval of the study.

Among the 16 studies of food intake and frequency of consumption, five studies used previous data of large cohort studies [33, 35, 37, 49, 52]. Eight studies recruited participants who were students through posters, flyers, or classroom visits at different university campuses [1, 15, 16, 34, 46–48, 51]. Participants of the three remaining studies were recruited differently; through community organizations [36, 50] or from staff of a large department store [49]. Three studies did not provide information regarding ethical approval [33, 49, 53], whereas all other thirteen studies mentioned that ethical approval was given prior to conducting the studies.

Exposure: perceived stress

In four of the eight studies that assessed diet quality [10, 39–41], the Perceived Stress Scale (PSS) was used as a measure of psychological stress, whereas the other four studies used different scales such as: the General Health Questionnaire [42], the Prenatal Psychosocial Profile stress sub-scale [43, 44], and Wheaton Chronic Stress Inventory [45]. None of the studies used biomarkers of psychological stress (e.g.

salivary cortisol) as a measure of the exposure.

All 16 studies that assessed food intake and frequency of consumption measured stress through self-reported measures: 10 studies used the Perceived Stress Scale [1, 15, 34, 37, 46–50, 53] and the six remaining studies used different other scales (Table 2).

Dietary assessment

A variety of dietary instruments were used to assess habitual dietary intake in the eight studies that assessed diet quality. Three studies [10, 41, 42] used different Food Frequency Questionnaires (FFQs) to assess dietary intake (Table 1). The other five studies used 24-h dietary recalls for either: three days [43–45], two days [40], or one-to-two days [39].

With respect to diet quality, all studies used the a priori defined method (using diet indices) to derive the diet quality. A variety of diet quality indices were included: i) Alternate Healthy Eating Index [10, 40], ii) Healthy Eating Index [39, 45], iii) The Dietary Approach to Stop Hypertension (DASH) Diet Index [10, 42], iv) Dietary Quality Index- Pregnancy [43, 44], v) Dietary Guideline Adherence Index [41]. Interestingly, only one study combined three diet quality indices to measure diet quality [10], while all other studies used only one index. No study was found to assess diet quality via a posteriori approach i.e. to define diet patterns with statistical methods such as Factor

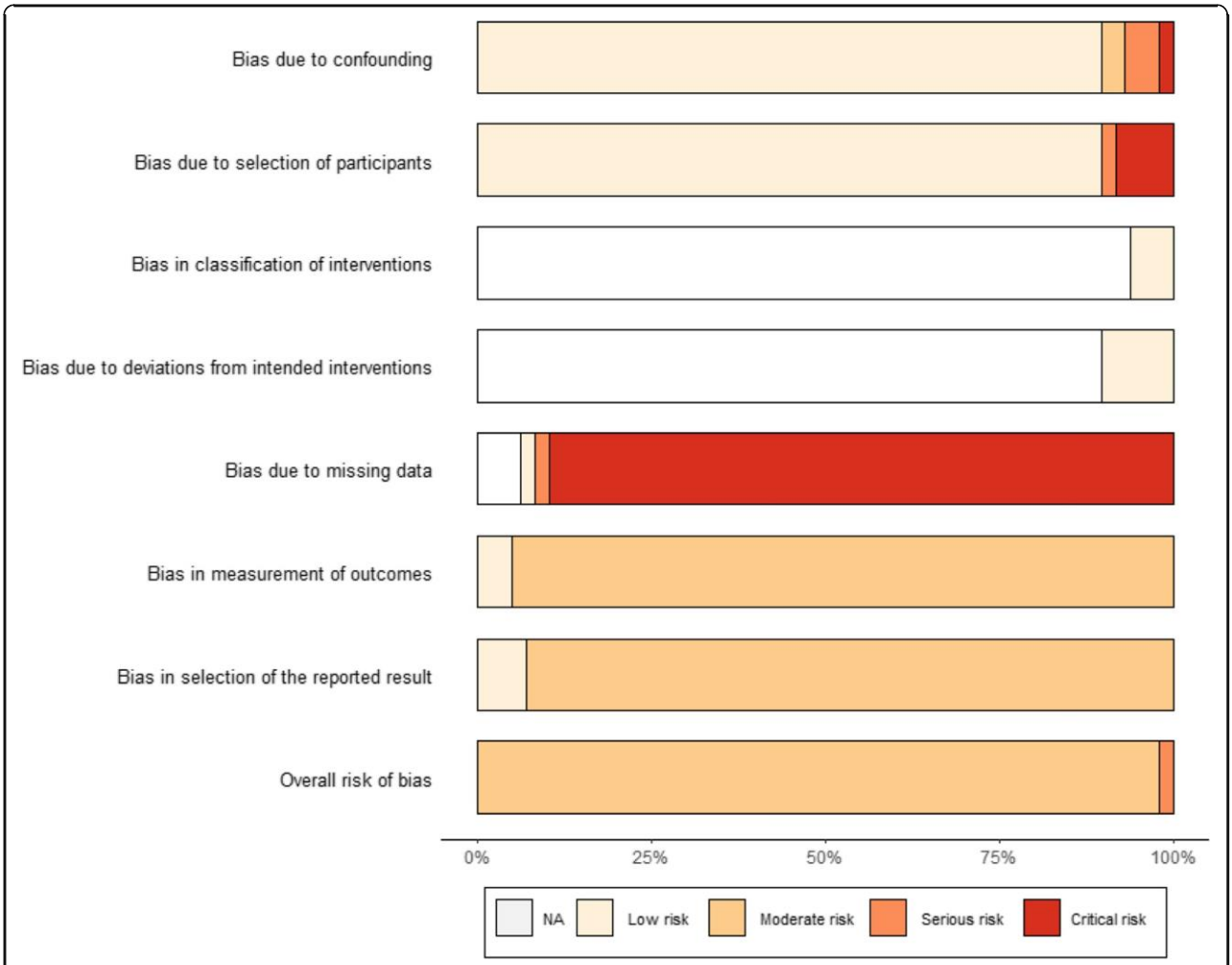


Fig. 3 Weighed bar plot of the distribution of risk-of-bias judgments within each bias domain

Figure 5: (Chapter 2 fig 3) - Weighed bar plot of the distribution of risk-of-bias judgments within each bias domain

Analysis.

There was also diversity in the tools used to assess food intake and frequency of consumption. Four of the 16 studies used food frequency questionnaires [15, 16, 34, 35], three used dietary recalls [36, 52, 53], another three used Block fat screener [1, 46, 49], two used alcohol intake frequency questions [49, 51], one used Block sodium screener [46], and one used weighed food records [50]. The remaining studies used different questions about food and beverages consumption (Table 1).

Confounding factors

Table 1 indicates that seven of the eight studies of diet quality identified and corrected for socioeconomic status of participants as confounding factor. The exception was the study by

Widaman et al. [45]. One study identified only age and educational level as means of socioeconomic status [44]. Three out of the eight studies did not assess the physical activity level of participants [39, 43, 44]. The anthropometric measures of participants were measured in all eight studies, either through BMI [10, 39, 41, 43–45] or both Waist Circumference and BMI [40, 42]. Smoking status was reported in three studies [42–44], marital status in five [10, 39, 42–44], and energy intake in three [10, 40, 45].

In the 16 studies of food intake and frequency of consumption, two studies did not identify or correct for confounding factors [15, 34]. All remaining studies identified socioeconomic status and demographic information of participants. Only five studies measured physical activity among participants [16, 35, 37, 49, 52]. BMI was reported in seven studies as a measure of adiposity [16, 35, 37, 46, 48, 50, 53] and only one study reported both waist circumference and BMI [52].

Discussion

Our findings suggest that stress appears to impact diet negatively regardless of the various dietary outcomes measured among studies. Stress decreased diet quality and contributed to unhealthy dietary patterns, particularly high fat, fast food, sweets, and energy dense foods. In contrast stress lowered the intake of fruits, vegetables, fish and unsaturated oils.

The mixed results, especially in the eight studies on diet quality, highlights the disparity of evidence that exists in the literature regarding the association between stress and diet quality for the general population. In other populations, such as adolescents, perceived stress has been associated with poorer diet quality, measured through Diet Quality Index for Adolescents (DQI-A) ($\beta = -0.04$, $p < 0.01$), [62]. An inverse association has been also reported in a systematic review with regards to mental health (including stress) and diet quality in children and adolescents [63] while Sims et al. [61] found no association between perceived stress and diet quality among female African American adults.

In almost all 16 studies on food intake and frequency of consumption included in our review, higher perceived stress was associated with an unhealthy eating pattern, characterised by increased consumption of sweets, fast food, fats and lower consumption of fruits and vegetables. This is in line with studies of other populations. Increased stress in female undergraduate students and peri-menopausal women has been linked with greater consumption of high calorie foods [64, 65]. Similarly, O'conner et al. [32] showed that daily stress was associated with a higher intake of high fat/sugar food and a reduced intake of fruits and vegetables in women. Wichianson et al. [30] found that stress was associated with unhealthy night-eating syndrome (NES) in a sample of 95 college students ($\beta = 0.259$, $p < 0.05$). Interestingly, one of the 16 studies on food intake and frequency of consumption found that stress was linked with decreased fat intake (along with all macro- and micronutrients) [52]. This contradicts the majority of studies in the field with only Torress et al. [23] finding an inverse association between stress and fat. Torres et al. [23] assessed daily record of stress and diet among male and female students and found that participants consumed less food and dietary fat when they were stressed. These conflicting results indicate that there might be inter-individual variation in response to stress.

The differences in results presented in Tables 1 and 2 must be interpreted with caution due to the challenges in assessing dietary intake. The eight studies on diet quality used different methods to collect dietary data: five studies used 24-h recalls [39, 40, 43–45] and mainly found negative association between stress and diet quality, while three studies [10, 41, 42] used food frequency questionnaires and found no association between stress and diet quality, which might explain the

variance in the findings. Similarly, the 16 studies on food intake and frequency of consumption used food frequency questionnaires [15, 16, 34, 35], dietary recalls [36, 52, 53], block fat screener [1, 46, 49], and other different tools to assess dietary intake and found that stress was associated with the intake of unhealthy diet (higher fat, sweets, fast food, salt; lower fruits, vegetables, whole grains, and seafood). Although the use of food frequency questionnaires, 24-h dietary recalls, and the above-mentioned tools in nutrition epidemiology is quite common, measurement errors caused by self-reporting (under-reporting or over-reporting) of food intake occur leading to the manipulation of the expected associations. Furthermore, these dietary assessment methods might not be ideal for investigating the response to perceived stress; different methods such as ecologic momentary assessment, which aims to minimise recall bias, might be better in reporting dietary/behavioural responses to stress that take place in real time [40, 66].

Disparities exist between the two groups of studies in our review. Most of the 16 studies on food intake and frequency of consumption indicate that stress increases energy intake and food consumption [15, 36, 47, 48, 51–53]. In contrast, the majority of the eight studies on diet quality found no association between diet quality, which depends on food consumption, and stress. This can be explained mainly due to the diet quality indices used in the studies. Of the three studies that measured diet quality through the Healthy Eating Index (HEI) (including the Alternative HEI), two found no association between stress and diet quality [10, 39] and one found an inverse association [40]. However, out of the twelve scoring components of the HEI, nine will be scored higher if the intake of certain foods is higher which means that participants might have a higher energy and food consumption than they need and still score high on the HEI and have a higher diet quality. Moreover, the mixed findings could be related to the socioeconomic status of the participants as low socioeconomic populations tend to be more stressed than socially advantaged populations. A previous meta-analysis found that socioeconomically disadvantaged individuals had increased odds of being stressed and depressed (odds ratio = 1.81, $p < 0.001$) [67].

Two studies on diet quality were conducted among pregnant women [43, 44] and were included in the review since prenatal stress and diet are considered important for the intrauterine environment that affects several developmental outcomes [68–70]. The variation in diet quality of women during pregnancy has been associated with health outcomes of the fetus [71–76]. Similarly, maternal stress during conception is linked to disease risk and developmental outcomes of the fetus [68, 77–81]. More studies looking on diet and stress in this population and in the preconception stage are needed and should be conducted across different countries and with unified methodologies to allow comparison and confirm the stress/diet association.

Strengths and limitations of the study

With diet quality and food intake in women of reproductive age being significant predictors of obesity and complications during pregnancy, the present systematic review adds to the body of knowledge by providing evidence on the role of psychological stress in manipulating diet quality. This will help in developing stress reducing strategies and guide future health care. The large sample size of most studies is a major strength of the present review. Another strength is restricting the sample to healthy women where studies with sample that had health conditions such as depression, metabolic diseases, and eating disorders were excluded, because these conditions might manipulate the diet quality and are considered significant confounding factors.

However, the 24 studies in the review are very heterogeneous in both participants that they recruited and the methods that they used, making pooling of these results challenging. Most of the eight studies on diet quality were conducted in USA and only two studies were conducted in the

Middle East; no studies were conducted in Europe or Asia. This highlights the importance of conducting similar studies on diet quality among populations with different ethnicity and cultural backgrounds to confirm any possible differences. Another limitation is that in the 24 studies, stress was measured by selfreported stress scales and dietary intake was measured using 24-h recalls, food frequency questionnaires, or other self-reported questionnaires, which could lead to errors during dietary reporting and classification. A study measuring physiological markers of stress (such as serum or salivary cortisol) and biomarkers of dietary intake (such as urinary nitrogen, plasma vitamin C, and serum carotenoids) would provide stronger evidence. Moreover, differences in diet quality indices, dietary outcomes measured, and methodologies between the 24 studies made it difficult to compare the results of the studies. This issue has been highlighted by Mikolajczyk et al. [34] who recommended that research looking on stress and diet should be conducted across diverse population groups and amongst different countries which can enable the use of unified methodology and meaningful comparison of comparable outcomes. At present, it is challenging to compare results derived from studies conducted in single countries due to variation in methodologies and measures of diet and stress. The study design was a major limitation where studies were cross-sectional and longitudinal; hence, no causation or definitive conclusions can be drawn about the association between psychological stress and diet. A case-control study could provide more accurate evidence on the relationship between stress and diet. Including studies that are only in English language might be another limitation where evidence from studies published in other languages was not considered. Moreover, a prospective registration of this systematic review (for example on PROSPERO) was not done and this was also considered a limitation of this paper. The authors also declare that a thorough review/search of unpublished literature was not done, however the authors of unpublished papers were contacted and there were only 3 non-English abstracts found during the literature search.

Conclusions

Studies exploring the association between stress and diet in women of reproductive age reported mixed results. This review adds to the current knowledge by highlighting the inverse association between stress and diet. However, there was substantial heterogeneity in both methods and outcomes, which made it difficult to pool the study results and draw a solid conclusion about the association between stress and diet quality/patterns. Studies of rigorous design and robust methodology are needed to determine the role of stress in manipulating the dietary patterns/quality of women of reproductive age. In particular, it is crucial to conduct studies in different countries, with larger number of participants, and with welldesigned, unified and standardised methodologies.

Although some studies reported a significant association between stress and diet, this systematic review cannot determine causation of this association. At the clinical level, results from this systematic review, that showed inverse association between stress and healthy dietary patterns/quality in women of reproductive age, might be useful to implement stress coping strategies aimed at lowering stress levels and improving the quality of diet, and vice versa.

Supplementary information

Supplementary information accompanies this paper at https://doi.org/10. 1186/s12937-020-00609-w.

Additional file 1: Table 1. Search strategy.

Additional file 2.

Additional file 3 Table 2. Characteristics extracted from the 24 included studies: BS (Breakfast skippers), BE (Breakfast eaters), CS (CrossSectional), LG (Longitudinal), y (years), m (months), FFQ (Food Frequency Questionnaire, WFR (Weigh food record), SES (Socioeconomic status), PA (Physical Activity), AM (Anthropometric measures), – (not reported).

Additional file 4: Table 3. Data values extracted from the included eight studies on Diet Quality: β (Beta coefficients), r (correlation coefficient), OR (Odd Ratio).

Additional file 5: Table 4. Data values extracted from the included studies on food intake and frequency of consumption: ↑ (increase), ↓ (decrease), <= > (no association).

Additional file 6.

Additional file 7.

Abbreviations
UK: United Kingdom; PRISMA: The Preferred Reporting Items for Systematic reviews and Meta-analysis Approach; PEO: Population, Exposure, and Outcome; AHEI: Alternate Healthy Eating Index; DASH: Dietary Approach to
Stopping Hypertension; MDS: Mediterranean Diet Score; CASP: Critical
Appraisal Skills Programme; PSS: Perceived Stress Scale; USA: United States of
America; CI: Confidence Intervals; FFQ: Food Frequency Questionnaires;
BMI: Body Mass Index; CS: Cross sectional; LG: Longitudinal; SES: Socioeconomic status; BS: Breakfast skippers; BE: Breakfast eaters; y: years; m: months; WFR: Weighed Food Records; PA: Physical activity;
AM: Anthropometric measures; OR: Odd ratio; DQIA: Diet Quality Index for Adolescents; HEI: Healthy Eating Index

Acknowledgements
Not applicable.

Authors' contributions
Conceptualization, F.T. and V.H.; methodology, K.K., F.T., V.H., and R.H.; formal analysis of study findings, K.K., O.A., F.T., and V.H.; interpretation, K.K., F.T., and V.H.; writing—original draft preparation, K.K.; writing—review and editing, K.K., F.T., V.H., R.H. and O.A.; supervision, F.T., and V.H. The author(s) read and approved the final manuscript.

Funding
This research received no external funding and was conducted as part of a PhD project.

Availability of data and materials Not applicable.

Ethics approval and consent to participate Not applicable.

Consent for publication Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author details
[1] Department of Rehabilitation & Sport Sciences, Faculty of Health & Social
Sciences, Bournemouth University, Bournemouth BH1 3LT, UK. [2]Centre for
Midwifery, Maternal & Perinatal Health, Faculty of Health & Social Sciences,
Bournemouth University, Bournemouth BH1 3LT, UK. [3]Department of
Graduate Studies, Cizik School of Nursing, University of Texas Health Science
Center at Houston, Houston, USA. [4]Department of Medical Science and Public Health, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth BH1 3LT, UK.
Received: 9 December 2019 Accepted: 18 August 2020
Published online: 28 August 2020

References
1. Vidal EJ, Alvarez D, Martinez-Velarde D, Vidal-Damas L, Yuncar-Rojas KA, Julca-Malca A, et al. Perceived stress and high fat intake: a study in a sample of undergraduate students. PLoS One. 2018;13(3):e0192827.
2. CMACE. Maternal obesity in the UK: findings from a national project: maternal, Confidential Enquiry; 2010.
3. Poston L, Caleyachetty R, Cnattingius S, Corvalán C, Uauy R, Herring S, et al. Preconceptional and maternal obesity: epidemiology and health consequences. Lancet Diabetes Endocrinol. 2016;4(12):1025–36.
4. Reynolds RM, Allan KM, Raja EA, Bhattacharya S, McNeill G, Hannaford PC, et al. Maternal obesity during pregnancy and premature mortality from cardiovascular event in adult offspring: follow-up of 1 323 275 person years. BMJ. 2013;347:f4539.
5. Kanguru L, McCaw-Binns A, Bell J, Yonger-Coleman N, Wilks R, Hussein J. The burden of obesity in women of reproductive age and in pregnancy in a middle-income setting: a population based study from Jamaica. PLoS One. 2017;12(12):e0188677.
6. Martin J, Moran L, Teede H, Ranasinha S, Lombard C, Harrison C. Exploring diet quality between urban and rural dwelling women of reproductive age.
Nutrients. 2017;9(6):586.
7. Organization WH. Rural poverty and health systems in the WHO European region. WHO Regional Office for Europe: Copenhagen; 2010.
8. Thangaratinam S, Rogozińska E, Jolly K, Glinkowski S, Roseboom T, Tomlinson J, et al. Effects of interventions in pregnancy on maternal weight and obstetric outcomes: meta-analysis of randomised evidence. BMJ. 2012;344:e2088.
9. Hu F. Dietary pattern analysis: a new direction in nutritional epidemiology. Curr Opin Lipidol. 2002;13(1):3–9.
10. Ferranti EP, Dunbar SB, Higgins M, Dai J, Ziegler TR, Frediani JK, et al. Psychosocial factors associated with diet quality in a working adult population. Res Nurs Health. 2013;36(3):242–56.
11. Kretowicz H, Hundley V, Tsofliou F. Exploring the perceived barriers to following a Mediterranean style diet in childbearing age: a qualitative study. Nutrients. 2018;10(11):1694.

12. Martini D. Health benefits of Mediterranean diet. Nutrients. 2019;11(8):1802.
13. Boynton A, Neuhouser M, Sorensen B, McTiernan A, Ulrich C. Predictors of diet quality among overweight and obese postmenopausal women. J Am Diet Assoc. 2008;108(1):125–30.
14. Giskes K, van Lenthe F, Avendano-Pabon M, Brug J. A systematic review of environmental factors and obesogenic dietary intakes among adults: are we getting closer to understanding obesogenic environments? Obes Rev. 2010;12(5):e95–e106.
15. El Ansari W, Adetunji H, Oskrochi R. Food and mental health: relationship between food and perceived stress and depressive symptoms among university students in the United Kingdom. Cent Eur J Public Health. 2014;22(2):90.
16. Papier K, Ahmed F, Lee P, Wiseman J. Stress and dietary behaviour among first-year university students in Australia: sex differences. Nutrition. 2015; 31(2):324–30.
17. Fink G. Stress: definition and history. Stress Sci: Neuroendocrinol. 2010:3–9.
18. Cohen S, Janicki-Deverts D, Miller GE. Psychological stress and disease. JAMA. 2007;298(14):1685–7.
19. Adam TC, Epel ES. Stress, eating and the reward system. Physiol Behav. 2007;91(4):449–58.
20. Lee M-J, Fried SK. The glucocorticoid receptor, not the mineralocorticoid receptor, plays the dominant role in adipogenesis and adipokine production in human adipocytes. Int J Obes. 2014;38(9):1228.
21. Block JP, He Y, Zaslavsky AM, Ding L, Ayanian JZ. Psychosocial stress and change in weight among US adults. Am J Epidemiol. 2009;170(2):181–92.
22. Pasquali R. The hypothalamic–pituitary–adrenal axis and sex hormones in chronic stress and obesity: pathophysiological and clinical aspects. Ann N Y Acad Sci. 2012;1264(1):20–35.
23. Torres S, Nowson C. Relationship between stress, eating behavior, and obesity. Nutrition. 2007;23(11–12):887–94.
24. Yau YH, Potenza MN. Stress and eating behaviors. Minerva Endocrinol. 2013; 38(3):255.
25. Oliver G, Wardle J, Gibson EL. Stress and food choice: a laboratory study. Psychosom Med. 2000;62(6):853–65.
26. Rutters F, Nieuwenhuizen AG, Lemmens SG, Born JM, Westerterp-Plantenga MS. Acute stress-related changes in eating in the absence of hunger. Obesity. 2009;17(1):72–7.
27. Zellner DA, Loaiza S, Gonzalez Z, Pita J, Morales J, Pecora D, et al. Food selection changes under stress. Physiol Behav. 2006;87(4):789–93.
28. Jastreboff AM, Sinha R, Lacadie C, Small DM, Sherwin RS, Potenza MN. Neural correlates of stress-and food cue–induced food craving in obesity: association with insulin levels. Diabetes Care. 2013;36(2):394–402.
29. Bayram N, Bilgel N. The prevalence and socio-demographic correlations of depression, anxiety and stress among a group of university students. Soc Psychiatry Psychiatr Epidemiol. 2008;43(8):667–72.
30. Wichianson JR, Bughi SA, Unger JB, Spruijt-Metz D, Nguyen-Rodriguez ST. Perceived stress, coping and night-eating in college students. Stress and Health: J Int Soc Investigation Stress. 2009;25(3):235–40.
31. Habhab S, Sheldon JP, Loeb RC. The relationship between stress, dietary restraint, and food preferences in women. Appetite. 2009;52(2):437–44.
32. O'connor DB, Jones F, Conner M, McMillan B, Ferguson E. Effects of daily hassles and eating style on eating behavior. Health Psychol. 2008;27(1S):S20.
33. Hinote BP, Cockerham WC, Abbott P. Psychological distress and dietary patterns in eight post-soviet republics. Appetite. 2009;53(1):24–33.
34. Mikolajczyk RT, El Ansari W, Maxwell AE. Food consumption frequency and perceived stress and depressive symptoms among students in three European countries. Nutr J. 2009;8(1):31.
35. Roohafza H, Sarrafzadegan N, Sadeghi M, Rafieian-Kopaei M, Sajjadi F, Khosravi-Boroujeni H. The association between stress levels and food consumption among Iranian population. Arch Iran Med. 2013;16(3):145–8.
36. Tseng M, Fang CY. Stress is associated with unfavorable patterns of dietary intake among female chinese immigrants. Ann Behav Med. 2011;41(3):324–32.
37. Barrington WE, Ceballos RM, Bishop SK, McGregor BA, Beresford SA. Perceived stress, behavior, and body mass index among adults participating in a worksite obesity prevention program, Seattle, 2005-2007. Prev Chronic Dis. 2012;9:E152.
38. Stroup D, Berlin J, Morton S, Olkin I, Williamson C, Rennie D, et al. Metaanalysis of observational studies in epidemiology a proposal for reporting. JAMA. 2000;283(15):2008–12.
39. Richardson AS, Arsenault JE, Cates SC, Muth MK. Perceived stress, unhealthy eating behaviors, and severe obesity in low-income women. Nutr J. 2015; 14(1):122.
40. Isasi CR, Parrinello CM, Jung MM, Carnethon MR, Birnbaum-Weitzman O, Espinoza RA, et al. Psychosocial stress is associated with obesity and diet quality in Hispanic/Latino adults. Ann Epidemiol. 2015;25(2):84–9.
41. El Ansari W, Berg-Beckhoff G. Nutritional correlates of perceived stress among university students in Egypt. Int J Environ Res Public Health. 2015; 12(11):14164–76.
42. Valipour G, Esmaillzadeh A, Azadbakht L, Afshar H, Hassanzadeh A, Adibi P. Adherence to the DASH diet in relation to psychological profile of Iranian adults. Eur J Nutr. 2017;56(1):309–20.
43. Fowles ER, Stang J, Bryant M, Kim S. Stress, depression, social support, and eating habits reduce diet quality in the first trimester in low-income women: a pilot study. J Acad Nutr Diet. 2012;112(10):1619–25.
44. Fowles ER, Bryant M, Kim S, Walker LO, Ruiz RJ, Timmerman GM, et al. Predictors of dietary quality in low-income pregnant women: a path analysis. Nurs Res. 2011;60(5):286.
45. Widaman AM, Witbracht MG, Forester SM, Laugero KD, Keim NL. Chronic stress is associated with indicators of diet quality in habitual breakfast skippers. J Acad Nutr Diet. 2016;116(11):1776–84.
46. Nastaskin RS, Fiocco AJ. A survey of diet self-efficacy and food intake in students with high and low perceived stress. Nutr J. 2015;14:42.
47. Pettit ML, DeBarr KA. Perceived stress, energy drink consumption, and academic performance among college students. J Am Coll Heal. 2011;59(5):335–41.
48. Errisuriz VL, Pasch KE, Perry CL. Perceived stress and dietary choices: the moderating role of stress management. Eat Behav. 2016;22:211–6.
49. Ng DM, Jeffery RW. Relationships between perceived stress and health behaviors in a sample of working adults. Health Psychol. 2003;22(6):638.
50. Grossniklaus DA, Dunbar SB, Tohill BC, Gary R, Higgins MK, Frediani J. Psychological factors are important correlates of dietary pattern in overweight adults. J Cardiovascular Nurs. 2010;25(6):450.

51. González AM, Cruz SY, Ríos JL, Pagán I, Fabián C, Betancourt J, et al. Alcohol consumption and smoking and their associations with socio-demographic characteristics, dietary patterns, and perceived academic stress in Puerto Rican college students. P R Health Sci J. 2013;32(2):82–8.
52. Hwang J-Y, Lee SE, Kim SH, Chung HW, Kim WY. Psychological distress is associated with inadequate dietary intake in Vietnamese marriage immigrant women in Korea. J Am Diet Assoc. 2010;110(5):779–85.
53. Wardle J, Steptoe A, Oliver G, Lipsey Z. Stress, dietary restraint and food intake. J Psychosom Res. 2000;48(2):195–202.
54. Peterson RA, Brown SP. On the use of beta coefficients in meta-analysis. J Appl Psychol. 2005;90(1):175.
55. Sterne J, Hernán M, Reeves B, Savović J, Berkman N, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016;355:i4919.
56. Chapter 25: Assessing risk of bias in a non-randomized study [Internet]. Training.cochrane.org. 2020 [cited 16 March 2020]. Available from: https:// training.cochrane.org/handbook/current/chapter-25.
57. Borenstein M, Hedges L, Higgins J, Rothstein H. Introduction to metaanalysis. Ltd, UK: Wiley; 2009.
58. Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane handbook for systematic reviews of interventions version 6.0 (updated July 2019). Cochrane, 2019. Available from www. training.cochrane.org/handbook.
59. Roberts C. The effects of stress on food choice, mood and bodyweight in healthy women. Nutr Bull. 2008;33(1):33–9.
60. Ball K, Lee C. Psychological stress, coping, and symptoms of disordered eating in a community sample of young Australian women. Int J Eat Disord.
2002;31(1):71–81.
61. Sims R, Gordon S, Garcia W, Clark E, Monye D, Callender C, et al. Perceived stress and eating behaviors in a community-based sample of African Americans. Eat Behav. 2008;9(2):137–42.
62. De Vriendt T, Clays E, Huybrechts I, De Bourdeaudhuij I, Moreno L, Patterson E, et al. European adolescents' level of perceived stress is inversely related to their diet quality: the healthy lifestyle in Europe by nutrition in adolescence study. Br J Nutr. 2011;108(2):371–80.
63. O'Neil A, Quirk S, Housden S, Brennan S, Williams L, Pasco J, et al. Relationship between diet and mental health in children and adolescents: a systematic review. Am J Public Health. 2014;104(10):e31–42.
64. O'Connor D, O'Connor R. Perceived changes in food intake in response to stress: the role of conscientiousness. Stress Health. 2004;20(5):279–91.
65. Tryon M, Carter C, DeCant R, Laugero K. Chronic stress exposure may affect the brain's response to high calorie food cues and predispose to obesogenic eating habits. Physiol Behav. 2013;120:233–42.
66. Kirkpatrick SI, Vanderlee L, Raffoul A, Stapleton J, Csizmadi I, Boucher BA, et al. Self-report dietary assessment tools used in Canadian research: a scoping review. Adv Nutr. 2017;8(2):276–89.
67. Lorant V, Deliège D, Eaton W, Robert A, Philippot P, Ansseau M.
Socioeconomic inequalities in depression: a meta-analysis. Am J Epidemiol. 2003;157(2):98–112.
68. Entringer S, Buss C, Wadhwa P. Prenatal stress and developmental programming of human health and disease risk: concepts and integration of empirical findings. Curr Opinion Endocrinol Diabetes Obesity. 2010;17(6):507–16.
69. Hobel C, Culhane J. Role of psychosocial and nutritional stress on poor pregnancy outcome. J Nutr. 2003;133(5):1709S–17S.
70. Spencer S. Perinatal nutrition programs neuroimmune function long-term: mechanisms and implications. Front Neurosci. 2013;7:144.
71. Horan M, McGowan C, Gibney E, Donnelly J, McAuliffe F. Maternal low glycaemic index diet, fat intake and postprandial glucose influences neonatal adiposity – secondary analysis from the ROLO study. Nutri J. 2014;13(1):78.
72. Dabelea D, Crume T. Maternal environment and the Transgenerational cycle of obesity and diabetes. Diabetes. 2011;60(7):1849–55.
73. Reynolds C, Gray C, Li M, Segovia S, Vickers M. Early life nutrition and energy balance disorders in offspring in later life. Nutrients.
2015;7(9):8090–111.
74. Pet M, Brouwer-Brolsma E. The impact of maternal vitamin D status on offspring brain development and function: a systematic review. Advances in Nutrition: An Int Rev J. 2016;7(4):665–78.
75. Emmett P, Jones L, Golding J. Pregnancy diet and associated outcomes in the Avon longitudinal study of parents and children. Nutr Rev. 2015; 73(suppl 3):154–74.
76. Devakumar D, Fall C, Sachdev H, Margetts B, Osmond C, Wells J, et al. Maternal antenatal multiple micronutrient supplementation for long-term health benefits in children: a systematic review and meta-analysis. BMC Med. 2016;14(1):90.
77. Buss C, Entringer S, Wadhwa P. Fetal Programming of Brain Development:
Intrauterine Stress and Susceptibility to Psychopathology. Science Signaling. 2012;5(245):pt7.
78. Dunkel SC. Psychological science on pregnancy: stress processes, biopsychosocial models, and emerging research issues. Annu Rev Psychol. 2011;62(1):531–58.
79. Entringer S, Buss C, Swanson J, Cooper D, Wing D, Waffarn F, et al. Fetal programming of body composition, obesity, and metabolic function: the role of intrauterine stress and stress biology. J Nutri Metabol. 2012;2012:1–16.
80. KINSELLA M, MONK C. Impact of maternal stress, depression and anxiety on fetal neurobehavioral development. Clin Obstet Gynecol. 2009;52(3):425–40.
81. Marques A, O'Connor T, Roth C, Susser E, Bjørke-Monsen A. The influence of maternal prenatal and early childhood nutrition and maternal prenatal stress on offspring immune system development and neurodevelopmental disorders. Front Neurosci. 2013;7:120.

Publisher's Note

The systematic review has highlighted several gaps in the literature which informed the next chapters/studies of this PhD project. First, the stress and diet association has not been previously conducted among women of reproductive age specifically in the literature. Additionally, most of the studies were conducted in a single country and hence hindered the ability to compare studies that have used different methodologies and tools to assess variables (including stress and dietary intake). When research was conducted in different countries (Mikolajczyk et al. 2009), the countries chosen were all from Europe and hence might have similar cultural, traditional, and socioeconomical properties, and there is a need to assess this association across populations that are different (from different areas/continents). Moreover, dietary patterns and quality in all studies on stress and diet were assessed via the a-priori approach which assesses the adherence to a specific diet pattern index, and no study has assessed dietary patterns using a-posteriori dietary approach or combining both dietary assessment approaches (a-priori and a-posteriori). This chapter has established the literature base on which the doctoral work is grounded and identified the gaps in the current knowledge. The large number of papers made the review challenging to handle, but I felt that it was important to be as inclusive as possible to give a strong basis for the thesis. This informed the next phase of the work, which involved collecting empirical data in two countries.

Prior to describing the empirical work, a chapter grounding the philosophical background of the thesis is discussed next.

2.1 Research Philosophy and Its Application to This Research

In this chapter, the philosophical context of the research within this thesis is described.

Different research paradigms that make assumptions about how the world works can be used to analyse scientific research, the methodical pursuit of knowledge (Creswell et al. 2014). These scientific philosophies, or research paradigms, shape the ontology (how reality is perceived), epistemology (how the nature of knowledge is conceived), axiology (the role and values of the research process), methodology (how the paradigm defines processes involved in conducting science), and rigor (the standards used to support the quality of research in the paradigm)

(Varpio et al. 2020). These guiding principles, or paradigms, help to define the processes and procedures involved in conducting science (Bunniss et al. 2010, Kneebone et al. 2022). This chapter begins by reviewing each of these research paradigms and then places the work within the thesis in context.

The philosophical position that guides and establishes the research methodology is known as a theoretical perspective (Crotty et al. 2021). Research philosophy is a crucial component because it helps determine which research design will be most effective. While Saunders et al (2009) considered research philosophy as a researcher thinking about the advancement of knowledge, Easterby-Smith et al (2001) focused on how to apply and why. But according to researchers' perspectives on the research process, there are four different types of research philosophy: positivism, interpretivism, realism, and pragmatism (Saunders et al. 2009). However, Collis et al (2003) distinguished between the positivistic paradigm and the phenomenological (or interpretivist) paradigm when classifying research paradigms. More particularly, "the development of scientific practice is based on people's philosophies and assumptions about the nature of the world and of knowledge." In other words, research design and methods will be influenced by people's worldviews (Collis et al. 2003).

Positivism argues that there can be clear-cut and accurate knowledge of the outside world. It refers to something that has been proposed (or given). The creation of a comprehensive social system is something that positivism is interested in. Positive science is founded on actual experience rather than conjecture. Knowledge in this field of study is not arrived at speculatively but is firmly and exclusively based on something that has been posited and tested. Thus, what is posited or given in direct experience is what is observed using scientific methods, according to positivists or positive science. The relationship between positivism and empirical science today is as strong as ever (Crotty et al. 2021). The Positivist philosophy adopts the natural scientist's philosophical stance, and the findings of this research philosophy can be generalizations that resemble laws, such as the findings of scientists working in the physical and natural sciences (Saunders et al. 2009). According to positivism, technological advancement and scientific discovery are what propel progress. Science has confidence in its knowledge because it is both accurate and certain.

Positivism is wholly objectivist. According to the positivist perspective, things have meaning before and apart from any consciousness of them.

Another theoretical viewpoint, which emerged in opposition to positivism to comprehend and explain human and social reality, is phenomenology (also known as interpretivism). By using an interpretive approach, researchers look for culturally derived interpretations of the social world that are historically positioned. The positivist approach, on the other hand, adopts the techniques of the natural sciences through purportedly value-free, detached observation, identifying universal traits of human nature, society, and history that offer explanation and, as a result, predictability, and control (Crotty et al. 2021). Because complex management studies in the social world will be lost if its complexity is reduced to law-like generalizations, this philosophy views the social world of behavioural science as being too complex to be treated as a physical science. According to the interpretivism philosophy, each business's situation is distinct from other situations. Due to the shifting nature of business, this methodology is not suitable for generalization. The complexity and uniqueness of the world, as well as its organization and various human interpretations, are all considered (Saunders et al. 2009). By emphasizing a subjective and descriptive method to deal with complex situations rather than an objective and statistical method, this interpretivist philosophy develops knowledge in a unique way (Remenyi et al. 2010). In contrast to other scientific research, social science is complex and does not lend itself to theorizing by set laws.

Another research philosophy that is related to scientific inquiry is realism. Realists hold the view that reality exists in the world and is unaffected by the ideas and convictions of individuals. Realism is in opposition due to independence from idealism because reality exists. Since realism is a kind of epistemology that relies on a scientific method to advance knowledge, it is comparable to positivism. However, there are two types of realism: critical realism, which holds that "what we see is not what we got," and direct realism, which holds that "what we see is what we get." Researchers view the world as sensations rather than actual objects, which calls for greater scrutiny of reality (Saunders et al. 2009)

Pragmatism affirms the existence of reality in the world and supports science's objectivity. Additionally, this philosophy makes the assumption that people's personalities may affect how they view the world, so research is subjective. Proponents of this philosophy offer numerous justifications and interpretations for science. According to Saunders et al (2012), this philosophy employs both objective and subjective standards. The pragmatist philosophy, which is situated between positivist and interpretivist research philosophy, holds that there is no single, effective philosophy and that instead, researchers can choose from a variety of approaches. According to pragmatism, it is possible to deal with different epistemologies (Saunders et al. 2009).

This scientific (or positivist/postpositivist) approach has dominated nutrition and dietetics research for the past century (Schubert et al. 2016, Palmero et al. 2021). However, there is evidence that nutrition research has evolved from its origins in the biomedical sciences to its more recent recognition as a social and behavioural science (Williams et al. 2016). The New Nutrition Science is one important movement that has criticized nutritionism and argued for the recognition of social and environmental determinants of food and eating behaviour and choice (Schubert et al. 2016, Scrinis et al. 2020). Along with this change, nutrition and dietetics research now favours whole-diet approaches that recognize complexity rather than single-nutrient approaches (Mozaffarian et al. 2018). However, some "reductionist" thinking persists in nutrition and dietetics research (Schubert et al. 2016). On the basis of a philosophy that sees knowledge as a component of a reality distinct from individuals and demonstrable through scientific methods, which primarily employ quantitative approaches, it typically focuses on hypothesis-driven questions determining causal pathways (Fade et al. 2003, Scrinis et al. 2020, Williams et al. 2016). Even though it is widely acknowledged that nutrition is tied to the environment, society, culture, and history and therefore involves both art and science, there is still little understanding of what the "social" entails in the nutrition context.

Given the focus of the research in this thesis on measurement one might assume that it sits firmly in the positivist domain. The stress and diet variables (in addition to all other variables) were measured through standardised and validated scales and questionnaires, and the association between stress and diet was tested to advance

the knowledge around factors that affect dietary patterns and quality in women of reproductive age; one of these factors is stress.

Positivism is a school of thought in science philosophy that places a strong emphasis on the value of observation in the advancement of knowledge. The pursuit of objective truth, facts, and laws is positivism's core goal. According to the positivist theory, truth exists that science can witness, quantify, and describe. By confirming or supporting a theory, positivist research advances (Popper et al. 2014). Positivism contends that an objective, external reality may be precisely and thoroughly comprehended while seeking universal rules that regulate behaviour.

However, the methodology used in this thesis consisted of several self-reported questionnaires grouped in a survey. This might imply that the research is not entirely positivist as the robust positivist approach to assessing diet for example would be through measuring the nutrient biomarkers in the body such as vitamin C, urinary nitrogen level, blood creatinine level, etc… instead of participants' response to subjective self-reported dietary surveys.

Research is an organised, methodical attempt to explore a particular issue and offer a solution. Its objectives include the addition of new knowledge, the development of hypotheses, and the gathering of data to support generalisations (Sekaran et al. 2016). According to Swanson et al (2005), research can be divided into three fundamental categories: quantitative research, qualitative research, and mixed method research. Each of these techniques is crucial to the field of study. To find, gather, and analyse information, researchers can choose from any one of the three types of research methodologies mentioned above depending on the aims, nature of the issue, and the research questions.

Through their underlying assumptions and guiding principles, research paradigms direct scientific discoveries. The quality of findings that support scientific studies can be better understood by understanding paradigm-specific assumptions, which also reveals any gaps in the production of reliable evidence. Positivism is compatible with the hypothetico-deductive model of science, which builds on experimental data and a priori hypotheses by operationalizing variables and measures; the findings of hypothesis testing are then used to advance science. Generalizable inferences, replication of findings, and controlled experimentation have all been guiding

principles in positivist science in this regard. Studies aligned with positivism typically focus on identifying explanatory associations or causal relationships through quantitative approaches, where empirically based findings from large sample sizes are preferred. There is discussion of the standards for judging the calibre of positivist research.

The research paradigm has an impact on methods. It is assumed that studies sitting within a positivist paradigm will use scientific methods to test theory and for that hypothesis is needed. A hypothesis is a potential explanation for a group of facts that can be explored by more research. Studies created by quantitative researchers allow for the testing of hypotheses. In the present thesis, the hypothesis was that higher level of perceived stress among women of reproductive age is associated with lower dietary quality and unhealthy dietary patterns. In quantitative research, there are three different types of variables: dependent variables, independent variables, and extraneous or confounding variables. Dependent variables are those that are hypothesised to depend on or be caused by other variables, i.e., those that track how subjects respond by measuring a response in one or more outcome measures; independent variables are those that are thought to be the cause or influence, i.e., those that are altered by the researcher; and extraneous variables are those that confuse or confuse the relationship between the dependent and independent variables. In this thesis, the independent variable was perceived stress, the dependant variable was dietary quality and patterns, and the extraneous factors were BMI, physical activity, and socio-demographic variables.

We may utilise quantitative research effectively when variables are well-defined and numerical data is provided, which allows it to evaluate theories of objectivity by looking at how variables are related to one another (Polit et al. 2006). One or more independent variables affect dependent variables. In the present thesis, the association between perceived stress and diet quality and pattern was studied. The dietary quality and patterns variable was the dependent variable that was hypothesised to be affected by several independent variables such as stress variable along with sociodemographic, anthropometric, and physical variables that were measured throughout the present research.

In this thesis, the survey questionnaire was mainly employed to collect data from participants in the different countries and in different studies due to the large sample size of the PhD project (n=493). In Lebanon, the data for the validation study of the EPIC FFQ was done through a collecting the food frequency questionnaire and several 24-hour recalls. For the main study, the data was collected through different questionnaires that assessed variables like sociodemographic characteristics, anthropometric measures, stress and depression levels, dietary intake, etc… In the UK, similar methodology was used to collect data and in the last study, these data collected from the two countries were modelled using Structural equation modelling technique. The observational design of studies commonly used in nutrition epidemiology was deemed the appropriate one to fulfil the research questions and aims. This is based on the nature of the studies integrated in this thesis to test the association between stress and dietary quality and pattern among women of reproductive age from two countries.

Research philosophy is essential to assist in determining the design of the research that is impacted by people's view of things. Positivism is the approach that is based on actual experience using scientific methods to assess and test the variables. In the present PhD thesis, surveys and questionnaires were used to assess the different dietary, mental, physical, anthropometric, and sociodemographic variables aiming to test the association between perceived stress and dietary quality and patterns among women of reproductive age in UK and Lebanon.

The next chapter describes the association between stress and diet in the UK cohort of this PhD project.

Chapter 3 The stress/diet study in United Kingdom

This chapter reports a study designed to explore the association between stress and dietary quality and patterns among women of reproductive age in the UK. The study was the first to assess the association between perceived stress and diet quality in women of reproductive age in the United Kingdom. It was published in the journal Nutrients and the paper is replicated here.

nutrients

MDPI

Article

Poor Dietary Quality and Patterns Are Associated with Higher Perceived Stress among Women of Reproductive Age in the UK

Karim Khaled [1,*], Vanora Hundley [2] and Fotini Tsofliou [1,2]

Citation: Khaled, K.; Hundley, V.; Tsofliou, F. Poor Dietary Quality and Patterns Are Associated with Higher Perceived Stress among Women of Reproductive Age in the UK. *Nutrients* **2021**, *13*, 2588. https://doi.org/10.3390/nu13082588

Academic Editor: Panagiota Mitrou

Received: 2 July 2021
Accepted: 26 July 2021
Published: 28 July 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

[1] Department of Rehabilitation & Sport Sciences, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth BH8 8GP, UK; ftsofliou@bournemouth.ac.uk
[2] Centre for Midwifery, Maternal & Perinatal Health, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth BH8 8GP, UK; vhundley@bournemouth.ac.uk
* Correspondence: Khaledk@bournemouth.ac.uk

Abstract: The aim of this study was to investigate the association between stress and diet quality/patterns among women of reproductive age in UK. In total, 244 reproductive aged women participated in an online survey consisting of the European Prospective into Cancer and Nutrition food frequency questionnaire in addition to stress, depression, physical-activity, adiposity, and socioeconomic questions. An a-priori diet quality index was derived by assessing the adherence to Alternate Mediterranean Diet (aMD). A-posteriori dietary-patterns (DPs) were explored through factor analysis. Regression models were used to assess the predictors of the DPs. Participants mainly had medium (n = 113) aMD adherence. Higher stress levels were reported by participants with low aMD adherence. Participants with high aMD adherence were of normal BMI. Factor analysis revealed three DPs: fats and oils, sugars, snacks, alcoholic-beverages, red/processed meat, and cereals (DP-1), fish and seafood, eggs, milk and milk-products (DP-2), and fruits, vegetables, nuts and seeds (DP-3). Regression models showed that DP-1 was positively associated with stress (p = 0.005) and negatively with age (p = 0.004) and smoking (p = 0.005). DP-2 was negatively associated with maternal educational-level (p = 0.01) while DP-3 was negatively associated with stress (p < 0.001), BMI (p = 0.001), and white ethnicity (p = 0.01). Stress was negatively associated with healthy diet quality/patterns among reproductive aged women.

1. Introduction

Increased body weight before pregnancy is associated with higher risk of pregnancy complications [1–4] and of severe maternal morbidity and mortality [5]. A recent metaanalysis has indicated that a healthy diet is crucial to prevent increased weight gain before and during pregnancy and its related complications (e.g., gestational diabetes, preeclampsia, caesarean section delivery) [6].

There are several predictors of diet quality, one of which is perceived stress. Stress is increasing among people and has been associated with poorer diet quality among women of reproductive age [7–11]. However, most studies have focused on the association between stress and individual foods/food groups. For example, a higher level of psychological stress among women of reproductive age was found to be significantly associated with a greater consumption of fat in their diet [12–15]. Studies have also found that stress has been associated with decreased intake of fruits and vegetables among women of reproductive age [16,17]. Moreover, higher levels of perceived stress have been found to associate with increased consumption of sweets, fast foods, snacks, and saturated fats and decreased intake of fruits, vegetables, and unsaturated oils [18,19]. However, these studies assessed dietary intake through recall questionnaires that do not include a variety and wide range of food items and food groups; this might predispose participants to misreporting [8,20–25].

Keywords: perceived stress; psychological; stress; diet quality; dietary patterns; women; reproductive age; childbearing age; a-priori; a-posteriori

With respect to the evaluation of diet quality, most studies on stress and diet have included only the a-priori dietary approach (based on measuring adherence to diet index) [12,22,25]. To the best of our knowledge, no study on stress and diet have combined both the apriori and a-posteriori (based on statistical techniques such as factor analysis) approaches which offer comprehensive insight and characterisation of the diet pattern specific to the population group under investigation. Additionally, the small sample sizes and the lack of representativeness in those studies mean that generalising the results is not possible. Not considering confounding factors such as sociodemographic characteristics and physical activity was also a major limitation of some studies [12,16,24,26,27]. Moreover, most studies on the association between stress and diet were conducted among the general adult population, however evidence is scarce among women of reproductive age (18–49 years old) [26,28,29].

In summary, studies on stress and diet in the literature have several limitations. Investigating the factors that affect diet quality in women of reproductive age has crucial importance especially because diet-related morbidity among these women had an increasing trend during the past years [30]. To our knowledge, this study is the first to examine the association between stress and diet quality among women of reproductive age in UK. The aim of this study is to investigate whether higher level of perceived stress is associated with lower diet quality among women of reproductive age in the UK.

2. Materials and Methods

This was a cross sectional study targeting women of reproductive age in the UK. The study used an online questionnaire survey developed and administered via the Bristol Online Surveys (BOS).

The sample was one of convenience and consisted of females of reproductive age (between 18 and 49 years old) who were students and staff at a UK University. There are varying definitions for reproductive age in the literature; the range for this study was chosen to reflect the majority of recent studies [31,32]. Participants were excluded if they were: males at birth, below 18 or above 49 years old, not students or staff, suffering from a chronic illness or disease such as: cancer, Crohn's disease, diabetes, heart disease, HIV/AIDS/multiple sclerosis, depression, asthma, COPD, cystic fibrosis, or mental health disorder, having any kind of food intolerance or food allergy, pregnant or breastfeeding, or were on any medication known to affect appetite or body weight or have undergone bariatric surgery. The sample size was calculated by applying the correlation sample-size method [33] with a power of 80%, and an α (significance level) of 0.05. A correlation coefficient of 0.18 was chosen for the power calculation and it was based on the lowest correlation coefficient r reported in studies about stress and diet quality in women of reproductive age [24,30]. This yielded a total sample of 240 participants.

Potential participants were targeted through posters and social media advertisements (e.g., twitter). Consent was ascertained on the landing page of the survey.

2.1. Methodological Measurements and Procedures

2.1.1. Diet

Diet quality and patterns were estimated via the European Prospective into Cancer and Nutrition food frequency questionnaire (EPIC FFQ) which has been previously validated among UK adult females [34,35]. The EPIC-FFQ consists of 130 food items and one additional question for milk (131 items). The questionnaire represents either individual food (51%), combination of between two and four individual foods (23%), or food types (26%) that are further described by examples of individual foods. The number and percentage of food types in the list are: vegetables, 25 (19%); fruit and fruit juices, 12 (9%); meats, poultry, fish and eggs, 18 (14%); breads, cereals and starches, 18 (14%); dairy foods and fats, 15 (11%); beverages, 10 (8%); sweets and confectionery items, 14 (11%) and miscellaneous foods, 19 (14%). The food list is associated with a set of nine frequency choices for consumption ranging from 'never or less than once a month' to '6 or more times per day'.
The questionnaire consists of two parts. Part 1, the main part, lists 130 food items. Part 2 includes a set of additional questions that determine further information on the type and brand of breakfast cereal and kind of fat used in frying, roasting, grilling or baking and the amount of visible fat on meat.

2.1.2. Dietary Data Analysis

The FETA software was used to analyse the EPIC FFQ data and calculate the grams/day of nutrients and food groups [36]. Eleven food groups (grams/day) were derived from the EPIC food frequency questionnaire data analysis which included fats and oils, sugars and snacks, cereals, alcoholic beverages, red and processed meat, fish and seafood, eggs, milk and milk products, fruits, vegetables, and nuts and seeds. Adherence to the Alternate Mediterranean Diet Index (aMED) was used to assess the a-priori approach for diet quality assessment. The aMED is an adjustment of the Mediterranean Diet Index, which is based on the evidence suggesting a protective effect of this diet on the risk of chronic diseases, and that was previously developed by Trichopoulou et al. [37]. The aMED is based on the consumption of nine food groups: vegetables (excluding potatoes), fruit, nuts, legumes, fish, whole grains, mono-unsaturated fatty acids to saturated fatty acids ratio, alcohol, and red and processed meat [38]. The a-posteriori approach was based on factor analysis that derived the dietary patterns of participants. The importance of factor analysis (a-posteriori approach) is that it characterises the sample's variation in dietary intake and provides a more meaningful description of the overall patterns and quality of the diet which complements the a-priori dietary approach [39].

2.1.3. Mental Health Indicators

Perceived stress was measured using the 14-item Perceived Stress Scale (PSS) [40]. PSS measures the level of psychological stress, thoughts, and feelings of each participant over the past month. The scale has been tested in several trials in adult populations and showed significant consistency with Cronbach's alpha = 0.75 and 0.85 [40]. The PSS is not a diagnostic tool; hence there are no cut-off points that determine if an individual is stressed. PSS was equally divided into two categories: low to medium level of stress (score = 0–27) and medium to high level of stress (score = 28–56) as per previous studies [11,41].

Depression was measured using the 21-item Beck Depression Inventory II (BDIII) [42]. The BDI-II has become one of the most widely used measures to assess depressive symptoms and their severity in adolescents and adults [43]. The BDI-II is a 21-item selfreport measure that taps major depression symptoms according to diagnostic criteria listed in the Diagnostic and Statistical Manual for Mental Disorders [44]. Since its publication, a number of studies have examined the validity and reliability of BDI-II across different populations and countries [45].

Results have consistently shown good internal consistency and test-retest reliability of the BDI-II in community [46,47] adolescent and adult clinical outpatients [48] as well as in adult clinical inpatients [49].

2.1.4. Physical and Socio-Demographic Characteristics

Physical activity was measured using the International Physical Activity Questionnaire (IPAQ) [50]. The IPAQ records the activity of participants of four intensity levels: vigorous-intensity activity such as aerobic, moderate-intensity activity such as leisure cycling, walking, and sitting [50].

Adiposity measures: weight in kg and height in cm were self-reported and body mass index (BMI) in kg/m^2 was estimated to classify body weight status [51]. BMI was calculated by dividing weight in kilograms over height squared in centimetres [51]. Previous papers stated that self-reported weight and height are acceptable for determining BMI [52].

Data on socioeconomic factors (age, education, income, race, and marital status) were collected to control for the influence of these confounding factors [53,54].

2.2. Statistical Analysis

IBM SPSS statistics version 25 (Chicago, IL, USA) was used for data analysis. The normality of the data was assessed by Shapiro–Wilk test. Descriptive data are presented as median and interquartile range (IQR) for data with non-normal distribution. Kruskal– Wallis test was used to compare continuous data among the aMD adherence categories

(low, medium, high). Categorical data among the three aMD adherence categories were compared through Chi-squared test. The Bonferroni method was used to correct for multiplicity in data.

The normality of the food groups' data was assessed, and appropriate transformation was undertaken when high skewness was detected in the data. Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were conducted to check the appropriateness of factor analysis. Results revealed a large KMO of 0.75 (>0.5) and a very significant Bartlett's test ($p < 0.00001$) with an approximate Chi-square of 832 and 55 degrees of freedom; therefore, factor analysis was deemed appropriate to use [55]. Additionally, the sample size of the present study ($n = 244$) is acceptable for conducting factor analysis [56,57]. To derive the number of factors from the food groups' data, a scree plot was generated showing the factors that have an eigenvalue >1. A varimax rotation was assigned to calculate factor loadings for each factor (dietary pattern) based on the assumption that factors were not correlated. Simple linear regression models carried out for each factor (dietary pattern) were revealed to investigate the association between that factor (dietary pattern) and the following variables separately: perceived stress, depression scores, BMI (kg/m^2), PA (Mets) and socioeconomic measures. The predictors with significant association were then included in a multiple linear regression model of the diet pattern along with the other significant predictors. Some categories of the socioeconomic measures were merged together before inclusion in the regression models due to their small size (e.g., marital status (single/divorced/widowed, living together/married), parity (never, once/two times or more), religion (no religion, Christian, other), education (No qualification/Certificate of Secondary School (CSE)/General Certificate of Secondary School (GCSE), A-level/higher education), ethnicity (white, other), smoking status

(smoker, non-smoker), income (below the average, above the average), parents occupation (employee, other)).

3. Results

A sample of 252 women participated in the study, and after screening eight were excluded since they did not meet the eligibility criteria (e.g., food intolerance/food allergy/chronic disease). In total, the data of 244 women were included in the analysis of the present study. Overall, participants had an average age of 24 years, were mainly of white ethnicity, single, non-smokers, and their parental educational level was mainly O-level or GCSE examinations taken at 16 years. In addition, 47% of the total sample had a moderate level of physical activity (Tables 1 and 2).

The participants' characteristics are reported across the three categories of the Alternate Mediterranean Diet Scores (aMDS: low, medium, and high). The majority of the 244 participants had a medium adherence to aMD (46%), followed by 39% having low adherence, and only 15% of participants had high adherence to aMD.

There was a significant association between perceived stress and diet quality. Medium to high levels of stress were more likely to be reported by participants (73%) with a low adherence to aMDS (X^2 (2, n = 244) = 14.08, p = 0.001). Pairwise comparisons showed that stress was different between low and high aMD adherence (p = 0.005) and between low and medium aMD adherence categories (p = 0.003) but not between medium and high adherence categories (p = 0.467).

Table 4: (Chapter 3, Table 1) - Physical and mental characteristics of participants (n = 244).

Participants' Characteristics(N (%))	Total Sample	Alternate Mediterranean Diet Adherence Categories			*p*-Value
		Low aMDS (0–3)	Medium aMDS (4–6)	High aMDS (7–9)	
		95 (39)	113 (46)	36 (15)	
Physical and lifestyle characteristics					
Age (years) #	24.0 (21.0–32.0)	23.0 (21.0–29.0)	25.0 (21.5–32.0)	24.0 (20.3–35.0)	0.277
Age (years) *					
18–24	124 (51)	54 (57)	51 (45)	19 (53)	
25–34	77 (32)	26 27)	44 (39)	7 (19)	0.09
35–49	43 (17)	15 (16)	18 (16)	10 (28)	
BMI (kg/m^2) #	23.7 (20.9–27.9)	26.1 (21.5–49.4)	23.7 (20.6–27.5)	21.9 (20.3–23.9)	0.093
BMI *					
Underweight	14 (6)	4 (4)	7 (6)	3 (8)	
Normal Weight	120 (49)	38 (40)	56 (50)	26 (72)	0.005
Overweight/obese	108 (44)	52 (56)	50 (44)	6 (17)	
Physical Activity (METs-h/wk) #	1429 (464.3–2824.5)	1159 (330.0–2615.0)	1440 (479.3–2886.3)	2380 (1325.5–3464.3)	0.336
Physical Activity level *					
Low (<600 MET minutes/week)	76 (31)	39 (41)	33 (29)	4 (11)	0.018
Moderate (>600 MET minutes/week)	114 (47)	39 (41)	55 (49)	20 (56)	
High (>3000 MET minutes/week)	54 (22)	17 (18)	25 (22)	12 (33)	
Mental Health Indicator					
Stress #	29 (22.0–33.0)	31 (26.0–34.0)	27 (22.0–27.0)	26.5 (18.0–31.8)	0.002
Stress *					
Low-Medium	103 (42)	26 (27)	58 (51)	19 (53)	0.001
Medium-High	141 (58)	69 (73)	55 (49)	17 (47)	
Depression #	5 (2.0–12.0)	5 (2.0–13.0)	5 (2.0–11.0)	5 (1.0–13.0)	0.926
Depression *					
Minimal (0–13) Mild (14–19)	191 (78)	73 (77)	90 (80)	28 (78)	
	28 (11)	15 (16)	10 (9)	3 (8)	0.07
Moderate (20–28)	12 (5)	4 (4)	8 (7)	0 (0)	
Severe (29–63)	13 (5)	3 (3)	5 (4)	5 (14)	

METs-h/wk: Metabolic equivalents of tasks-hours per week, BMI: body mass index., GCSE: General Certificate of Secondary Education, O-level: ordinary level. *p*-values were derived through a Chi-squared test of independence to display differences in physical activity, mental health indicators, and BMI of participants across the three Alternate Mediterranean diet (aMD) scores categories. The differences between median (IQR) of physical, mental health, and lifestyle characteristics were explored with Kruskal–Wallis test and post-hoc pairwise comparisons. * represents N (%). # represents median (IQR). aMDS: alternate Mediterranean Diet Score.

Table 2. Socio-demographic characteristics of participants (*n* = 244).

	Alternate Mediterranean Diet Adherence Categories

Participants' Characteristics (N (%))	Total Sample N (%)	Low aMDS (0–3)	Medium aMDS (4–6)	High aMDS (7–9)	*p*-Value
		95 (39)	**113 (46)**	**36 (15)**	
Father's education	23 (9)	8 (8)	11 (10)	4 (11)	
No qualifications	57 (23)	28 (29)	25 (22)	4 (11)	
Certificate of Secondary education (CSE) taken at 14–16 years at a lower level than GCSE					0.626
O-level or GCSE examinations taken at 16 years	71 (29)	23 (24)	35 (31)	13 (36)	
A-level school examinations taken at 18 years	45 (18)	18 (19)	19 (17)	8 (22)	
Higher education	48 (20)	18 (19)	23 (20)	7 (19)	
Mother's education	16 (7)	5 (5)	9 (8)	2 (6)	
No qualifications	47 (19)	24 (25)	20 (18)	3 (8)	
Certificate of Secondary education (CSE) taken at 14–16 years at a lower level than GCSE					0.399
O-level or GCSE examinations taken at 16 years	82 (34)	26 (27)	41 (36)	15 (42)	
A-level school examinations taken at 18 years	44 (18)	17 (18)	18 (16)	9 (25)	
Higher education	55 (23)	23 (24)	25 (22)	7 (19)	
Father's occupation	92 (38)	35 (37)	42 (37)	15 (42)	
Working as an employee	5 (2)	4 (4)	1 (1)	0 (0)	
On a government sponsored training scheme	68 (28)	28 (29)	30 (27)	10 (28)	
Self-employed or freelance	31 (13)	13 (14)	15 (13)	3 (8)	
Working paid or unpaid for your own or your family's business					0.424
Doing any other kind of paid work	9 (4)	6 (6)	1 (1)	2 (6)	
Retired (whether receiving a pension or not)	36 (15)	8 (8)	22 (19)	6 (17)	
Long-term sick or disabled	3 (1)	1 (1)	2 (2)	0 (0)	
Mother's occupation Working as an employee?	101 (41)	38 (40)	43 (38)	20 (56)	
On a government sponsored training scheme	9 (4)	4 (4)	5 (4)	0 (0)	
Self-employed or freelance	25 (10)	6 (6)	14 (12)	5 (14)	
Working paid or unpaid for your own or your family's business	17 (7) 20 (8)	9 (9) 11 (12)	7 (6) 6 (5)	1 (3) 3 (8)	0.266
Doing any other kind of paid work					
Retired (whether receiving a pension or not)	34 (14)	8 (8)	22 (19)	4 (11)	
Looking after home or family	27 (11)	14 (15)	11 (10)	2 (6)	
Long-term sick or disabled	11 (5)	5 (5)	5 (4)	1 (3)	
Income per year					
<£13,000	119 (49)	43 (45)	54 (48)	22 (61)	
£13,000 to £33,800	99 (40)	45 (48)	47 (41)	7 (19)	0.047

>£33,800	26 (11)	7 (7)	12 (11)	7 (19)	

Table 2. *Cont.*

Participants' Characteristics (N (%))	Total Sample N (%)	Alternate Mediterranean Diet Adherence Categories			*p*-Value
		Low aMDS (0–3)	Medium aMDS (4–6)	High aMDS (7–9)	
		95 (39)	**113 (46)**	**36 (15)**	
Parents' annual income					
<£13,000	36 (15)	14 (15)	15 (13)	7 (19)	
£13,000 to £23,400	51 (21)	21 (22)	25 (22)	5 (14)	
>£23,400 to £33,800	69 (28)	31 (33)	33 (29)	5 (14)	0.432
>£33,800 to £52,000	47 (19)	16 (17)	20 (18)	11 (31)	
>£52,000	41 (17)	13 (14)	20 (18)	8 (22)	
Marital Status					
Single	176 (72)	67 (71)	84 (74)	25 (69)	
Married	43 (18)	16 (17)	18 (16)	9 (25)	
Divorced	17 (7)	9 (9)	8 (7)	0 (0)	0.46
Separated but still legally married	6 (2)	3 (3)	2 (2)	1 (3)	
Widowed	2 (1)	0 (0)	1 (1)	1 (3)	
Smoking					
Current Smoker Ex-smoker	56 (23)	25 (26)	23 (20)	8 (22)	
	27 (11)	10 (11)	11 (10)	6 (17)	0.47
Never smoked	161 (66)	60 (63)	79 (70)	22 (61)	
Religion					
No religion	104 (43)	36 (38)	53 (47)	15 (42)	
Christian	105 (43)	45 (47)	42 (37)	18 (50)	
Buddhist Hindu	7 (3)	2 (2)	5 (4)	0 (0)	
	9 (4)	5 (5)	3 (3)	1 (3)	0.437
Jewish	(0)	(0)	(0)	(0)	
Muslim	19 (8)	7 (7)	10 (9)	2 (6)	
Sikh	(0)	(0)	(0)	(0)	
Ethnicity					
Mixed/multiple ethnic groups	10 (4)	5 (5)	4 (4)	1 (3)	
White	177 (73)	61 (64)	82 (73)	34 (34)	
Asian/Asian British	35 (14)	18 (19)	16 (14)	1 (3)	0.231
Black/African/Caribbean/Black British	15 (6)	7 (7)	8 (7)	0 (0)	
Other ethnic group	7 (3)	4 (4)	3 (3)	0 (0)	
Parity					
Never	189 (77)	72 (76)	92 (81)	25 (69)	
Once	26 (11)	14 (15)	6 (5)	6 (17)	0.229

Two times or more	29 (12)	9 (9)	15 (13)	5 (14)

aMDS: alternate Mediterranean Diet Score. GCSE: General Certificate of Secondary Education, O-level: ordinary level. *p*-values were derived through a Chi-squared test of independence to display differences in socio-demographics of participants across the three alternate Mediterranean diet scores (aMDS) categories.

BMI was also found to be different among aMD adherence groups (X^2 (4, n = 244) = 14.815, p = 0.005) (Table 1). Participants who had normal BMI were more likely to have high aMDS (72%) compared to those who were underweight (8%) and overweight/obese

(17%). The physical activity level of participants differed across the three categories (X^2 (4, n = 244) = 11.92, p = 0.018). A higher percentage of participants with high aMDS adherence were engaging in moderate (56%) and high (33%) physical activity levels whereas those with low aMDS adherence were engaging in low (41%) and moderate (41%) physical activity levels.

Income per year showed a significant, but weak, association with adherence to aMDS (X^2 (10, n = 244) = 18.48, p = 0.047). However, adherence to aMD was not associated with any other socio-demographic characteristics (Table 2).

Factor Analysis

Figure 1 demonstrates a scree plot showing the number of factors (dietary patterns) retained from factor analysis. As shown in the scree plot, the number of factors (dietary patterns) with eigenvalue ≥1 is 3. The three factors (dietary patterns) explained 60% of the total variance in data.

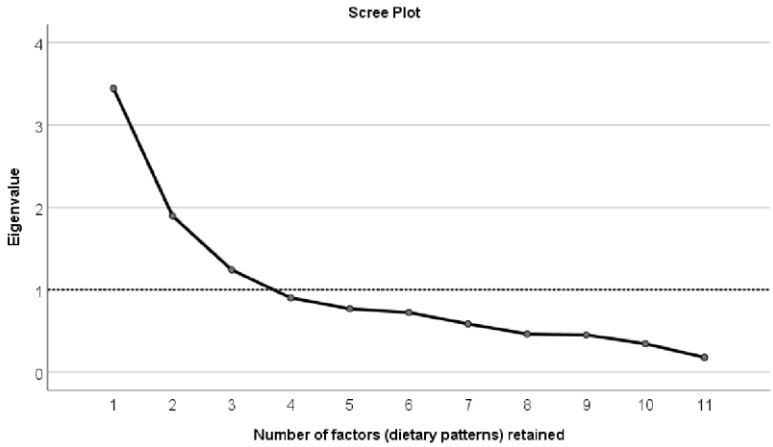


Figure 6: (Chapter 3, fig 1) - Scree plot showing the number of factors (dietary patterns) retained from factor analysis on the X-axis and the eigenvalues on Y-axis.

Table 3 demonstrates the 11 food groups with factor loadings for the three factors (dietary patterns). Coefficients with absolute value below 0.3 for each factor were suppressed, therefore five food groups were assigned to factor 1 (DP-1), three to factor 2 (DP-2), and three to factor 3 (DP-3). The first dietary pattern (DP-1) had high factor loadings for the following food groups: fats and oils, sugars and snacks, alcoholic beverages, cereals, and red and processed meat and was labelled "Western-style" dietary pattern. DP-2 had high factor loadings for food groups such as fish and seafood, eggs, and milk and milk products and was labelled "high-quality protein" dietary pattern. The third dietary pattern (DP-3) was labelled "vegetarian-like" dietary pattern with factor loadings high for fruits, vegetables, and nuts and seeds food groups.

Regression analysis that was used to examine the association between the three dietary patterns (DPs), which were derived from factor analysis, and all other variables indicated the following: In the first model, DP-1 was positively associated with stress ($p = 0.005$) and negatively with age ($p = 0.004$) and smoking ($p = 0.005$) (Table 4). DP-1 was common among young, smokers, and highly stressed women. Model 2 of the second dietary pattern showed that DP-2 was negatively associated with mother's educational level ($p = 0.019$) (Table 4). The second dietary pattern (DP-2) was common among participants who had mothers with lower educational level. The third dietary pattern (DP-3) was common among normal weight people who had low stress level and non-white. As shown in Table 4, DP-3 was negatively associated with stress ($p < 0.001$), BMI ($p = 0.001$), and ethnicity ($p = 0.013$).

Table 5: (Chapter 3, Table 2) - Orthogonally rotated (varimax) factor loadings for the 3 factors (dietary patterns) of the 11 food groups (grams/day).

11 Food Groups Derived from the European Prospective into Cancer and Nutrition (EPIC) Food Frequency Questionnaire	Factors (Dietary Patterns)		
	1	2	3
Fats and Oils (grams/day)	0.838		
Sugars and Snacks (grams/day)	0.738		
Cereals (grams/day)	0.712		
Alcoholic beverages (grams/day)	0.665		
Red and processed meat (grams/day)	0.553		
Fish and Seafood (grams/day)		0.821	
Eggs (grams/day)		0.809	
Milk and milk products (grams/day)		0.518	
Fruits (grams/day)			0.750
Vegetables (grams/day)			0.747
Nuts and Seeds (grams/day)			0.619

Table 3. *Cont.*

Table 4. Multiple regression models showing the association between each a-posteriori-derived diet pattern and its predictor variables.

Model	Predictor	Coefficient Estimate	*p*-Value
1 (DP-1) "fats & oils, sugars & snacks, alcoholic beverages, red and processed meat, and cereals" DP	Intercept	0.419	<0.001
	Stress	0.003	0.005
	Physical activity (METs-h/wk)	−0.0000002	0.395
	BMI	0.002	0.062
	Age	−0.003 −0.027	0.004
	Father's educational level (A-level/higher)	−0.006	0.107
	Mother's educational level (A-level/higher)		0.713

DP: dietary pattern. METs-h/wk: metabolic equivalents of tasks-hours per week. Model 1 of the first dietary pattern was based on the following formula: DP − 1 = β0 + β1 Stress + β2 Physical activity + β3 BMI + β4 Age + β5 Father's educational level + β6 Mother's educational level + β7 Ethnicity + β8 Father's occupation + β9 Mother's occupation + β10 Smoking status + β11 Participant's income. Model 2 of the second dietary pattern was based on the following formula: DP − 2 = β0 + β1 Stress + β2 Depression + β3 Mother's education + β4 Father's occupation + β5 Mother's occupation + β6 Participant's income. Model 3 of the third dietary pattern was based on the following formula: DP − 3 = β0 + β1 Stress + β2 Physical activity + β3 BMI + β4 Ethnicity + β5 Parent's income + β6 Smoking.

	Ethnicity (white)	0.026	0.128
	Father's occupation (other)	0.015	0.369
	Mother's occupation (other)	0.022	0.174
	Smoking status (smoker)	−0.05	0.005
	Participant's income (above average)	0.026	0.098
2 (DP-2) "fish & seafood, eggs, and milk & milk products" DP	Intercept	0.441	<0.0001
	Stress	−0.002	0.14
	Depression	0.0001	0.676
	Mother's education (A-level/higher)	−0.038	0.019
	Father's occupation (other)	0.035	0.057
	Mother's occupation (other)	0.018	0.313
	Participant's income (above average)	0.033	0.069
3 (DP-3) "fruits, vegetables, and nuts & seeds" DP	Intercept	0.653	<0.001
	Stress	−0.005	<0.001
	Physical activity (METs-h/wk)	0.0000006	0.115
	BMI	−0.005	0.001
	Ethnicity (white)	−0.047	0.013
	Parent's income (above average)	0.023	0.184
	Smoking (smoker)	0.033	0.092

4. Discussion

This is the first study to investigate the association between perceived stress and diet quality/patterns among women of reproductive age in the UK. The association between stress and diet quality/patterns has recently gained the interest of health researchers, especially that diet is a main modifiable risk factor of obesity and many chronic diseases [21]. In the present study, diet quality/patterns analysis was used, rather than individual-nutrient assessment, because it allows the description of the whole diet of the population and is considered essential in understanding the relationship between dietary consumption and diet-related diseases [16]. Additionally, the association between stress and single nutrients is difficult to investigate since they are never consumed separately but rather within meals, and they metabolically interact with one another [16]. Our findings indicate that stress is associated with lower diet quality where 73% of participants who had low adherence to the alternate Mediterranean Diet (aMD) had a high stress level. Therefore, stress-coping strategies and programs for women of reproductive age should be implemented to prevent unhealthy eating habits and poor diet quality and their adverse health consequences.

Participants in this study were recruited from a university setting and included both students and employees (18–49 years old) to provide a more representative sample of reproductive aged women of this setting.

The a-priori assessment of diet quality indicated an overall medium adherence to the alternate Mediterranean Diet index (46% of the total sample). Similar results were found in the US where 43% of women of reproductive age (n = 248) had a moderate adherence to the Mediterranean Diet [58] and in the UK where most workplace females (n = 426) were moderate adherers to the Mediterranean Diet Index (n = 346) [59]. Similarly, our research team has previously assessed diet quality by the Mediterranean Diet Index, among 123 women of reproductive age in the UK and also reported an overall moderate adherence [60]; the alternate Mediterranean Diet Index was used in the present study because it has been considered more reflective of MD for non-Mediterranean countries such as the UK [61]. In this context, women of reproductive age should be supported with nutrition counselling and education, in addition to reproductive health care services, to further enhance their diet quality [62].

The a-posteriori dietary approach (Table 4) corroborated further the negative association between stress and healthy diet quality/patterns and offered additional dietary insight by highlighting the types of food groups that might contribute to this association. It showed that stress was positively associated with the Western-style dietary pattern (DP-1) consisting of fats and oils, sugar and snacks, alcoholic beverages, red/processed meat, and cereals ($p = 0.005$) and negatively with the vegetarian-like dietary pattern (DP-3) consisting of fruits, vegetables, nuts and seeds ($p < 0.001$). These findings agree with other studies targeting the association between stress and diet. For instance, El-Ansari et al. [16] assessed stress levels using the Perceived Stress Scale and nutritional habits through a 12-food item FFQ and found that among female university students in the UK, stress was significantly associated with poorer diet quality resembled by high intake of sugar, snacks, fat, and low intake of unsaturated fats, fruits, and vegetables. Additionally, Isasi et al. [25] found that stress was negatively linked with diet quality (Alternate-Healthy Eating Index 2010) among Hispanic/Latino females in the US. Similarly, Groesz et al. [63] targeted 561 females from the US and found that highly stressed females reported high consumption of unhealthy foods (fast food, sweets, etc.) and low consumption of whole grains, fruits, and vegetables as assessed via a food frequency questionnaire. In another study conducted among females across three countries (Germany, Poland, and Bulgaria), a positive association between stress and poor dietary patterns was reported [26]. Habhab et al. [64] also assessed the link between stress and food restraint and diet quality/patterns among 40 women of childbearing age via mixed-design analysis of variance and found that women with poorer diet quality had a high stress level. These findings were corroborated by our recent systematic review and meta-analysis [30] that was the first to examine the association between perceived stress and diet quality in women of reproductive age. The systematic literature review included 24 studies (8 had diet quality as the primary outcome and 16 assessed food frequency of consumption) with a total of 41,033 participants. Overall, the 16 studies on food intake and frequency of consumption ($n = 33,477$) found that stress was associated with high intake of fat, fast food, sweets, processed foods, and low intake of fruits, vegetables, whole grains, and legumes. The meta-analysis included the 8 studies on diet quality ($n = 7556$) and reported a significantly negative association between stress and diet quality ($r = -0.35$, $p < 0.001$, 95% CI (−0.56; −0.15)).

On the contrary, some studies reported different findings. For example, Richardson et al. [24] assessed stress through the 14-item PSS and diet quality via Healthy Eating Index-2010 among 101 childbearing aged women (aged 18–44 years) and found no association between stress and diet quality. Similarly, Ferranti et al. [65] found no association between perceived stress and diet quality among 433 females in the US who were university and health centre employees. The study assessed stress via the 14-item PSS and diet quality via a-priori approach using three diet quality indices: Alternate Healthy Eating Index, Mediterranean Diet Index, and Dietary Approach to Stop Hypertension Index. Two other studies in Egypt [66] and Iran [67] among women of childbearing age also found no significant association between diet quality and stress.

Discrepancies in findings between these studies and the present study might be explained by variations in sample sizes, diversity of the tools used to assess variables, and difference in the population from which the sample was taken. For instance, Richardson et al. [24] recruited 101 women and Widaman et al. [23] recruited 75 females. On the other hand, the present study recruited 244 participants. Secondly, most studies on the association between perceived stress and diet quality in women of reproductive age have used 24-h recalls as the dietary assessment tool [21–25] whereas the EPIC food frequency questionnaire, which measures a wide variety of food items and the frequency of consumption over the past one year, was used in the present study.

In understanding the stress/diet relationship, studies have argued that the association between perceived stress and dietary quality/patterns is bidirectional: psychological stress symptoms could be associated with behaviours that are considered "health-compromising" that put the individual at risk of health problems [16]. For example, in a group of female students, high stress levels were associated with weight dissatisfaction and other healthcompromising behaviours such as alcohol intake, binge eating and smoking, skipping breakfast [68]. Stressed people tend to consume high energy-dense foods to taper down their stressful emotions [69]. Adam et al. [69] suggested that the important reason behind these eating behaviours resulting from negative emotions and stress is the lack of eating control. This is when the consumption of high caloric and palatable foods relates to satisfaction and reward and becomes comfort eating during the stressful periods [69]. However, the absence of significant association between perceived stress and diet quality/patterns in some studies does not support these views. The findings of these studies can be explained by the following coping strategies that are not related to food such as spirituality that could attenuate the effect of stress on dietary behaviour [70]. Although these studies show no significant associations between perceived stress and diet quality, some environmental factors including stress coping strategies, cultural food traditions, cognitive factors (such as the knowledge of nutrition), and the cost of food might contribute to the dietary pattern and quality and must be further studied. Another explanation of the stress/diet relationship is derived from the fact that perceived stress causes physiological changes (in addition to psychological changes) to the human body that trigger food craving [71]. Upon stress, the hypothalamus and central nervous system secrete the hormone cortisol into the bloodstream which leads, if in high circulating concentrations, to the formation and accumulation of visceral fat in the body [69]. Additionally, several studies have pointed out that elevated levels of stress cortisol can be associated with increased food intake [72,73]. This is because perceived stress, and elevated serum cortisol, stimulate the secretion of the gastric hormone Ghrelin that increases appetite and food craving [71].

Strengths and Limitations

The study has several strengths. To our knowledge, it is the first to assess the association between perceived stress and diet quality in women of reproductive age in the United Kingdom. Diet quality/patterns were assessed comprehensively through two approaches: the a-priori (hypothesis-driven) and the a-posteriori (data-driven) which gave robust results and clearer insight about the overall dietary quality/patterns of the study's participants. Another strength of this study is the fact that the tools used to assess all variables were validated and standardised, such as the Perceived Stress Scale to assess stress levels [40], Becks Depression Inventory II to assess depression [42], in addition to the anthropometric and socioeconomic questions [74–76]. Furthermore, while most studies on the association between stress and diet utilised dietary recalls to assess dietary intake, this study used the EPIC food frequency questionnaire which is considered a gold standard dietary assessment tool [34,35].

On the other hand, there are several limitations which are worth acknowledging. The cross-sectional design of the study made it hard to draw and generalise a definitive conclusion about the association between perceived stress and diet quality/patterns among women of reproductive age. Additionally, the convenience sample that was selected from a population of a UK university setting and consequently might not be representative of the general population of women of reproductive age. Although all variables were measured using validated and standardised tools, they have been self-reported by participants, which might have caused inaccuracy in the results. For example, anthropometric measures would be better estimated using advanced and more accurate tools such as Dual-Energy X-ray Absorptiometry (DEXA) which measures the whole-body composition including weight, height, fat mass, and fat-free

body mass [77]. Similarly, the Perceived Stress Scale, that was used to assess stress levels of participants, was self-reported and hence participants might not have accurately recalled the stressful situations that occurred over the past weeks. A more accurate measure of stress should be used in future studies such as blood or salivary cortisol [78]. Moreover, food intake biomarkers (such as urinary and blood samples), which objectively measure the nutritional intake of individuals, should complement the food frequency questionnaires and other self-reported measures of dietary intake [79].

5. Conclusions

In conclusion, the negative association between perceived stress and diet quality (in both a-priori and a-posteriori approaches) that was found among a sample of women of reproductive age in the present study is important and merits further investigation. The results of this study have implications for future interventions which should include not only dietary but also other behavioural aspects to support lifestyle changes among women of reproductive age. In other words, the interventions are complex; they are more than simply changing the diet alone. Women of reproductive age seem to eat depending on the level of stress and therefore dietary interventions need to take that into consideration when applying it. Future randomised controlled trials with accurate measures should be implemented to further confirm this negative association.

Author Contributions: Conceptualization, K.K., F.T. and V.H.; methodology, K.K., F.T. and V.H.; formal analysis, K.K.; data curation, K.K.; writing—original draft preparation, K.K.; writing—review and editing, K.K., F.T. and V.H.; visualization, K.K., F.T. and V.H.; supervision, F.T. and V.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of Bournemouth University (protocol code 22344) on 27 January 2020.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Acknowledgments: The authors would like to thank Laya Awada for her help in data cleaning. As authors, who have used the FETA software for the analysis of the EPIC FFQ data in the present study, we are asked by FETA-software team to acknowledge the following: The EPIC-Norfolk study (DOI 10.22025/2019.110.1105.00004) has received funding from the Medical Research Council (MR/N003284/1 and MC-UU_112015/1) and Cancer Research UK (C864/A14136). We are grateful to all the participants who have been part of the project and to the many members of the study teams at the University of Cambridge who have enabled this research.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Durst, J.K.; Tuuli, M.G.; Stout, M.J.; Macones, G.A.; Cahill, A.G. Degree of obesity at delivery and risk of preeclampsia with severe features. *Am. J. Obstet. Gynecol.* **2016**, *214*, 651.e1–651.e5. [CrossRef]
2. Guelinckx, I.; Devlieger, R.; Beckers, K.; Vansant, G. Maternal obesity: Pregnancy complications, gestational weight gain and nutrition. *Obes. Rev.* **2008**, *9*, 140–150. [CrossRef] [PubMed]
3. Wei, Y.-M.; Yang, H.; Zhu, W.-W.; Liu, X.-Y.; Meng, W.-Y.; Wang, Y.-Q.; Shang, L.-X.; Cai, Z.-Y.; Ji, L.-P.; Wang, Y.-F.; et al. Risk of adverse pregnancy outcomes stratified for pre-pregnancy body mass index. *J. Matern. Neonatal Med.* **2015**, *29*, 2205–2209. [CrossRef] [PubMed]
4. Sun, Y.; Shen, Z.; Zhan, Y.; Wang, Y.; Ma, S.; Zhang, S.; Liu, J.; Wu, S.; Feng, Y.; Chen, Y.; et al. Effects of pre-pregnancy body mass index and gestational weight gain on maternal and infant complications. *BMC Pregnancy Childbirth* **2020**, *20*, 1–13. [CrossRef]
5. Lisonkova, S.; Muraca, G.; Potts, J.; Liauw, J.; Chan, W.-S.; Skoll, A.; Lim, K.I. Association Between Prepregnancy Body Mass Index and Severe Maternal Morbidity. *JAMA* **2017**, *318*, 1777–1786. [CrossRef] [PubMed]
6. International Weight Management in Pregnancy (i-WIP) Collaborative Group. Effect Of Diet And Physical Activity Based Interventions In Pregnancy On Gestational Weight Gain And Pregnancy Outcomes: Meta-Analysis Of Individual Participant Data From Randomised Trials. *BMJ* **2017**, *358*, j3991.

7. Ng, D.M.; Jeffery, R.W. Relationships Between Perceived Stress and Health Behaviors in a Sample of Working Adults. *Health Psychol.* **2003**, *22*, 638–642. [CrossRef]
8. Tseng, M.; Fang, C. Stress is Associated with Unfavorable Patterns of Dietary Intake Among Female Chinese Immigrants. *Annal. Behav. Med.* **2011**, *41*, 324–332. [CrossRef]
9. Bayram, N.; Bilgel, N. The prevalence and socio-demographic correlations of depression, anxiety and stress among a group of university students. *Soc. Psychiatry Psychiatr. Epidemiol.* **2008**, *43*, 667–672. [CrossRef] [PubMed]
10. Bauer, K.W.; Hearst, M.O.; Escoto, K.; Berge, J.; Neumark-Sztainer, D. Parental employment and work-family stress: Associations with family food environments. *Soc. Sci. Med.* **2012**, *75*, 496–504. [CrossRef] [PubMed]
11. Laugero, K.D.; Falcon, L.M.; Tucker, K. Relationship between perceived stress and dietary and activity patterns in older adults participating in the Boston Puerto Rican Health Study. *Appetite* **2011**, *56*, 194–204. [CrossRef] [PubMed]
12. Vidal, E.J.; Alvarez, D.; Martinez-Velarde, D.; Vidal-Damas, L.; Yuncar-Rojas, K.A.; Julca-Malca, A.; Bernabe-Ortiz, A. Perceived stress and high fat intake: A study in a sample of undergraduate students. *PLoS ONE* **2018**, *13*, e0192827. [CrossRef] [PubMed]
13. Wichianson, J.R.; Bughi, S.A.; Unger, J.; Spruijt-Metz, D.; Nguyen-Rodriguez, S.T. Perceived stress, coping and night-eating in college students. *Stress Health* **2009**, *25*, 235–240. [CrossRef]
14. Nastaskin, R.S.; Fiocco, A.J. A survey of diet self-efficacy and food intake in students with high and low perceived stress. *Nutr. J.* **2015**, *14*, 1–8. [CrossRef]
15. Roohafza, H.; Sarrafzadegan, N.; Sadeghi, M.; Rafieian-Kopaei, M.; Sajjadi, F.; Khosravi-Boroujeni, H. The Association Be-tween Stress Levels And Food Consumption Among Iranian Population. *Arch. Iran. Med.* **2013**, *16*, 145–148.
16. El Ansari, W.; Adetunji, H.; Oskrochi, R. Food and Mental Health: Relationship between Food and Perceived Stress and
Depressive Symptoms among University Students in the United Kingdom. *Central Eur. J. Public Health* **2014**, *22*, 90–97. [CrossRef]
17. Papier, K.; Ahmed, F.; Lee, P.; Wiseman, J. Stress and dietary behaviour among first-year university students in Australia: Sex differences. *Nutrients* **2015**, *31*, 324–330. [CrossRef]
18. O'Connor, D.B.; O'Connor, R.C. Perceived changes in food intake in response to stress: The role of conscientiousness. *Stress Health* **2004**, *20*, 279–291. [CrossRef]
19. Tryon, M.; Carter, C.; DeCant, R.; Laugero, K. Chronic Stress Exposure May Affect the Brain's Response to High Calorie Food Cues And Predispose To Obesogenic Eating Habits. *Physiol. Behav.* **2013**, *120*, 233–242. [CrossRef]
20. Hwang, J.; Lee, S.; Kim, S.; Chung, H.; Kim, W. Psychological Distress Is Associated with Inadequate Dietary Intake In Viet-namese Marriage Immigrant Women In Korea. *J. Am. Diet. Assoc.* **2010**, *110*, 779–785. [CrossRef] [PubMed]
21. Fowles, E.R.; Bryant, M.; Kim, S.; Walker, L.O.; Ruiz, R.J.; Timmerman, G.M.; Brown, A. Predictors of Dietary Quality in Low-Income Pregnant Women. *Nurs. Res.* **2011**, *60*, 286–294. [CrossRef] [PubMed]
22. Fowles, E.R.; Stang, J.; Bryant, M.; Kim, S. Stress, Depression, Social Support, and Eating Habits Reduce Diet Quality in the First Trimester in Low-Income Women: A Pilot Study. *J. Acad. Nutr. Diet.* **2012**, *112*, 1619–1625. [CrossRef] [PubMed]
23. Widaman, A.; Witbracht, M.G.; Forester, S.M.; Laugero, K.D.; Keim, N.L. Chronic Stress is Associated with Indicators of Diet Quality in Habitual Breakfast Skippers. *J. Acad. Nutr. Diet.* **2016**, *116*, 1776–1784. [CrossRef]
24. Richardson, A.S.; Arsenault, J.E.; Cates, S.C.; Muth, M.K. Perceived stress, unhealthy eating behaviors, and severe obesity in low-income women. *Nutr. J.* **2015**, *14*, 1–10. [CrossRef]
25. Isasi, C.; Parrinello, C.; Jung, M.; Carnethon, M.; Birnbaum-Weitzman, O.; Espinoza, R.; Penedo, F.; Perreira, K.; Schneiderman, N.; Sotres-Alvarez, D.; et al. Psychosocial Stress Is Associated with Obesity and Diet Quality in Hispanic/Latino Adults. *Annal. Epidemiol.* **2015**, *25*, 84–89. [CrossRef]
26. Mikolajczyk, R.T.; El Ansari, W.; Maxwell, A.E. Food consumption frequency and perceived stress and depressive symptoms among students in three European countries. *Nutr. J.* **2009**, *8*, 31. [CrossRef]
27. González, A.M.; Cruz, S.Y.; Ríos, J.L.; Pagán, I.; Fabián, C.; Betancourt, J.; Rivera-Soto, W.T.; González, M.J.; Palacios, C. Alcohol consumption and smoking and their associations with socio-demographic characteristics, dietary patterns, and perceived academic stress in Puerto Rican college students. *Puerto Rico Health Sci. J.* **2013**, *32*, 82–88.
28. Fulkerson, J.E.; Sherwood, N.E.; Perry, C.L.; Neumark-Sztainer, D.; Story, M. Depressive symptoms and adolescent eating and health behaviors: A multifaceted view in a population-based sample. *Prev. Med.* **2004**, *38*, 865–875. [CrossRef]
29. Liu, C.; Xie, B.; Chou, C.-P.; Koprowski, C.; Zhou, D.; Palmer, P.; Sun, P.; Guo, Q.; Duan, L.; Sun, X.; et al. Perceived stress, depression and food consumption frequency in the college students of China seven cities. *Physiol. Behav.* **2007**, *92*, 748–754. [CrossRef] [PubMed]
30. Khaled, K.; Tsofliou, F.; Hundley, V.; Helmreich, R.; Almilaji, O. Perceived stress and diet quality in women of reproductive age: A systematic review and meta-analysis. *Nutr. J.* **2020**, *19*, 1–15. [CrossRef] [PubMed]

31. Morema, E.N.; Atieli, H.E.; Onyango, R.O.; Omondi, J.H.; Ouma, C. Determinants of Cervical screening services uptake among
18–49 year old women seeking services at the Jaramogi Oginga Odinga Teaching and Referral Hospital, Kisumu, Kenya. *BMC Health Serv. Res.* **2014**, *14*, 1–7. [CrossRef]
32. Proportion of Women of Reproductive Age (Aged 15–49 Years) Who Have Their Need for Family Planning Satisfied with Modern Methods (SDG 3.7.1). Available online: https://www.who.int/data/maternal-newborn-child-adolescent-ageing/ indicator-explorer-new/mca/proportion-of-women-of-reproductive-age-(aged-15--49-years)-who-have-their-need-forfamily-planning-satisfied-with-modern-methods (accessed on 22 July 2021).
33. Hulley, S.; Cummings, S.; Browner, W.; Grady, D.; Newman, T. *Designing Clinical Research*, 4th ed.; Wolters Kluwer/Lippincott Williams & Wilkins: Philadelphia, PA, USA, 2013.
34. Verkasalo, P.K.; Appleby, P.N.; Allen, N.E.; Davey, G.; Adlercreutz, H.; Key, T.J. Soya intake and plasma concentrations of daidzein and genistein: Validity of dietary assessment among eighty British women (Oxford arm of the European Prospective Investigation into Cancer and Nutrition). *Br. J. Nutr.* **2001**, *86*, 415–421. [CrossRef]
35. Welch, A.A.; Luben, R.; Khaw, K.T.; Bingham, S.A. The CAFE computer program for nutritional analysis of the EPIC-Norfolk food frequency questionnaire and identification of extreme nutrient values. *J. Hum. Nutr. Diet.* **2005**, *18*, 99–116. [CrossRef]
36. Mulligan, A.A.; Luben, R.; Bhaniani, A.; Parry-Smith, D.J.; O'Connor, L.; Khawaja, A.; Forouhi, N.; Khaw, K.-T. A new tool for converting food frequency questionnaire data into nutrient and food group values: FETA research methods and availability. *BMJ Open* **2014**, *4*, e004503. [CrossRef] [PubMed]
37. Trichopoulou, A.; Costacou, T.; Bamia, C.; Trichopoulos, D. Adherence to a Mediterranean Diet and Survival in a Greek Population. *N. Engl. J. Med.* **2003**, *348*, 2599–2608. [CrossRef] [PubMed]
38. Fung, T.; McCullough, M.; Newby, P.; Manson, J.; Meigs, J.; Rifai, N.; Willett, W.; Hu, F. Diet-Quality Scores and Plasma Concentrations Of Markers Of Inflammation And Endothelial Dysfunction. *Am. J. Clin. Nutr.* **2005**, *82*, 163–173. [CrossRef]
[PubMed]
39. Zhao, J.; Li, Z.; Gao, Q.; Zhao, H.; Chen, S.; Huang, L.; Wang, W.; Wang, T. A review of statistical methods for dietary pattern analysis. *Nutr. J.* **2021**, *20*, 1–18. [CrossRef]
40. Cohen, S.; Kamarck, T.; Mermelstein, R. A Global Measure of Perceived Stress. *J. Health Soc. Behav.* **1983**, *24*, 385. [CrossRef]
41. Tavolacci, M.P.; Ladner, J.; Grigioni, S.; Richard, L.; Villet, H.; Dechelotte, P. Prevalence and association of perceived stress, substance use and behavioral addictions: A cross-sectional study among university students in France, 2009–2011. *BMC Public Health* **2013**, *13*, 724. [CrossRef]
42. Beck, A.; Steer, R.; Brown, G. *Manual for the Beck Depression Inventory-II*, 2nd ed.; Psychological Corporation: San Antonio, TX, USA, 1996.
43. García-Batista, Z.E.; Guerra-Peña, K.; Cano-Vindel, A.; Herrera-Martínez, S.X.; Medrano, L.A. Validity and reliability of the Beck Depression Inventory (BDI-II) in general and hospital population of Dominican Republic. *PLoS ONE* **2018**, *13*, e0199750. [CrossRef] [PubMed]
44. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed.; American Psychiatric Association: Washington, DC, USA, 2011.
45. Wang, Y.-P.; Gorenstein, C. Psychometric properties of the Beck Depression Inventory-II: A comprehensive review. *Rev. Bras. Psiquiatr.* **2013**, *35*, 416–431. [CrossRef] [PubMed]
46. Gomes-Oliveira, M.H.; Gorenstein, C.; Neto, F.L.; Andrade, L.H.; Wang, Y.P. Validation of the Brazilian Portuguese Version of the Beck Depression Inventory-II in a community sample. *Rev. Bras. Psiquiatr.* **2012**, *34*, 389–394. [CrossRef] [PubMed]
47. Segal, D.L.; Coolidge, F.L.; Cahill, B.S.; O'Riley, A.A. Psychometric Properties of the Beck Depression Inventory—II (BDI-II) Among Community-Dwelling Older Adults. *Behav. Modif.* **2008**, *32*, 3–20. [CrossRef]
48. Grothe, K.B.; Dutton, G.R.; Jones, G.; Bodenlos, J.; Ancona, M.; Brantley, P.J. Validation of the Beck Depression Inventory-II in a Low-Income African American Sample of Medical Outpatients. *Psychol. Assess.* **2005**, *17*, 110–114. [CrossRef] [PubMed]
49. Subica, A.M.; Fowler, J.C.; Elhai, J.D.; Frueh, B.C.; Sharp, C.; Kelly, E.L.; Allen, J.G. Factor structure and diagnostic validity of the Beck Depression Inventory–II with adult clinical inpatients: Comparison to a gold-standard diagnostic interview. *Psychol. Assess.* **2014**, *26*, 1106–1115. [CrossRef] [PubMed]
50. Craig, C.L.; Marshall, A.; Sjöström, M.; Bauman, A.E.; Booth, M.L.; Ainsworth, B.E.; Pratt, M.; Ekelund, U.; Yngve, A.; Sallis, J.F.; et al. International Physical Activity Questionnaire: 12-Country Reliability and Validity. *Med. Sci. Sports Exerc.* **2003**, *35*,
1381–1395. [CrossRef]
51. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic: Report of a WHO Consultation*; WHO: Geneva, Switzerland, 2000.
52. Nikolaou, C.K.; Hankey, C.R.; Lean, M.E.J. Accuracy of on-line self-reported weights and heights by young adults. *Eur. J. Public Health* **2017**, *27*, 898–903. [CrossRef]

53. Martorell, R.; Kettel Khan, L.; Hughes, M.; Grummer-Strawn, L. Obesity in Women From Developing Countries. *Eur. J. Clin. Nutr.* **2000**, *54*, 247–252. [CrossRef]
54. Monteiro, C.A.; Conde, W.L.; Lu, B.; Popkin, B. Obesity and inequities in health in the developing world. *Int. J. Obes.* **2004**, *28*, 1181–1186. [CrossRef]
55. Matore, E.; Khairani, A.; Adnan, R. Exploratory Factor Analysis (EFA) For Adversity Quotient (AQ) Instrument among Youth. *J. Crit. Rev.* **2019**, *6*, 234–242.
56. MacCallum, R.; Widaman, K.; Zhang, S.; Hong, S. Sample Size in Factor Analysis. *Psychol. Methods* **1999**, *4*, 84–99. [CrossRef]
57. de Winter, J.; Dodou, D.; Wieringa, P.A. Exploratory Factor Analysis with Small Sample Sizes. *Multivar. Behav. Res.* **2009**, *44*, 147–181. [CrossRef] [PubMed]
58. Boghossian, N.S.; Yeung, E.H.; Mumford, S.L.; Zhang, C.; Gaskins, A.J.; Wactawski-Wende, J.; Schisterman, E.; for the BioCycle Study Group. Adherence to the Mediterranean diet and body fat distribution in reproductive aged women. *Eur. J. Clin. Nutr.*
2013, *67*, 289–294. [CrossRef]
59. Papadaki, A.; Wood, L.; Sebire, S.J.; Jago, R. Adherence to the Mediterranean diet among employees in South West England: Formative research to inform a web-based, work-place nutrition intervention. *Prev. Med. Rep.* **2015**, *2*, 223–228. [CrossRef]
[PubMed]
60. Khaled, K.; Hundley, V.; Almilaji, O.; Koeppen, M.; Tsofliou, F. A Priori and a Posteriori Dietary Patterns in Women of Childbearing Age in the UK. *Nutrients* **2020**, *12*, 2921. [CrossRef] [PubMed]
61. Chen, G.-D.; Dong, X.-W.; Zhu, Y.-Y.; Tian, H.-Y.; He, J.; Chen, Y.-M. Adherence to the Mediterranean diet is associated with a higher BMD in middle-aged and elderly Chinese. *Sci. Rep.* **2016**, *6*, 25662. [CrossRef] [PubMed]
62. Nestle, M. Obesity. Halting the obesity epidemic: A public health policy approach. *Public Health Rep.* **2000**, *115*, 12–24. [CrossRef] [PubMed]
63. Groesz, L.M.; McCoy, S.; Carl, J.; Saslow, L.; Stewart, J.; Adler, N.; Laraia, B.; Epel, E. What is eating you? Stress and the drive to eat. *Appetite* **2012**, *58*, 717–721. [CrossRef] [PubMed]
64. Habhab, S.; Sheldon, J.; Loeb, R. The Relationship Between Stress, Dietary Restraint, And Food Preferences in Women. *Appetite* **2009**, *52*, 437–444. [CrossRef]
65. Ferranti, E.P.; Dunbar, S.B.; Higgins, M.; Dai, J.; Ziegler, T.R.; Frediani, J.; Reilly, C.; Brigham, K.L. Psychosocial factors associated with diet quality in a working adult population. *Res. Nurs. Health* **2013**, *36*, 242–256. [CrossRef]
66. El Ansari, W.; Berg-Beckhoff, G. Nutritional Correlates of Perceived Stress among University Students in Egypt. *Int. J. Environ. Res. Public Health* **2015**, *12*, 14164–14176. [CrossRef]
67. Valipour, G.; Esmaillzadeh, A.; Azadbakht, L.; Afshar, H.; Hassanzadeh, A.; Adibi, P. Adherence To The DASH Diet In Re-lation To Psychological Profile Of Iranian Adults. *Eur. J. Nutr.* **2015**, *56*, 309–320. [CrossRef] [PubMed]
68. Stice, E.; Presnell, K.; Spangler, D. Risk Factors For Binge Eating Onset In aAdolescent Girls: A 2-Year Prospective Investiga-tion. *Health Psychol.* **2002**, *21*, 131–138. [CrossRef] [PubMed]
69. Adam, T.; Epel, E. Stress, Eating And The Reward System. *Physiol. Behav.* **2007**, *91*, 449–458. [CrossRef]
70. Musgrave, C.F.; Allen, C.E.; Allen, G.J. Spirituality and Health for Women of Color. *Am. J. Public Health* **2002**, *92*, 557–560. [CrossRef] [PubMed]
71. Azzam, I.; Gilad, S.; Limor, R.; Stern, N.; Greenman, Y. Ghrelin Stimulation by Hypothalamic–Pituitary–Adrenal Axis Acti-vation Depends On Increasing Cortisol Levels. *Endo. Connect.* **2017**, *6*, 847–855. [CrossRef]
72. Herhaus, B.; Ullmann, E.; Chrousos, G.; Petrowski, K. High/low cortisol reactivity and food intake in people with obesity and healthy weight. *Transl. Psychiatry* **2020**, *10*, 1–8. [CrossRef]
73. Hewagalamulage, S.; Lee, T.; Clarke, I.; Henry, B. Stress, Cortisol, And Obesity: A Role For Cortisol Responsiveness in Iden-tifying Individuals Prone To Obesity. *Domes. Anim. Endocrinol.* **2016**, *56*, S112–S120. [CrossRef]
74. Flint, E.; Webb, E.; Cummins, S. Change in commute mode and body-mass index: Prospective, longitudinal evidence from UK Biobank. *Lancet Public Health* **2016**, *1*, e46–e55. [CrossRef]
75. Prady, S.L.; Pickett, K.E.; Croudace, T.; Fairley, L.; Bloor, K.; Gilbody, S.; Kiernan, K.E.; Wright, J. Psychological Distress during
Pregnancy in a Multi-Ethnic Community: Findings from the Born in Bradford Cohort Study. *PLoS ONE* **2013**, *8*, e60693. [CrossRef]
76. Bowman, S.A. A comparison of the socioeconomic characteristics, dietary practices, and health status of women food shoppers with different food price attitudes. *Nutr. Res.* **2006**, *26*, 318–324. [CrossRef]
77. Shepherd, J.A.; Ng, B.K.; Sommer, M.J.; Heymsfield, S.B. Body composition by DXA. *Bone* **2017**, *104*, 101–105. [CrossRef] [PubMed]
78. Hellhammer, D.; Wüst, S.; Kudielka, B. Salivary Cortisol as A Biomarker in Stress Re-search. *Psychoneuroendocrinology* **2009**, *34*, 163–171. [CrossRef] [PubMed]
79. Picó, C.; Serra, F.; Rodríguez, A.; Keijer, J.; Palou, A. Biomarkers of Nutrition and Health: New Tools For New Approaches. *Nutrients* **2019**, *11*, 1092. [CrossRef] [PubMed]

This chapter has reported the first empirical study in the thesis. The study was not without challenges, in large part due to the Covid-19 pandemic, however the findings provide the first evidence of the association between stress and dietary patterns among women of reproductive age. This study informed the next stage of this thesis and as most studies in the literature were conducted in a single country and there have been calls to conduct studies, especially related to stress and diet association, across different countries from different regions and cultures. The study was conducted in the UK and the next step in the doctoral work was to repeat this research in Lebanon in order to bridge the gap in the literature. To allow comparison between the studies, the same methodology should be used to avoid bias and ensure robust and standard tools have been allocated. To do this, a validated dietary tool, compared to the UK study methodology, was needed; this is discussed further in the next chapter. The EPIC FFQ was validated in Lebanon among adults as a first step before using it in the main study that assessed the association between stress and diet among women of reproductive age in Lebanon.

Chapter 4 Validating the EPIC FFQ in Lebanon

In the next step, a study in Lebanon about stress and diet had to be conducted. However, the project aimed to ensure consistency in methodology between the studies (UK and Lebanon) especially with regards to tools used in the assessment of variables (e.g., dietary assessment). Thus, and since the European Prospective Investigation into Cancer food frequency questionnaire (EPIC FFQ) was used in the UK study but has not been validated in Lebanon previously, a validation study of the EPIC FFQ was conducted among adults in Lebanon. This paper was published in the journal Public Health Nutrition and is replicated here.

Validation of the European Prospective Investigation into Cancer (EPIC) Food Frequency Questionnaire for use among Adults in Lebanon

Karim Khaled[1]*, Vanora Hundley[2], Maya Bassil[3], Mira Bazzi[3], Fotini Tsofliou[1, 2]

[1]Department of Rehabilitation & Sport Sciences, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth BH8 8AJ, UK; Khaledk@bournemouth.ac.uk (K.K.); ftsofliou@bournemouth.ac.uk (F.T.)

[2]Centre for Midwifery, Maternal & Perinatal Health, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth BH8 8AJ, UK; vhundley@bournemouth.ac.uk

[3]Department of Natural Sciences, Faculty of Arts & Sciences, Lebanese American University, Beirut, Lebanon; Mbassil@lau.edu.lb (M.B.1); Mira.bazzi@lau.edu (M.B.2)

***Corresponding author:** Karim Khaled, Department of Rehabilitation and Sport Sciences Faculty of Health and Social Sciences Bournemouth Gateway Building, Bournemouth University St Pauls Lane, Bournemouth, BH88AJ, khaledk@bournemouth.ac.uk, 01202966742

This is an Accepted Manuscript for Public Health Nutrition as part of the Cambridge Coronavirus Collection. This peer-reviewed article has been accepted for publication but not yet copyedited or typeset, and so may be subject to change during the production process.

The article is considered published and may be cited using its DOI

10.1017/S1368980021002123

Public Health Nutrition is published by Cambridge University Press on behalf of The Nutrition Society

Short title: [Validation of the EPIC FFQ among Lebanese Adults]

Acknowledgements: [Here you may acknowledge individuals or organizations that provided advice and/or support (non-financial)]

Financial Support: [This research received no external funding.]

Conflict of Interest: ["None."]

Authorship: [Conceptualisation and study design, K.K., F.T., and V.H.; methodology, K.K. and F.T.; ethical approval applications preparation: K.K., F.T., V.H., M.B.1, M.B.2; data collection, K.K., M.B.1, M.B.2; formal data analysis, K.K.; data interpretation, K.K., F.T., and V.H.; writing—original first draft preparation, K.K.; writing—review and editing, K.K., F.T., and V.H.; supervision, F.T. and V.H. All authors have read and agreed to the published version of the manuscript.]

Ethical Standards Disclosure: ["This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the [Lebanese American University Institutional Review Board] IRB#: LAU.SAS.MB3.2/Dec/2019. Written informed consent was obtained from all subjects/patients."] Accepted manuscript

Abstract:

Objective: To validate the EPIC food frequency questionnaire (FFQ) in Lebanon. **Design:** Validation of the EPIC FFQ was done against three 24-hour recalls. Unadjusted and energy adjusted correlations, Bland Altman plots, and weighed kappa statistics were used to assess the agreement between the two methods.

Setting: Lebanon.

Participants: 119 adults (staff and students) at a Lebanese University.

Results: Good unadjusted and energy-adjusted correlation coefficients were found between data from the two methods which ranged from -0.002 (vitamin A) to 0.337 (carbohydrates) and were all statistically significant except for vitamin D, vitamin E, vitamin A, selenium, and niacin. Slight/fair agreement was reported through weighed kappa estimates for unadjusted data ranging from -0.05 (vitamin C) to 0.248 (magnesium) and for energy-adjusted data ranging from -0.034 (vitamin A) to 0.203 (phosphorus). Individuals were categorised into exact and adjacent quartiles with an average of 78% for unadjusted data and 70% for energy-adjusted data, indicating a very good agreement between the EPIC FFQ and the average of the 24-HRs data. The visual inspection of the Bland-Altman plots revealed an over-estimation of energy, carbohydrates, protein, and fat intakes by the FFQ method.

Conclusion: Overall, when all tests were taken into consideration, this study demonstrated an acceptable agreement of the EPIC FFQ with the 24-hour dietary recall method and significantly good correlations between dietary intakes. Therefore, the EPIC FFQ can be considered a valid tool for assessing diet in epidemiological studies among Lebanese adults.

Keywords: Diet, Validation, Food frequency questionnaire, 24-hour recalls, Adults, Lebanon.

INTRODUCTION

The prevalence of obesity in the Middle East, especially the Arab Gulf States, is growing rapidly; 75% of adults are considered obese [1]. Lebanon is a middle income Middle Eastern country having food ingredients that are representative of the Mediterranean diet [2].

Traditionally, Lebanese cuisine has included cereals and legumes, fresh vegetables, along with sea food, meat, or chicken, filled or mixed with olive oil and herbs, ending up with common dishes known as "mezze" and "stews". The traditional Mediterranean diet consisted of fruits, vegetables, seeds, whole grains, non-refined cereals, olive oil, and vegetable protein has shifted to a westernised dietary pattern based on animal proteins, low fibre, refined grains, and high in sugar and saturated fats [3]. However, Lebanon has experienced a dietary transition with the traditional Mediterranean diet being substituted by a more westernised diet in the past few years [2]. This change in eating pattern has contributed to the increase in obesity and consequently, the prevalence of nutrition-related diseases (e.g metabolic syndrome, diabetes, cancer, and heart diseases) has grown among the Lebanese population over the last decade [4, 5].

There is a need to study the link between food/nutrition and health outcomes through standardised and validated dietary tools [6]. For such studies, rigorous methods to estimate shortterm and long-term dietary intake are needed. However, thorough dietary methods are often expensive, time-consuming and demand a high commitment from participants [7]. There are several dietary assessment methods including: diet records that ask individuals to report everything they consumed over several days/weeks, 24-hour recalls that involve reporting food consumed in the past 24 hours (including the Automated Self-Administered 24-hour dietary recall (ASA-24) and Intake-24 which are newer methods that reduce the burden on participants), food frequency questionnaires (FFQs), nutrition biomarkers e.g. urinary nitrogen or blood-lipid profile that confirm results of food intake [6,8-10]. Food frequency questionnaires has numerous advantages compared to other dietary tools as they allow the assessment of food intake over a long-time interval and can estimate the past intake of large populations [11]. Further, although FFQs are not the easiest dietary assessment tools to use, they are still deemed to be inexpensive, exert a low burden on participants, and easy to administer [11,12].

Self-reported FFQs collect from individuals their frequency of consumption and portion size of several foods. In large surveys that primarily demonstrate an overview of the health status Accepted manuscript

within a particular population, the methods employed for dietary evaluations (e.g. dietary patterns) should be feasible before assessments [7]. FFQs assess the usual intake across a medium or long duration that is very crucial to be able to monitor individuals' behaviours. Medical surveys often use FFQs to compare groups or people based on their intake of various food groups, and thereby FFQ is a suitable method of choice for such surveys [12]. Yet, to minimse the burden on participants, ultimately an FFQ should be comprised of a limited number of food types. Additionally, it is necessary to adapt the food list according to the population's food consumption habits [11]. Similar to all other dietary tools, FFQs can exhibit measurement errors and it is strongly advised that they get validated among the studied population [7, 11]. In other words, FFQs ought to be culture and population specific [13]. This means that it is unacceptable for them to be used cross-culturally (in different countries) except if they were validated in those countries [11, 13].

The European Prospective Investigation of Cancer food-frequency questionnaire (EPIC FFQ) has been widely used for dietary assessment [14]. It represents a gold standard assessment tool of the diet in nutrition epidemiological studies. The EPIC FFQ has been validated for use in adolescents and adults in the United Kingdom (UK) [15-17], in patient groups (celiac disease patients) [18], and in other European countries such as Italy [19] providing a reasonable assessment of habitual diet; however, no validation study of the EPIC FFQ has been done in the MENA region. Although food frequency questionnaires are commonly used in the USA and European countries, nutrition epidemiology in the MENA (Middle East and North Africa) region and Lebanon is considered poor due to the scarcity of rigour and representative dietary questionnaires, specifically FFQs [20]. To date, there have been no studies on dietary patterns across different continents using a common FFQ. The aim of this study was to validate an existing tool, the EPIC food frequency questionnaire, in a new country context, Lebanon.

MATERIALS AND METHODS

The validation was done by comparing data collected from the EPIC FFQ with that collected from three 24-hour recalls (24-HRs).

2.1 Participants

The sample consisted of adults aged 18 years and older who were staff and students at LAU in Lebanon. A total of 119 participants were eligible for the study. This number was also recommended by professionals in this field who confirm that more than 105 individuals are required to assess the agreement between tools used to evaluate dietary intakes [7, 11]. Exclusion criteria included adults who were: suffering from a chronic disease such as: Cancer, Crohn's Disease, Diabetes, Heart Disease, HIV/AIDS/ Multiple sclerosis, Asthma, COPD, Cystic fibrosis, or mental health disorder, having food intolerance or allergy, pregnant/breastfeeding, on any medication known to affects appetite or have undergone bariatric surgery.

2.2 Methodological Procedure

Participants were approached by a licensed dietician through classroom and office visits during term where they were asked to fill out three 24-HRs in paper form: two on weekdays and one on a weekend day providing qualitative (e.g., type of food) and quantitative (e.g., portion) details about what they consumed in the last 24-hours. Participants were given guidance on how to use the 24-HRs and were filled out on different days. One week after completing the 24-HRs, participants were asked to fill in the adapted version of the EPIC FFQ. Additionally, their demographic characteristics were collected. Data was then entered electronically to an online survey in order to facilitate its analysis.

2.3 Measures

2.3.1 Socioeconomic and Physical characteristics

Self-reported age, body weight, height, education, income, race, and marital status were collected to describe the socio-demographic characteristics of participants.

2.3.2 24-hour recalls

The three 24-hour recalls (24-HRs) collected dietary data about foods and drinks consumed over the past 24 hours. Participants were asked to fill out the second 24-HR on a weekday two days after completing the first one while the third 24-HR to be completed in the weekend of the same week so that the data collected is representative of the individual's overall dietary intake. After the recalls were collected, the researcher and the nutrition team at LAU checked the recalls.

2.3.4 EPIC FFQ

The EPIC FFQ consists of 130 food items and one additional question for milk (131 items). The tool was adapted to reflect the Lebanese diet (Appendix 1). To adapt the EPIC FFQ to the Lebanese diet, the researcher (Lebanese) substituted some foods from the original EPIC FFQ with foods that are commonly consumed in Lebanon. In order to retain its international comparability, most foods items from the original EPIC FFQ remained the same in each of the sections. Since students and staff at LAU were from different religions (Christians and Muslims), food items like pork and alcohol intake were kept unchanged, unlike other validation studies that took place in other Arab countries where pork and alcohol sections were excluded because participants were solely Muslims. The frequency of dietary intake of the adapted FFQ remained the same as the original version: never or less than once per month, 1-3 times per month, once a week, 2-4 times per week, 5-6 times per week, once a day, 2-3 time per day, 4-5 times per day, more than 6 times per day.

To ensure that adaptation was correct and improve content and face validity, the adapted version of the EPIC FFQ was cross checked by nutrition academic staff at LAU.

Additionally, before the main validation study, the adapted version of EPIC FFQ was completed by 10 adults in Lebanon as a pilot study. Participants for this pilot study were approached via classroom visits and 10 volunteers were eligible to participate. The participants were then contacted and followed-up to fill the EPIC FFQ. Once completed, participants were asked if the EPIC FFQ was easy to answer and if there were any food items that was uneasy to understand. This was checked by the researcher and by the nutrition team at LAU and, where needed, changes were done. This step was essential to confirm the time required to complete the questionnaire and that the questions were easy to understand, and instructions were easy to follow. Also, any feedback from participants was taken into consideration and modifications were made such as changing unclear food items into more familiar ones.

2.4 Data analysis

The FFQ data were analysed through FETA software that is designed to derive dietary data (energy, macro- and micro-nutrients, etc...) specifically from EPIC FFQs [21]. Data from the 24-hour recalls were entered into the NUTRITICS software, which is a dietary analysis tool containing more than 750,000 food items [22]. Foods were entered into Nutritics based on their name and amount consumed by the participants. When a food item was not found in Nutritics, the simple components of that food were entered separately based on the portion/amount consumed (e.g., for chicken shawarma, the components entered were bread, chicken, pickles, chips, and garlic sauce). The mean (± Standard deviation) and median (with Interquartile range) for energy and nutrients were derived from the adapted EPIC FFQ and three 24-hour recalls. The adapted EPIC FFQ was compared to the average of three 24-hour recalls. Pearson's Correlation (or Spearman's Rank Correlation Coefficient for non-normally distributed data) was used to measure the correlations of unadjusted, energy-adjusted, and age, gender, and BMI-adjusted data between the energy and macro- and micro-nutrient intakes of the two methods [23, 24]. The residual method (from regression model) was used to obtain energy-adjustment data for nutrients correlations and age, gender, and BMI-adjustment data for energy and nutrients correlations [25]. Moreover, the unadjusted and energy-adjusted data of energy and all nutrients were categorised into quartiles and weighed kappa statistics was used to determine the agreement between the FFQ method and the 24-HRs method. The proportion of individuals categorised in same quartile by the FFQ and average 24-HRs and in contiguous quartiles as well as opposite (and/or 1 quartile apart) were calculated. We interpreted weighed kappa results based on Cohen suggestion as follows: value <0 indicates no agreement, 0-0.20 slight agreement, 0.21-0.40 fair, 0.41-0.60 moderate, 0.61-0.80 substantial, 0.81-1.00 nearly perfect agreement [26]. The Bland-Altman plot was performed to estimate agreement between the two methods [27, 28]. The intake values difference between FFQ and average of 24-hour recalls were plotted against the average intake values of these methods (intakes from FFQ + intakes from average of 24-hour recalls divided by 2). Limits of agreements (95%) were formed to illustrate the range of agreement between the two measures (mean ± 1.96 SD). Linear regression was performed to derive the slope coefficient for each nutrient where the average intake of the two measures was the independent variable and the intake difference was the dependent variable. Therefore, the slope coefficient was used to determine the degree of overestimation or underestimation of intakes from FFQ compared to the average of the three 24-HRs. Data were analysed using IBM SPSS statistics version 25 (Chicago, IL, USA).

RESULTS

We recruited 120 participants of those one was excluded due to completing only one 24HR out of three, leaving a final sample of 119 participants. The median age of the validation study participants was 20 (3) years, and the median BMI was 22.7 (4.51) kg/m^2 (Table 1). Almost all participants were single (99.2 %), and most of them were females (71.4 %) and nonsmokers (75.6 %). More than 60 % of participants' parents were university graduates and most of them were employees. The main source of income of participants was through the support of their families, and most participants reported a good/comfortable financial status with a family monthly income of >$3000. Participants had a family size of four to six persons, and more than 60% reported that two persons sleep in each room of the house.

Table 6: (Chapter 1, Table 1) - Socio-demographic characteristics of study participants

Socio-demographic characteristics	**N (%)**	**Median (Interquartile Range)**
Gender		
Male	34 (28.6)	-
Female	85 (71.4)	
Age (years)	-	20 (3)
BMI (kg/m^2)	-	22.75 (4.51)
Marital status		-
Single	118 (99.2)	
Married	1 (0.8)	
Father's educational level		
No education	8 (6.7)	
Grade 9 (Brevet)	12 (10.1)	-
Grade 12 (Baccalaureate)	25 (21.0)	
University graduate	74 (62.2)	
Mother's educational level		
No education	2 (1.7)	
Grade 9 (Brevet)	11 (9.2)	-
Grade 12 (Baccalaureate)	3 (2.5)	
University graduate	73 (61.3)	

Father's employment status		
Unemployed	4 (3.4)	
Unable to work due to health problems	4 (3.4)	-
Employee	99 (83.2)	
Full-time homeworker, parent, or caregiver	3 (2.5)	
Retired	8 (6.7)	
Mother's employment status		
Unemployed	34 (28.6)	
Unable to work due to health problems	1 (0.8)	-
Employee	45 (37.8)	
Full-time homeworker, parent, or caregiver	37 (31.1)	
Retired	2 (1.7)	
Main source of income		
Family support	98 (82.4)	-
Self-support	10 (8.4)	
Scholarship or stipend	11 (9.2)	
Family monthly income		
< $500	3 (2.5)	
$500-$1499	23 (19.3)	-
$1500-$2999	33 (27.7)	
>$3000	59 (49.6)	
Financial status		
Do not have enough to make ends meet	5 (4.2)	-
Have enough to make ends meet	54 (45.4)	
Have more than enough to make ends meet	59 (49.6)	
Family size		-
Four or below	48 (40.3)	
Five or above	69 (57.9)	

Persons in each room of the house		
One	41 (34.5)	
Two	72 (60.5)	-
Three	3 (2.5)	
Four	2 (1.7)	
Five	1 (0.8)	
Smoking status		-
Non-smoker	90 (75.6)	
Ex-smoker	2 (1.7)	
Smoker	27 (22.7)	

Table 2 presents the median (IQR) intake for energy, macronutrients, and micronutrients calculated from the FFQ, the three 24-HRs, and their average. All data of energy and nutrients derived from FFQ were higher than those derived from the three 24-HRs and their average. It can be seen that the intakes of energy and macronutrients are approximately 1.3 times high in FFQ than the average of three 24-HRs. The difference of estimates of micronutrients ranged from 0.87 (Niacin) to 2.56 (Vitamin E) times higher through the FFQ method compared to 24HR method.

Table 7: (Chapter 4 Table 2) - Median (IQR) of energy and nutrients in the FFQ, average 24-hour recalls, first 24-hour recall, second 24-hour recall, and third 24-hour recall.

	FFQ	**Average 24-HRs**	**24-HR 1**	**24-HR 2**	**24-HR 3**
Energy (kcal)	2721.33 (2048.3)	2245.1 (1124.33)	2326.0 (1534.0)	2116.0 (1368.0)	1900.0 (1243.0)
Carbohydrates (grams)	309.29 (234.4)	231.66 (126.0)	248.0 (173.0)	229.0 (165.0)	217.0 (134.0)
Protein (grams)	117.34 (81.76)	87.0 (34.63)	100.0 (61.0)	76.0 (56.0)	79.0 (56.0)
Fat (grams)	124.54 (95.8)	95.6 (56.67)	103.0 (91.0)	83.0 (67.0)	79.0 (66.0)

Calcium (mg)	1243.86 (826.58)	669.0 (475.33)	684.0 (696.0)	653.0 (557.0)	612.0 (599.0)
Vitamin D (µg)	3.35 (4.35)	1.51 (2.36)	1.1 (2.67)	1.1 (2.54)	1.2 (2.47)
Folate (µg)	312.13 (275.36)	226.0 (155.67)	215.0 (196.0)	195.0 (220.0)	198.0 (168.0)
Iron (mg)	13.64 (12.72)	10.76 (5.9)	10.4 (7.8)	9.2 (9.8)	9.3 (7.6)
Zinc (mg)	13.51 (10.81)	8.26 (5.63)	7.6 (7.5)	6.9 (6.4)	7.1 (5.7)
Magnesium (mg)	384.1 (299.0)	260.0 (165.0)	247.0 (226.0)	208.0 (236.0)	229.0 (213.0)
Vitamin E (mg)	22.1 (19.47)	8.6 (8.37)	8.4 (9.4)	7.6 (10.0)	7.6 (9.10)
Vitamin C (mg)	126.8 (143.33)	63.76 (58.97)	51.0 (82.3)	54.0 (112.0)	49.0 (118.3)
Vitamin B_{12} (µg)	8.26 (10.24)	3.16 (3.01)	2.5 (3.8)	2.4 (4.16)	2.9 (4.0)
Vitamin A (µg)	1417.48 (1988.38)	640.33 (643.0)	506.0 (1161.0)	336.0 (911.0)	454.0 (1017.0)
Thiamine (mg)	1.82 (1.50)	1.23 (0.78)	1.30 (1.0)	1.20 (1.17)	1.10 (0.95)
Sodium (mg)	3562.40 (2760.85)	2158.00 (1497.33)	2307.0 (1881.0)	2056.0 (2002.0)	1868.0 (1694.0)
Selenium (µg)	82.81 (56.53)	38.20 (30.07)	39.7 (53.0)	29.7 (30.30)	33.6 (33.5)
Riboflavin (mg)	2.71 (1.77)	1.17 (0.81)	1.2 (1.24)	0.95 (1.09)	1.1 (0.91)
Pyridoxine (mg)	2.7 (2.33)	1.46 (0.84)	1.6 (1.12)	1.2 (1.42)	1.3 (1.32)
Potassium (mg)	4428.67 (3372.37)	2236.66 (1121.33)	2296.0 (1531.0)	2011.0 (1679.0)	2034.0 (1742.0)

Phosphorus (mg)	1945.77 (1209.23)	1089.0 (624.33)	1132.0 (898.0)	963.0 (806.0)	965.0 (663.0)
Niacin (mg)	29.28 (24.89)	33.43 (21.73)	31.8 (32.2)	25.1 (27.2)	25.6 (24.9)

mg: milligrams. µg: micrograms.

Table 3 lists the unadjusted and energy-adjusted correlation coefficients between the FFQ and the average of the three 24-HRs of participants. Energy and nutrients in the unadjusted correlations were all statistically significant except for selenium, potassium, niacin, vitamin D, vitamin E, and vitamin A. Unadjusted and energy-adjusted correlation coefficients ranged from 0.002 (vitamin A) to 0.34 (carbohydrates). Energy-adjusted correlation coefficients were all statistically significant except for vitamin D, vitamin E, vitamin A, selenium, and niacin. Compared to unadjusted correlation coefficients, energy-adjusted correlation coefficients increased for protein, fat, folate, iron, magnesium, thiamine, sodium, selenium, and potassium, and decreased for zinc, vitamin E, riboflavin, pyridoxin, and phosphorus, and remained the same for carbohydrates, calcium, vitamin D, vitamin C, vitamin B_{12}, vitamin A, niacin. The correlation coefficient of potassium intake became statistically significant after energy-adjustment. For folate and phosphorus intakes, the significance level increased from <0.05 to <0.001 and decreased from <0.001 to <0.05, respectively. Adjusting for age, gender, and BMI did not show any change in the correlation coefficient than through energy-adjustment. Overall, a significant moderate correlation was observed between FFQ and average of the three 24-HRs.

Table 8: (Chapter 4, Table 3) - Correlation between energy and nutrients intake from FFQ and average of three 24hour recalls

	Unadjusted [A]	Energy adjusted [AB]	Age, gender, & BMI adjusted [AB]
Energy (kcal)	0.33**	-	0.33**
Carbohydrates (grams)	0.34**	0.34**	0.34**
Protein (grams)	0.18*	0.21*	0.21*
Fat (grams)	0.27**	0.29**	0.29**
Calcium (mg)	0.26**	0.26**	0.26**
Vitamin D (µg)	0.15	0.15	0.15
Folate (µg)	0.23*	0.24**	0.24**
Iron (mg)	0.30**	0.31**	0.31**

Zinc (mg)	0.19*	0.18*	0.18*
Magnesium (mg)	0.31**	0.33**	0.33*
Vitamin E (mg)	0.18	0.18	0.18
Vitamin C (mg)	0.20*	0.2*	0.2*
Vitamin B_{12} (µg)	0.21*	0.21*	0.21*
Vitamin A (µg)	-0.002	-0.002	-0.002
Thiamine (mg)	0.32**	0.34**	0.34**
Sodium (mg)	0.22*	0.22*	0.22*
Selenium (µg)	0.05	0.06	0.06
Riboflavin (mg)	0.26**	0.26**	0.26**
Pyridoxine (mg)	0.25**	0.25**	0.25**
Potassium (mg)	0.18	0.18*	0.18*
Phosphorus (mg)	0.26**	0.23*	0.23*
Niacin (mg)	0.15	0.15	0.15

***Correlation is significant at p<0.01. * Correlation is significant at p<0.05. [A] Spearman's correlation. [B] Pearson's correlation. mg: milligrams. µg: micrograms.*

Table 4 shows the kappa statistics for unadjusted and energy-adjusted data. The weighed kappa estimates for unadjusted data ranged from -0.05 (vitamin C) to 0.248 (magnesium). Weighed kappa values were statistically significant for energy, carbohydrates, protein, fat, calcium, iron, zinc, magnesium, vitamin E, thiamine, riboflavin, and niacin. Weighed kappa values were not statistically significant for vitamin D, folate, vitamin C, vitamin B_{12}, vitamin A, sodium, selenium, pyridoxin, potassium, and phosphorus. After energy adjustment, weighed kappa values were reduced for energy and all nutrients but increases for vitamin C, vitamin B_{12}, pyridoxin, and phosphorus and remained unchanged for folate. Weighed kappa for energy adjusted data ranged from -0.034 (vitamin A) to 0.203 (phosphorus). Overall, the weighed kappa statistics showed a slight-to-fair agreement between the FFQ and the average of the three 24HRs. The classification of subjects into the same quartile for unadjusted data ranged from 18% (vitamin D) to 50% (total energy). Exact plus adjacent agreement ranged from 58 (vitamin D) to 92% (carbohydrates) while the disagreement ranged from 4.5% (total energy) to 38% (vitamin D). For energy-adjusted data, the exact agreement ranged from 21% (calcium) to 49% (sodium) whereas the exact plus adjacent agreement ranged from 58 (calcium) to 94% (vitamin E) and the disagreement ranged from 15% (carbohydrates) to 38% (folate).

Table 9: (Chapter 4, Table 4) - Agreement (weighed Kappa) and cross classification of quartiles of energy and nutrients intake

Nutrients	Unadjusted data					Energy-adjusted data				
	*K*w	95% CI	Exact agreement (%)	Exact agreement + adjacent (%)	Disagreement (%)	*K*w	95% CI	Exact agreement (%)	Exact agreement + adjacent (%)	Disagreement (%)
Energy (kcal)	0.168	0.047;0.289	50.7	88.5	4.5	-	-	-	-	-
Carbohydrates (grams)	0.148	0.03;0.265	47.3	92.5	5.3	0.06	0.004;0.116	34.8	82.7	15.4
Protein (grams)	0.14	0.015;0.265	42.5	86.8	12.2	0.087	-0.081;0.265	33.2	74.1	27.9
Fat (grams)	0.134	0.013;0.265	29.0	74.5	23.5	0.052	-0.022;0.127	40.3	89.8	7.8
Calcium (mg)	0.179	0.077;0.281	35.2	71.4	25.8	0.042	0.012;0.072	21.6	58.6	31.8
Vitamin D (µg)	0.062	-0.043;0.168	18.6	58.4	38.1	0.004	-0.007;0.014	22.9	65.7	33.1
Folate (µg)	0.084	-0.035;0.204	37.2	77.8	21.4	0.084	-0.035;0.204	30.4	63	38.8
Iron (mg)	0.215	0.068;0.362	41.9	78.2	23.8	0.179	-0.011;0.369	35.2	67.2	26.8
Zinc (mg)	0.115	0.023;0.207	30.6	67.7	35.6	0.086	0.011;0.161	25.8	67.2	32
Magnesium (mg)	0.248	0.095;0.402	49.8	89.1	9.4	0.185	0.077;0.294	25.8	64.3	28.4
Vitamin E (mg)	0.167	-0.017;0.352	33.9	78.2	21.4	0.042	-0.046;0.131	38.6	94.6	15.4

Vitamin C (mg)	-0.05	-0.106;0.006	32.6	62.5	24.1	0.03	-0.025;0.084	26.6	62.2	33.2
Vitamin B_{12} (µg)	0.007	-0.02;0.035	34.4	71.5	25.9	0.15	0.018;0.293	39.9	70.8	28.3
Vitamin A (µg)	-0.003	-0.111;0.104	31.6	78	21.2	-0.034	-0.127;0.059	32.3	66.3	29.1
Thiamine (mg)	0.211	0.011;0.411	39.9	83.3	12.4	0.111	-0.064;0.286	35.9	81.7	19
Sodium (mg)	0.085	-0.041;0.21	49.5	84.6	15.3	0.046	-0.025;0.118	49.5	79.5	16.1
Selenium (µg)	0.075	-0.021;0.171	41.2	85.8	31.1	-0.008	-0.17;0.154	47.9	85	17.5
Riboflavin (mg)	0.064	-0.049;0.176	37.9	80.4	16.9	0.058	-0.003;0.119	33.4	64.8	25.9
Pyridoxine (mg)	0.044	-0.075;0.162	49.8	83.8	6.9	0.056	-0.009;0.12	32.2	67.5	30.1
Potassium (mg)	0.006	-0.079;0.09	41.2	85.2	10.2	0.018	-0.028;0.065	34.3	72.7	21.1
Phosphorus (mg)	0.075	-0.01;0.16	44.5	84.7	12.8	0.203	0.05;0.356	27.4	61.4	35.3
Niacin (mg)	0.181	0.001;0.36	40.1	81.9	16.9	0.023	-0.143;0.189	34.6	71.8	25.4

*Weighed **K** was performed between the FFQ and average of 24-HRs. **K**w: Weighed Kappa. mg: milligrams. µg: micrograms.CI: confidence interval.*

Table 5 demonstrates the agreement between FFQ and average of the three 24-HRs. It shows the mean difference with the 95% limits of agreement (lower and upper) and the linear

regression coefficients for energy, macronutrients, and micronutrients where data of the average of three 24-HRs were entered as predictor of FFQ data. The mean difference for energy (±SD) was 1212.7 ±2630.3 with wide limits of agreement (-3942.7; 6368.1). For energy and macronutrients, a positive slope coefficient with p-value <0.05 was found showing that the FFQ has overestimated higher energy and macronutrients intake levels. A positive slope was also found for all micronutrients except vitamin D (-0.45), vitamin C (-0.35), vitamin B_{12} (-0.28), and selenium (0.17). Further, the visual inspection of the Bland-Altman plots (figure 1) also shows a pattern of over-estimation of energy, carbohydrates, protein, and fat intakes by the FFQ method. A greater number of data points is observed to be below the mean difference line vs above the mean difference line for energy, protein, and fat intakes and as the mean intake of energy and macronutrients increases, the difference increases indicating a slight proportional bias. This has been also evidenced through the linear regression that found a statistically significant t score (p-value <0.05) for energy and macronutrients indicating that the null-hypothesis that there is no proportional bias is rejected. Linear regression of all micronutrients data indicated a slight proportional bias except for zinc (p=0.36), magnesium (p=0.54), vitamin E (p=0.557), vitamin B_{12} (p=0.065), vitamin A (p=0.686), selenium (p=0.345), riboflavin (p=0.244), pyridoxin (p=0.954), and niacin (p=0.27). β coefficients were all close to 0 indicating that there is no huge proportional bias. Overall, the FFQ was shown to slightly overestimate nutrient intakes compared to the 24-HRs.

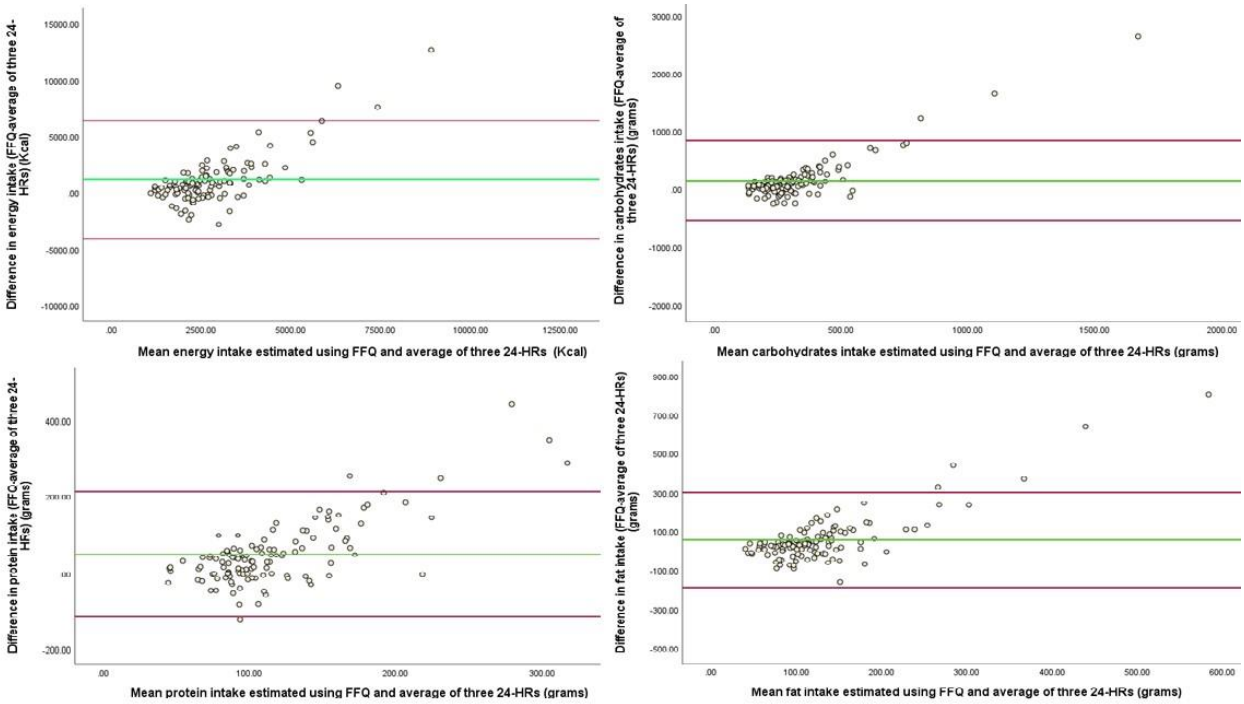


Figure 7: (Chapter 4, fig 1) - Bland Altman plots for energy, carbohydrates, protein, and fat intakes.

Table 10: (Chapter 4, Table 5) - Limits of Agreement (LOA) and β coefficients between FFQ and average of three 24HRs

Energy and nutrients	Mean difference (FFQ & average 24-HRs) ± SD	95% LOA Lower; upper	β	P-value
Energy (kcal)	1212.7 ± 2630.3	-3942.7;6368.1	0.63	<0.001
Carbohydrates (grams)	151.2±343.7	-522.4;824.9	0.71	<0.001
Protein (grams)	49.8±83.1	-113.1;212.7	0.59	<0.001
Fat (grams)	56.8±124.6	-187.5;301.1	0.47	0.001
Calcium (mg)	664.5±769.8	-844.3;2173.4	0.42	0.003
Vitamin D (µg)	2.9±5.7	-8.2;14.0	-0.45	0.007
Folate (µg)	169.1±252.9	-326.7;664.9	0.36	0.014
Iron (mg)	6.8±11.4	-15.6;29.2	0.43	0.001
Zinc (mg)	8.3±10.5	-12.4;28.9	0.14	0.36
Magnesium (mg)	167.0±255.8	-334.3;668.4	0.08	0.54
Vitamin E (mg)	14.1±19.5	-24.1;52.4	0.09	0.557
Vitamin C (mg)	85.5±153.9	-216.2;387.2	-0.35	0.026
Vitamin B_{12} (µg)	8.3±11.0	-13.4;30.0	-0.28	0.065
Vitamin A (µg)	1520.8±2433.7	-3249.2;6290.8	0.08	0.686
Thiamine (mg)	0.8±1.3	-1.7;3.3	0.34	0.008
Sodium (mg)	2037.6±3031.7	-3904.6;7979.8	0.32	0.029
Selenium (µg)	56.1±66.9	-75.1;187.2	-0.17	0.345
Riboflavin (mg)	1.8±1.6	-1.2;4.9	0.17	0.244
Pyridoxine (mg)	1.7±1.8	-1.9;5.2	0.01	0.954
Potassium (mg)	2833.5±3146.5	-3333.6;9000.6	0.33	0.033
Phosphorus (mg)	1141.9±1299.8	-1405.7;3689.5	0.42	0.004
Niacin (mg)	1.9±23.2	-43.7;47.5	0.17	0.27

Mean difference and LOA were derived through a One-sample T test. B coefficients and p-values were derived through a linear regression of Log-transformed data. LOA: Limit of Agreement. SD: Standard deviation.

DISCUSSION

The EPIC FFQ is an easy-to-use gold-standard tool that is widely used to assess the dietary intake of large populations. Nutrition epidemiology in Lebanon is deemed poor due to the scarcity of rigour and representativeness of dietary questionnaires, specifically FFQs [20]. To the best of our knowledge, this is the first validation study of the EPIC FFQ for assessing dietary intake among adults in the MENA region, and especially in Lebanon. Although the FFQ showed overestimation of intake of energy and some nutrients in comparison with 24-HRs, this validation study demonstrated an overall acceptable agreement compared to the 24-h recall method and significantly good correlation between intakes.

In our study, the moderate correlation coefficients reported between the FFQ and the average of three 24-HRs were statistically significant for all but six nutrients, and this has been similarly reported in validation studies from Bangladesh [11, 29, 30]. The correlation coefficient for zinc intake in the study by Mumu et al. [11] between FFQ and three 24-HRs was 0.161 which is very similar to that reported in the present study (0.192). Additionally, comparable validation studies of different FFQs done in Lebanon have found similar correlation coefficients with multiple 24HRs. For example, in a recent validation study by Harmouch-karakir et al. [31] done among Lebanese adults, the correlation coefficient for magnesium was 0.38 ($p<0.001$) and for thiamine

0.33 ($p<0.001$) compared to 0.31 ($p<0.001$) and 0.32 ($p<0.001$) in the present study, respectively. On the other hand, another recent study by Aoun et al. [32] conducted with Lebanese adults found higher correlation coefficients than the present study; however, they were not statistically significant for energy and several nutrients. For example, the correlation coefficient for energy was 0.998 ($p=0.098$), 0.996 ($p=0.877$) for fat, 0.967 ($p=0.073$) for iron, 0.987 ($p=0.348$) for vitamin C, and 0.973 ($p=0.289$) for vitamin B_{12}. After energy adjustment, the correlation coefficients in the present study were improved for protein, fat, folate, iron magnesium, thiamine, sodium, selenium, and potassium intakes; however, for the majority of nutrients they showed no change or a decrease in correlation coefficients. The correlation of fat intake, which is a major predictor of cardio-vascular diseases, slightly increased after adjusting for energy (0.27 to 0.29). It is argued that if the correlation coefficient of a specific nutrient increased after energy-adjustment, the variability of this nutrient's intake is linked to energy intake [13]. In contrast, if the correlation coefficient decreased after energy-adjustment, it means that the variability depends on systematic error of under and overestimation of that nutrient's intake [13]. Willet et al. [7] recommends that the demographic confounder should be controlled-for in nutrition epidemiological research, and accordingly we adjusted for age, gender, and BMI for unadjusted correlations in this study. This is recommended because these confounders affect the between-person variation in food intake and usually manipulate the correlation between the dietary tools [7].

From the analysis of the data, it can be concluded that FFQ resulted in an overall overestimation of total energy, macronutrients, and micronutrients intakes compared to the 24HRs. Similar findings have been found in previous research [13, 33, 34]. It is widely accepted that an accurate estimation of energy intakes using self-report tools is hard to achieve, however energyadjustment improves the estimation of other macro- and micro-nutrients [35]. It is

argued that when participants are asked to recall the frequency of different foods, they usually overestimate the overall intake [13]. However, others suggest that FFQs generally contains a large list of foods that covers usual and local foods of the population under study, which explains the need for energy adjustment [36]. The larger the food list is, the more inflated the estimates of total dietary intake will be when summing the foods [33]; and in the present study we used a 130-food item FFQ which is considered a quite large food list. Moreover, participants tend to overreport the frequency of consumption of foods in an FFQ because of recall and social-desirability biases, and this leads to over-estimation of dietary intake [11]. Interestingly in our study, data collection was done during the COVID-19 pandemic, which might have manipulated the reporting of dietary intake of participants [37]. Nevertheless, this study indicates that there exists an agreement (slight-/fair) between the FFQ and the average of three 24-HRs for most of the nutrients, which

is in line with what other validation studies, that validated different FFQs, have reported [38, 39]. A study by Sauvageot et al. [40] aimed to validate an FFQ against 3-day food record and found a slight/fair agreement between the two methods. For example, the study reported kappa values of 0.02 for energy, 0.12 for lipids, 0.22 for protein, 0.02 for iron, 0.17 for potassium. Similar to the present study, these authors considered this agreement acceptable and the FFQ was validated for use among their specific population. Regarding the cross-classification of subjects into quartiles, the FFQ showed quite good results. Individuals were correctly categorised into the exact and adjacent quartiles with an average of 78% for unadjusted data and 70% for energy-adjusted data, which is similar to other studies [13, 38, 41].

One strength of the present study is that the food list of the EPIC FFQ was adapted to accurately reflects the Lebanese diet and hence it represents this population. Another strength is the statistical methodologies conducted in this paper. Although applying one to three statistical approaches is considered enough in such studies [42], the present study used several statistical methods to assess the validity of the EPIC FFQ [11].

A great challenge of validation studies is considered choosing a suitable reference method to validate the target dietary tool since there is not one gold standard tool for dietary intake measurement [7, 13]. Although other dietary tools (e.g., weighed food records) have been utilized in validation studies, they were not practical because of the increased cost involved. One limitation of this study is that both dietary tools that we used rely on memory. However, the 24HRs have several advantages such as being inexpensive, quick to administer, and able collect detailed information on food consumed during the day. Moreover, the 24-HRs require only short-term memory and are eligible to be used among all populations [12, 33, 43]. A study by [43] mentions that 24-HRs might sometimes have a higher objectivity than FFQ and that their use as a dietary tool does not alter the habitual diet of participants as the prospective food record dietary tool. In this study, we collected 24-h recall for 3 days and on both a weekend day and two weekdays to minimize the day-to-day variability. Our sample was selected from a university campus and contained a high proportion of young females who are educated and from a high socioeconomic status and at a higher educational level; and thus, caution should be taken regarding the generalization to all Lebanese adults. This is the first Lebanese validation study of the food frequency questionnaire and future research should ensure a broader sample is selected. Another limitation of the present study is the use of Nutritics

software which is based on UK guidelines which is different than the Lebanese nutrition guidelines. In the same context, there is no existing Lebanese software to analyse the dietary intake of Lebanese population. Estimating the dietary composition in Lebanon is challenging and nutritionists should aim to continuously implement accurate food databases [44]. In the present study, the 24-HRs were collected one week after collecting the FFQ, data due to time restraint, which might be less representative than if they were collected through out several months.

CONCLUSION

This study showed that the EPIC FFQ is a valid tool to assess diet in epidemiological studies among Lebanese adults. Caution is needed as the EPIC FFQ may overestimate individuals' dietary intake; however, this is not yet clear. Future studies should further assess the validity of the EPIC FFQ among Lebanese adults using nutritional biomarkers.

References:

1. Ng S, Zaghloul S, Ali H et al. The prevalence and trends of overweight, obesity and nutrition-related non-communicable diseases in the Arabian Gulf States. Obesity Reviews. 2010;12(1):1-13.
2. El-Kassas G, Ziade F. Exploration of the Dietary and Lifestyle Behaviors and Weight Status and Their Self-Perceptions among Health Sciences University Students in North Lebanon. BioMed Research International. 2016;2016:1-14.
3. Bonaccio M, Bonanni A, Di Castelnuovo A et al. Low income is associated with poor adherence to a Mediterranean diet and a higher prevalence of obesity: cross-sectional results from the Moli-sani study. BMJ Open. 2012;2(6):e001685.
4. Mallat S, Geagea A, Jurjus R et al. Obesity in Lebanon: A National Problem. World Journal of Cardiovascular Diseases. 2016;06(06):166-174.
5. Nasreddine L, Naja F, Chamieh M et al. Trends in overweight and obesity in Lebanon: evidence from two national cross-sectional surveys (1997 and 2009). BMC Public Health. 2012;12(1).
6. Satija A, Yu E, Willett W et al. Understanding Nutritional Epidemiology and Its Role in Policy. Advances in Nutrition. 2015;6(1):5-18.
7. Willett W. Nutritional epidemiology. New York: Oxford University Press; 2013.

8. Foster E, Lee C, Imamura F et al. Validity and reliability of an online self-report 24-hour dietary recall method (Intake24): A doubly-labelled water study and repeated measures analysis — CORRIGENDUM. Journal of Nutritional Science. 2019;8.
9. Subar A, Kirkpatrick S, Mittl B et al. The Automated Self-Administered 24-Hour Dietary Recall (ASA24): A Resource for Researchers, Clinicians, and Educators from the National Cancer Institute. Journal of the Academy of Nutrition and Dietetics. 2012;112(8):1134-1137.
10. Cade J. Measuring diet in the 21st century: use of new technologies. Proceedings of the Nutrition Society. 2016;76(3):276-282.
11. Mumu S, Merom D, Ali L et al. Validation of a food frequency questionnaire as a tool for assessing dietary intake in cardiovascular disease research and surveillance in Bangladesh. Nutrition Journal. 2020;19(1).
12. Subar A. Developing dietary assessment tools. Journal of the American Dietetic Association. 2004;104(5):769-770.
13. Liu L, Wang P, Roebothan B et al. Assessing the validity of a self-administered foodfrequency questionnaire (FFQ) in the adult population of Newfoundland and Labrador, Canada. Nutrition Journal. 2013;12(1).
14. Welch A, Luben R, Khaw K et al. The CAFE computer program for nutritional analysis of the EPIC-Norfolk food frequency questionnaire and identification of extreme nutrient values. Journal of Human Nutrition and Dietetics. 2005;18(2):99-116.
15. Bingham S. Validation of dietary assessment methods in the UK arm of EPIC using weighed records, and 24-hour urinary nitrogen and potassium and serum vitamin C and carotenoids as biomarkers. International Journal of Epidemiology. 1997;26(90001):137S151.
16. McKeown N, Day N, Welch A et al. Use of biological markers to validate self-reported dietary intake in a random sample of the European Prospective Investigation into Cancer United Kingdom Norfolk cohort. The American Journal of Clinical Nutrition. 2001;74(2):188-196.
17. Lietz G, Barton K, Longbottom P et al. Can the EPIC food-frequency questionnaire be used in adolescent populations?. Public Health Nutrition. 2002;5(6):783-789.

18. Mazzeo T, Roncoroni L, Lombardo V et al. Evaluation of a Modified Italian European Prospective Investigation into Cancer and Nutrition Food Frequency Questionnaire for Individuals with Celiac Disease. Journal of the Academy of Nutrition and Dietetics. 2016;116(11):1810-1816.
19. Bonaccio M, Di Castelnuovo A, Pounis G et al. High adherence to the Mediterranean diet is associated with cardiovascular protection in higher but not in lower socioeconomic groups: prospective findings from the Moli-sani study. International Journal of Epidemiology. 2017;46(5):1478-1487.
20. Papazian T, Hout H, Sibai D et al. Development, reproducibility and validity of a food frequency questionnaire among pregnant women adherent to the Mediterranean dietary pattern. Clinical Nutrition. 2016;35(6):1550-1556.
21. Mulligan A, Luben R, Bhaniani A et al. A new tool for converting food frequency questionnaire data into nutrient and food group values: FETA research methods and availability. BMJ Open. 2014;4(3):e004503.
22. Nutritics | Nutrition Analysis Software For Professionals [Internet]. Nutritics.com. 2020 [cited 12 December 2020]. Available from: https://www.nutritics.com/p/home
23. Brunst K, Kannan S, Ni Y et al. Validation of a Food Frequency Questionnaire for Estimating Micronutrient Intakes in an Urban US Sample of Multi-Ethnic Pregnant Women. Maternal and Child Health Journal. 2015;20(2):250-260.
24. El Kinany K, Garcia-Larsen V, Khalis M et al. Adaptation and validation of a food frequency questionnaire (FFQ) to assess dietary intake in Moroccan adults. Nutrition Journal. 2018;17(1).
25. WILLETT W, SAMPSON L, STAMPFER M et al. REPRODUCIBILITY AND VALIDITY OF A SEMIQUANTITATIVE FOOD FREQUENCY QUESTIONNAIRE. American Journal of Epidemiology. 1985;122(1):51-65.
26. McHugh M. Interrater reliability: the kappa statistic. Biochemia Medica. 2012;:276-282.
27. Bartlett J, Frost C. Reliability, repeatability and reproducibility: analysis of measurement errors in continuous variables. Ultrasound in Obstetrics and Gynecology. 2008;31(4):466-475.
28. Bland J, Altman D. Measuring agreement in method comparison studies. Statistical Methods in Medical Research. 1999;8(2):135-160.

29. Habibul CYA, Parvez F, Howe GR. Validity of a food-frequency questionnaire for a large prospective cohort study in Bangladesh. Br J Nutr. 2004;92:851–9.
30. Lin P, Bromage S, Mostofa M et al. Validation of a Dish-Based Semiquantitative Food Questionnaire in Rural Bangladesh. Nutrients. 2017;9(1):49.
31. Harmouche-Karaki M, Mahfouz M, Obeyd J et al. Development and validation of a quantitative food frequency questionnaire to assess dietary intake among Lebanese adults. Nutrition Journal. 2020;19(1).
32. Aoun C, Bou Daher R, El Osta N et al. Reproducibility and relative validity of a food frequency questionnaire to assess dietary intake of adults living in a Mediterranean country. PLOS ONE. 2019;14(6):e0218541.
33. Bowen L, Bharathi A, Kinra S et al. Development and evaluation of a semi-quantitative food frequency questionnaire for use in urban and rural India. Asia Pac J Nutr. 2020;21:355–60.
34. Rodríguez M, Méndez H, Torún B et al. Validation of a semi-quantitative food-frequency questionnaire for use among adults in Guatemala. Public Health Nutrition. 2002;5(5):691-698.
35. Subar A, Freedman L, Tooze J et al. Addressing Current Criticism Regarding the Value of Self-Report Dietary Data. The Journal of Nutrition. 2015;145(12):2639-2645.
36. Jaceldo-Siegl K, Knutsen S, Sabaté J et al. Validation of nutrient intake using an FFQ and repeated 24 h recalls in black and white subjects of the Adventist Health Study-2 (AHS2) – Corrigendum. Public Health Nutrition. 2011;14(11):2079-2080.
37. Eftimov T, Popovski G, Petković M et al. COVID-19 pandemic changes the food consumption patterns. Trends in Food Science & Technology. 2020;104:268-272.
38. Araujo M, Yokoo E, Pereira R. Validation and Calibration of a Semiquantitative Food Frequency Questionnaire Designed for Adolescents. Journal of the American Dietetic Association. 2010;110(8):1170-1177.
39. Bentzen S, Knudsen V, Christiensen T et al. Relative validity of a web-based food frequency questionnaire for patients with type 1 and type 2 diabetes in Denmark. Nutrition & Diabetes. 2016;6(9):e232-e232.

40. Sauvageot N. Validation of the Food Frequency Questionnaire Used to Assess the Association between Dietary Habits and Cardiovascular Risk Factors in the NESCAV Study. Journal of Nutrition & Food Sciences. 2013;03(03).
41. Fernández-Ballart J, Piñol J, Zazpe I et al. Relative validity of a semi-quantitative foodfrequency questionnaire in an elderly Mediterranean population of Spain. British Journal of Nutrition. 2010;103(12):1808-1816.
42. Lombard M, Steyn N, Charlton K et al. Application and interpretation of multiple statistical tests to evaluate validity of dietary intake assessment methods. Nutrition Journal. 2015;14(1).
43. Lee R, Nieman D. Nutritional assessment. New York, NY: McGraw-Hill; 2013.
44. Hébert J, Hurley T, Steck S et al. Considering the Value of Dietary Assessment Data in Informing Nutrition-Related Health Policy. Advances in Nutrition. 2014;5(4):447-455.

This chapter has reported the validation of the EPIC FFQ in Lebanon. As mentioned above, the EPIC FFQ has been validated for use among Lebanese adults that include women of reproductive age. This tool was needed as it will be used to collect dietary data from participants in the next phase which assessed the association between stress and diet among women of reproductive age in Lebanon. This is of high importance as it will enable country comparisons to be made between the study done in the UK and the one that was done in Lebanon. In the next chapter the association between stress and diet in Lebanon is explored.

Chapter 5 The stress/diet study in Lebanon

After validating the EPIC FFQ in Lebanon, the association between stress and dietary quality and patterns was assessed among women of reproductive age in Lebanon.

The Association between Psychological Stress and Dietary Quality and Patterns in Women of Childbearing Age from a University Population in Lebanon

Karim Khaled[1]*, Vanora Hundley[2], Maya Bassil[3], Mira Bazzi[3], Fotini Tsofliou[1, 2]

[1]Department of Rehabilitation & Sport Sciences, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth BH8 8AJ, UK; Khaledk@bournemouth.ac.uk (K.K.); ftsofliou@bournemouth.ac.uk (F.T.)
[2]Centre for Midwifery, Maternal & Perinatal Health, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth BH8 8AJ, UK; vhundley@bournemouth.ac.uk

[3]Department of Natural Sciences, Faculty of Arts & Sciences, Lebanese American University, Beirut, Lebanon; Mbassil@lau.edu.lb (M.B.[1]); Mira.bazzi@lau.edu (M.B.[2])

Corresponding author: Karim Khaled, Department of Rehabilitation and Sport Sciences Faculty of Health and Social Sciences Bournemouth Gateway Building, Bournemouth University St Pauls Lane, Bournemouth, BH88AJ, khaledk@bournemouth.ac.uk, 01202966742

Short version title: Stress and Diet among Women in Lebanon

Keywords: Psychological stress, stress, diet, diet quality, dietary patterns, women, females, childbearing age, reproductive age, childbearing aged women, Lebanon, Lebanese, Lebanese women, a priori, a posteriori

Abstract

Psychological stress linked to poorer dietary quality can lead to serious diseases. The objective of this study was to examine the association between psychological stress and dietary quality/patterns among childbearing-aged women in Lebanon. Female participants (n= 249) participated in an online survey-questionnaire which included the previously adapted European Prospective into Cancer and Nutrition food frequency questionnaire and stress, depression, anxiety, physical activity, adiposity, and socio-demographic questions. The a-priori dietary quality was assessed through the Mediterranean Diet (MD) index. The a-posteriori latent dietary-patterns (DPs) were derived through factor analysis. Regression analysis was performed to investigate the predictors of the DPs. Participants mainly had a medium MD adherence (61%). No association was found between stress and MD adherence. Factor analysis revealed four DPs: "potatoes, vegetables, legumes, soups and sauces, and non-alcoholic beverages" (DP1), "cereals, fats and oils, milk and dairy products, and sugars and snacks" (DP2), "alcoholic beverages, fish and seafood, eggs, and meats and meat products" (DP3), and "fruits and nuts and seeds" (DP4). Regression analysis indicated that DP1 was positively associated with monthly income (p = 0.02) and negatively with mother's educational level (p = 0.03). DP2 was negatively associated with father's employment status (p = 0.01) and marital status (p= 0.008). DP3 was negatively associated with higher father's educational level (p = 0.018), but

positively with BMI ($p < 0.001$). DP4 was positively linked with BMI ($p = 0.01$). Further studies are needed to investigate the association between psychological stress and dietary quality/patterns among Lebanese childbearing aged women.

1. Introduction

Although the obesity epidemic has reached countries across the globe, in some regions the impact has disproportionately affected women compared to men [1]. Called the Middle Eastern gender health inequality paradox, there is evidence that women in the middle east and north Africa (MENA) region are twice as likely to be obese compared to men [2]. This can be seen in Lebanon, where obesity among women of childbearing age has reached 34% [3]. Over the last two decades, Lebanon has passed through an epidemiologic nutritional transition shifting from the traditional Mediterranean diet to a more western-type of diet [4]. Having unhealthy dietary quality and patterns during childbearing age is one of the main causes of obesity and its related complications during pregnancy (such as gestational diabetes, preeclampsia, caesarian section, macrosomia of the baby) [5]. Following a healthy dietary quality/pattern among women of childbearing age is hence deemed crucial to combat the rise of obesity before and during pregnancy and the preconception stage of women's life cycle offers an important opportunity for a change in their dietary behaviour [6]. However, the reasons for the gender differences are complex and it is argued that unhealthy diet and lack of physical activity alone cannot account for them [2].

Data demonstrate that around 16.2 to 42.7% of females in Arab countries follow poor dietary quality/patterns (high in saturated fats, sugar, energy-dense foods, and low in fruits, vegetables, and nutrient dense foods) [7]. Factors associated with dietary quality include adiposity, smoking, age, income, education level, race/ethnicity, and marital status [8,9]. There is rising evidence that poor eating habits and poor mental health are highly common among women of childbearing age in the Middle East region [7]. Studies in the MENA region have found that women are more likely to select foods high in calories and fat when experiencing stressful situations [10], but the evidence is conflicting. A recent study conducted in Saudi Arabia found a positive association between psychological stress and the consumption of sweets, cakes, cookies and beverages and a lower consumption of fruits and vegetables among young female students [11]. In Egypt, a study of university students (16-30 years old) found that psychological stress was negatively associated with the consumption of fruits and vegetables among females [12]. In contrast, Ahmad et al. [13] found that, among 385 university female students in the United Arab Emirates, stress was positively associated with higher consumption of fruits and vegetables and negatively with sweets and processed meats.

Evidence of the association between psychological stress and dietary quality/patterns in Lebanon is scarce, and studies on psychological stress and diet in the literature have several limitations [14]. For example, dietary intake was assessed through dietary recall questionnaires that did not include all food items and this might have led to under reporting [15-17]. Moreover, the sample sizes of some studies were small, and they did not account for confounding factors such as sociodemographic characteristics and physical activity which were major limitations [12, 18, 19].

There is a need to understand the factors that influence the high obesity rates among women of childbearing age in Lebanon. No study to date has assessed the association between psychological stress and dietary quality and patterns in Lebanon, particularly among Lebanese women of childbearing age. Looking at the diet-stress relationship in

this age group will provide evidence that can inform the development of a lifestyle intervention to improve dietary quality.

2. Methods

This was a cross sectional study designed to investigate the association between psychological stress and dietary quality/patterns among women of childbearing age in Lebanon. An online survey was used to enable a broad range of participants. This was particularly important given the social distancing required by the pandemic.

2.1 Sample

The target population was women of childbearing age in the Lebanese American University (LAU), Lebanon. A convenience sample of students and staff who were females, aged between 18 and 49 years, and based at the LAU were recruited. Participants were excluded if they had chronic diseases (e.g., cancer, diabetes mellitus, cardiovascular diseases, HIV/AIDS, multiple sclerosis, lung diseases, or mental disorders), suffer from food intolerance/allergy, were pregnant or breastfeeding, were on medications that influence appetite, or had previously had a bariatric surgery. Potential participants were approached via their student emails and classroom visits. Consent was ascertained on the landing page of the survey where participants had the chance to consent prior to answering the survey questions. The online survey included questions on diet, mental health indicators, adiposity measures, and socio-demographic characteristics of participants.

To calculate the sample size, the correlation method was applied based on 80% power, 0.05 significance level, and a correlation coefficient of 0.18 [20]. The correlation coefficient (0.18) was reported in previous studies investigating the correlation between stress and dietary quality/patterns among women of childbearing age in the literature [6, 19]. A total sample size of 240 was denoted by the sample size calculation.

2.2 Measures

The online survey used for collecting data was comprised of the following questionnaires/tools:

- The European Prospective into Cancer and Nutrition food frequency questionnaire (EPIC FFQ)
- The Perceived Stress Scale (PSS)
- Becks Depression Inventory II (BDI-II)
- Beck Anxiety Inventory (BAI)
- The International Physical Activity Questionnaire (IPAQ)
- Adiposity measures (weight and height)
- Socio-demographic questions

2.2.1 Dietary Assessment and Dietary quality and patterns

The EPIC FFQ is a semi-quantitative dietary tool containing 130 food-items and a set of additional questions that determine further information on the type and brand of breakfast cereal and kind of fat used in frying, roasting, grilling, or baking and the amount of visible fat on meat (Appendix 1). Standard portion sizes are assigned to each of the 130 food-item and respondents were requested to assess the frequency of each one. The food

list is associated with a set of nine frequency choices for consumption ranging from ‘never or less than once a month’ to ‘6 or more times per day’. The EPIC FFQ was chosen for dietary assessment because it has been widely used [21] and was recently validated for use among adults in Lebanon [22].

2.2.2 Covariates

Age, parental education, parental employment status, source of income, current family size, number of persons who sleep in each room of the house, smoking status, parity, and marital status were included in the survey to describe the participants’ sociodemographic characteristics. Adiposity measures (weight, height, and waist circumference) [23] were self-reported. Weight (kg) was divided over height-squared (m^2) to derive BMI (kg/m^2) [23]. Self-reported weight and height are considered suitable for estimating BMI according to the literature [24].

To assess the impact of behavioural factors on diet, the study explored psychological stress, depression, anxiety, and physical activity. Psychological stress was estimated through the 14-item PSS [25], which was previously validated among Arabs to be used in evaluating stress levels of participants during the past 30 days [26]. Depression was assessed via the 21- item BDI-II that measures the presence and severity of depressive symptoms [27]. The BDI-II has previously shown acceptable validity among Arab population [28]. The anxiety level of participants was assessed using BAI (21-items) which assesses anxiety symptoms over the past week [29]. BAI is considered acceptable for use and has been validated among an Arab population [30, 31]. Physical Activity levels were evaluated via IPAQ [32] where participants reported the frequency of undertaking four intensity exercise levels during the past week: vigorous-intensity activity, moderate-intensity activity, walking, and sitting [32]. IPAQ has been previously validated for use among Lebanese adults [33].

2.3. Statistical Analysis

PSS was modelled by equally divided quartiles of perceived stress: The first quartile represented participants with the lowest level of stress (score of 0-14), second quartile contain ones with middle-lowest level of stress (score of 14-28), third quartile with middle-highest level of stress (score of 28-42), and fourth quartile representing ones with highest level of stress (score of 42-56) [34, 35]. Depression scores were derived from the 21-item BDI-II by scoring each question from zero to three and then summing the total scores of the 21 items to get a total score between 0 and 63 [27]. Depression was considered minimal when the total BDI-II score was between 0 and 13, mild when score was between 14 and 19, moderate when score was between 20 and 28, and severe when score was between 29 and 63 [27]. The level of anxiety was determined from BAI score as follows: low anxiety level (0-21), moderate anxiety level (22-35), potentially concerning anxiety level (≥36) [29]. From the adapted EPIC food frequency questionnaire, 15 food groups (gams per day) were derived: fruits, vegetables, cereals, nuts and seeds, legumes, potatoes, fish and sea food, meat and meat products, milk and milk products, alcoholic beverages, non-alcoholic beverages, eggs, sugars and snacks, fats and oils, and sauces and soups. The a-priori dietary quality was assessed through the Mediterranean Diet Index which measures the adherence to Mediterranean Diet (MD) based on nine food groups (grams per day): fruits and nuts, vegetables, legumes, cereals, fish and seafood, alcoholic beverages, meat and meat products, milk and dairy products, and the ratio of unsaturated to saturated fats [36]. Participants whose consumption was below the median

intake of fruits and nuts, vegetables, legumes, cereals, fish and seafood, and the ratio of unsaturated to saturated fats were given a score of 0 whereas those whose consumption was at or above the media were given a score of 1. In contrast, participants who consumed below the median intake of meat and meat products and milk and dairy products were given a score of 1 and those whose consumption was at or above the median intake of these food were given a score of 0. For alcoholic beverages, participants who consumed between 5 and 25 grams per day were given a score of 1 and those whose consumption was outside that range were given a score of 0 [36]. Additionally, a-posteriori dietary patterns were identified through factor analysis. Assuming that there are underlying (latent) dietary patterns among our target population, factor analysis was performed to uncover these latent patterns. The 15 food groups (grams per day) were included in the factor analysis and statistical transformations were applied to correct for non-normally distributed data and high skewness. The appropriateness of factor analysis was determined through Kaiser Meyer Olkin (KMO) and Bartlett's test of sphericity, and the results indicated a large KMO of 0.8 (>0.5) and a very significant Bartlett's test of sphericity ($p<0.0001$). Therefore, factor analysis was deemed appropriate for data analysis. A scree plot was created to select the number of dietary patterns (factors) retained. Based on the hypothesis that the factors were uncorrelated, a varimax rotation was used to compute the factor loading for each food group across the factors (dietary patterns) revealed. Further, simple linear regression was run for each factor (dietary pattern) to investigate the association between each dietary pattern and the variables in the data (such as stress, anxiety, BMI, etc.) After that, variables that had a significant association were included in a multiple regression model along with all other variables that showed significant association with the specific dietary pattern.

Statistical analysis was done using IBM SPSS statistics version 28 (Chicago, IL, USA). Shapiro-Wilk tests were performed to assess the normality of the data. Normally distributed data are presented as means and standard deviations and non-normally distributed data are presented as medians and interquartile ranges. Variables were compared across the three MD adherence categories through Chi-square tests for categorical data and Kruskal Wallis tests for continuous data.

3. Results

In total, 249 participants were included in the analysis after excluding 6 participants for having incomplete data and not meeting the inclusion criteria on the landing page of the study survey. The majority (61%) of the participants had a medium adherence to Mediterranean Diet (MD) (figure 1).

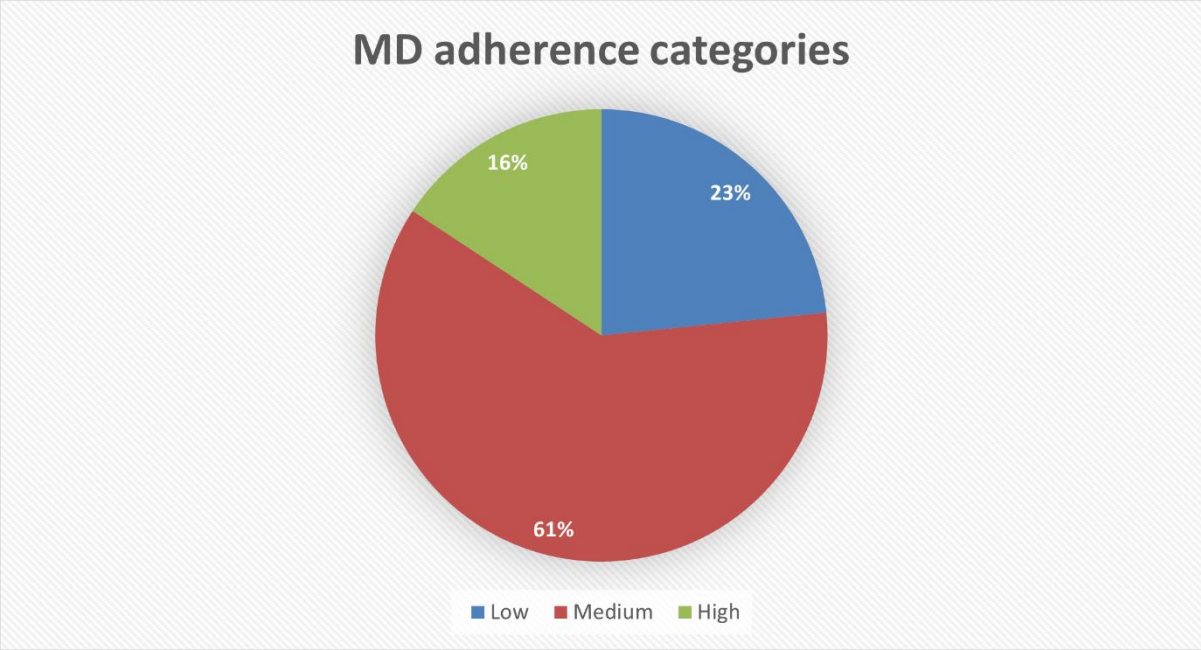


Figure 8: (Chapter 5, fig 1) - Pie chart showing the percentage of participants with low, medium, and high adherence to Mediterranean Diet.

Table 1 shows the socio-demographic characteristics of participants who were mainly single (96.4%), non-smokers (73.5%), and never gave birth (94.8%). Additionally, around 42% of participants had a monthly income of less than 500$ and family support was the source of income for 80% of them. The percentage of participants with family sizes of ≤ 4 and ≥ 5 persons were 45.8 % and 53%, respectively, and 79.1 % of them reported to have <2 persons in each room of their house. Regarding their parental status, the majority of participants parents (father and mother) were university graduates and work as employees. Chi-square tests performed for all socio-demographic variables showed no significant difference between any variable across the three MD adherence categories.

Table 11: (Chapter 5, Table 1) - Socio-demographic characteristics of participants (n=249).

Socio-demographic variables	**N (%)**	**Q1 (MDS 0-3)** *N= 58*	**Q2 (MDS 4-6)** *N= 151*	**Q3 (MDS 7-9)** *N= 39*	**P-value**
Father's Educational level					
Grade 9 (Brevet)	58 (23.3)	12 (21.4)	35 (62.5)	9 (16.1)	0.88
Grade 12 (Baccalaureate)	57 (22.9)	15 (25.9)	36 (62.1)	7 (12.1)	
University graduate	129 (51.8)	29 (22.5)	77 (59.7)	23 (17.8)	
Mother's Educational level					
Grade 9 (Brevet)	46 (18.5)	7 (15.2)	29 (63.0)	10 (21.7)	0.17
Grade 12 (Baccalaureate)	59 (23.7)	10 (16.9)	41 (69.5)	8 (13.6)	
University graduate	142 (57.0)	40 (28.4)	81 (57.4)	20 (14.2)	
Father's Employment status					
Employed	156 (62.7)	31 (20.0)	99 (63.9)	25 (16.1)	
Full-time homeworker, parent,	40 (16.1)	14 (35.0)	21 (52.5)	5(12.5)	
caregiver	13 (5.2)	2 (15.4)	8 (61.5)	3(23.1)	0.64
Retired	3 (1.2)	1 (33.3)	2 (66.7)	0 (0.0)	
Unable to work due to health problems	29 (11.6)	6 (20.7)	17 (58.6)	6 (20.7)	
Unemployed					
Mother's Employment status					
Employed	120 (48.2)	30(25.0)	69 (57.5)	21 (17.5)	

Full-time homeworker, parent, caregiver Retired Unable to work due to health problems Unemployed	71 (28.5) 10 (4.0) 3 (1.2) 41 (16.5)	17(23.9) 3(30.0) 0(0.0) 7 (17.5)	43 (60.6) 6 (60.0) 2 (66.7) 28 (70.0)	11 (15.5) 1 (10.0) 1 (33.3) 5 (12.5)	0.88
Source of income					
Family support Other Self-support Stipend or scholarship	201 (80.7) 3 (1.2) 26 (10.4) 16 (6.4)	45 (22.4) 1 (33.3) 6 (23.1) 4 (25.0)	123 (61.2) 2 (66.7) 17 (65.4) 9 (56.3)	33(16.4) 0(0.00) 3(11.5) 3 (18.8)	0.97
Monthly income					
> $500 $500 -$1499 $1500- $2999 ≥ $3000	105 (42.2) 55 (22.1) 30 (12.0) 37 (14.9)	23 (21.9) 11 (20.0) 9 (30.0) 8 (21.6)	65 (61.9) 32 (58.2) 16 (53.3) 26 (70.3)	17 (16.2) 12 (21.8) 5 (16.7) 3 (8.1)	0.62
Family size					
≤ 4 ≥ 5	114 (45.8) 132 (53)	30 (25.9) 28 (21.2)	67 (57.8) 84 (63.6)	19 (16.4) 20 (15.2)	0.61
Number of persons in each room of the house					0.65
≤ 2 ≥ 3	197 (79.1) 24 (9.6)	45 (22.8) 6 (26.1)	121 (61.4) 12 (52.2)	31 (15.7) 5 (21.7)	
Smoking status					
Smoker Non-smoker	64 (25.7) 183 (73.5)	13 (20.3) 43 (23.6)	43 (67.2) 108 (59.3)	8 (12.5) 31 (17.0)	0.51
Parity					
Never Once Two times or more	236 (94.8) 4 (1.6) 1 (0.4)	56 (23.8) 0 (0.0) 0 (0.0)	142 (60.4) 4 (100.0) 1 (100.0)	37 (15.7) 0 (0.0) 0 (0.0)	0.52
Marital status					
Single Separated Married Divorced	240 (96.4) 1 (0.4) 6 (2.4) 1 (0.4)	57 (23.8) 0 (0.0) 0 (0.0) 0 (0.0)	144 (60.3) 1 (100.0) 5 (83.3) 1 (100.0)	38 (15.9) 0 (0.0) 1 (16.7) 0 (0.0)	0.77

P-values are derived from Chi-square tests for categorical variables. Q1: Quartile 1 (Low MD adherence), Q2: Quartile 2 (Medium MD adherence), Q3: Quartile 3 (High MD adherence).

The mean (standard deviation) and median (interquartile range) of the physical and mental characteristics of the study sample are presented in table 2. The Kruskal-Wallis H non-parametric tests for stress score, depression score, anxiety score, BMI, and physical activity showed no significant difference between these variables across the categories of adherence to MD. Age was found to be statistically different among the MD adherence categories ($X^2(2, n=249) = 10.376$, $p = 0.006$). Participants with an age of more than or equal 20 years were less likely to have high MD adherence (28.9%) than those who aged ≤19 years (71.1%). After adjusting values by the Bonferroni correction for multiple tests, pairwise comparisons showed that age was different between low and medium MD adherence categories (p= 0.02), but not between low and high (p= 0.97) nor between medium and high MD adherence categories (p= 0.75).

Table 12: (Chapter 5, Table 2) - Physical and mental characteristics of participants (n=249).

Variable	**Total sample (n=248)**	**Q1 (MDS 0-3)** *Low adherence*	**Q2 (MDS 4-6)** *Medium adherence*	**Q3 (MDS 7-9)** *High adherence*	**P-value**
Age (years)*	19 (18-21)	19 (18-19)	19 (18-21)	19 (18-21)	0.02
Age ≤19	150 (62.5)	42 (77.8)	81 (54.7)	27 (71.1)	0.006

≥20	90 (37.5)	12 (22.2)	67 (45.3)	11 (28.9)	
Stress score^	31.6 (7.1)	30.9 (7.3)	31.9 (7.3)	31.7 (6.2)	0.81
Stress level					
Low	1 (0.4)	0 (0)	1 (0.7)	0 (0)	
Low-medium	75 (30.2)	23 (39.7)	44 (29.1)	8 (20.5)	0.44
Medium-high	157 (63.3)	33 (56.9)	95 (62.9)	29 (74.4)	
High	15 (6)	2 (3.4)	11 (7.3)	2 (5.1)	
Depression score*	12 (6-20)	10 (6-20)	12 (6-19)	12 (6-21)	0.68
Depression					
Minimal	141 (56.9)	37 (63.8)	83 (55)	21 (53.8)	
Mild	43 (17.3)	5 (8.6)	32 (21.2)	6 (15.4)	0.17
Moderate	40 (16.1)	13 (22.4)	21 (13.9)	6 (15.4)	
Severe	24 (9.7)	3 (5.2)	15 (9.9)	6 (15.4)	
Anxiety score*	25 (14.5-34.5)	25.5 (18-35)	26 (14-35)	24 (14-32)	0.77
Anxiety					
Low	100 (40.3)	25 (43.1)	57 (37.7)	18 (46.2)	0.85
Moderate	90 (36.3)	21 (36.2)	57 (37.7)	12 (30.8)	
Potentially concerning	58 (23.4)	12 (20.7)	37 (24.5)	9 (23.1)	
BMI (kg/m^2)*	22.5 (20.1-25.6)	22.6 (19.8-24.9)	22.1 (20.2-25.1)	23.0 (20.5-28.5)	0.16
BMI					
Underweight	18 (7.3)	5 (8.6)	11 (7.3)	2 (5.1)	
Normal	155 (62.5)	37 (63.8)	98 (64.9)	20 (51.3)	0.81
Overweight	52 (21)	7 (12.1)	34 (22.5)	11 (28.2)	
Obese	23 (9.3)	9 (15.5)	8 (5.3)	6 (15.4)	
Physical Activity (METs-hr/wk)*	990 (346.5-2170.5)	1539 (321.8-3321.3)	894 (346.5-1599.4)	1287 (288.8-2847.0)	0.09
Physical activity level					
Low	96 (38.7)	22 (37.9)	61 (40.4)	13 (33.3)	0.18
Moderate	111 (44.8)	22 (37.9)	72 (47.7)	17 (43.6)	
High	41 (16.5)	14 (24.1)	18 (11.9)	9 (23.1)	

*Median (Interquartile Range), ^ Mean (Standard Deviation). Q1: Quartile 1 (Low MD adherence), Q2: Quartile 2 (Medium MD adherence), Q3: Quartile 3 (High MD adherence). MDS: Mediterranean Diet Score. METs-hr/wk: Metabolic Equivalents of tasks-hours per week. P-values for continuous variables are derived from Kruskal-Wallis H non-parametric tests. P-values for categorical variables are derived from Chi-square tests.

3.1 Factor Analysis

The scree plot in figure 2 indicates that the number of factors (dietary patterns) with an eigenvalue ≥ 1 retained from factor analysis is four.

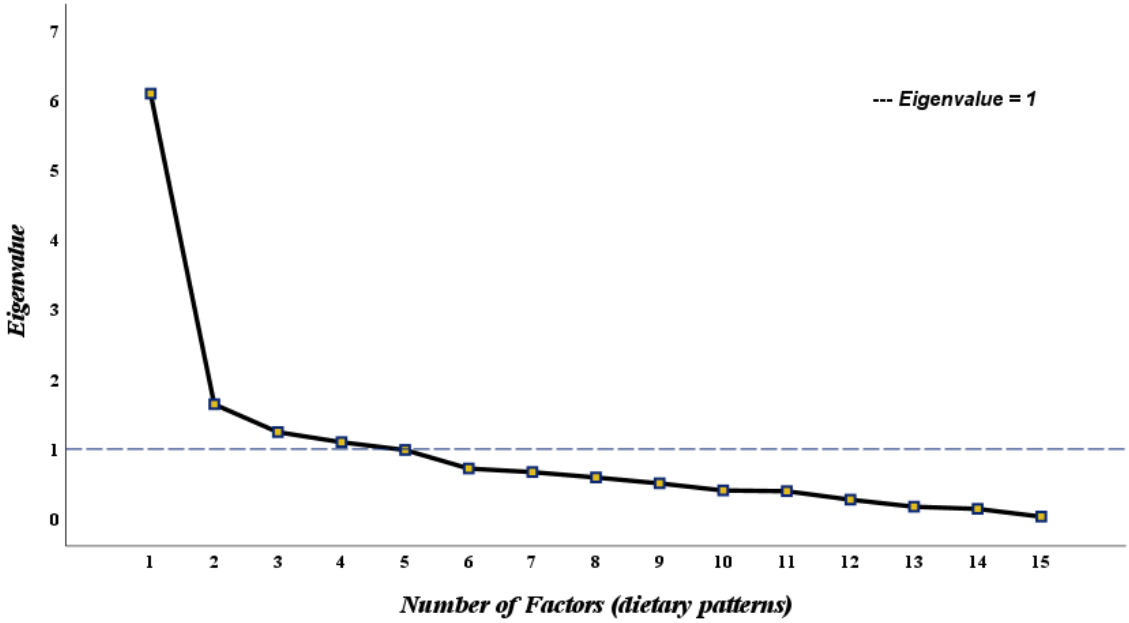


Figure 9: (Chapter 5, fig 2) - Scree Plot of the 15 food groups (grams/day) showing the Eigenvalues and the number of factors (dietary patterns).

The four factors (dietary patterns) that were retained from factor analysis explained 67% of the total variance in data (Table 3). The varimax rotation used in the analysis to compute the factor loadings of the food groups is presented in table 3 and shows that four food groups (grams per day) were found in factors 1,2, and 3 (DP1, DP2, and DP3) while two food groups were found in factor 4 (DP4). The first dietary pattern (DP1) had high factor loadings for potatoes, vegetables, legumes, soups and sauces, and non-alcoholic beverages. The second dietary pattern retained (DP2) contained cereals, fats and oils, milk and dairy products, and sugars and snacks. Dietary pattern 3 (DP3) included alcoholic beverages, fish and seafood, eggs, and meats and meat products. The fourth dietary pattern (DP4) included fruits and nuts and seeds food groups.

Table 13: (Chapter 5, Table 3) - Varimax-rotated factor loadings for the four factors (dietary patterns) of the 15 food groups derived from the adapted EPIC food frequency questionnaire.

Food Groups (grams per day)	**Factor 1 (DP1)**	**Factor 2 (DP2)**	**Factor 3 (DP3)**	**Factor 4 (DP4)**
Alcoholic beverages			.154	
Non-alcoholic beverages	.473			
Cereals		.784		
Eggs			.664	
Fats and Oils		.756		
Fish and Seafood			.801	
Fruits				.618
Nuts and Seeds				.453
Meat and meat products			.701	

Milk and dairy products		.476		
Potatoes	.556			
Sugars and snacks		.475		
Vegetables	.785			
Legumes	.904			
Soup and sauces	.770			

DP: Dietary Pattern.

Table 4 shows the multiple regression models of the four dietary patterns retained from factor analysis. The first model of DP1 was based on the following equation: DP1 = β_0 + β_1Age + β_2Mother's educational level + β_3Monthly income. Results showed that DP1 was negatively associated with higher educational level of the mother (university graduate) (p = 0.03). Additionally, the first regression model showed a positive association with monthly income (p = 0.02). DP1 was found to be dominant among childbearing aged women who had a higher income and a lower mother's educational level.

Model 2 was formed on the subsequent formula: DP2 = β_0 + β_1Father's employment status + β_2Marital status. Table 4 shows that the second regression model indicates that DP2 had a negative association with Father's employment status (employee) (p = 0.01) and marital status (single) (p = 0.008). DP2 was found to be uncommon among the single women whose father work as an employee.

The third multiple regression model was formed based on the formula: DP3 = β_0 + β_1BMI + β_2 Father's educational level. Model 3 showed that DP3 was positively associated with BMI (p <0.001) and negatively with higher father's educational level (university graduate) (p = 0.018) (Table 4). This pattern was common among women with higher BMI but lower father's educational level.

Model 4 was formed on the subsequent formula: DP4 = β_0 + β_1Depression+ β_2BMI. The fourth regression model indicates that DP2 had a positive association with BMI (p = 0.015) (Table 4). DP4 was found to be common among women who have greater BMI (kg/m^2).

Table 14: (Chapter 5, Table 4) - Multiple regression models presenting the association between the dietary patterns derived from factor analysis and the variables in data.

Model	**Predictor**	**Coefficient Estimate**	**P-value**
1 *(DP1)* *"Potatoes, vegetables, legumes, soups and sauces, and non-alcoholic beverages"*	Intercept Age Mother's educational level (university graduate) Monthly income (above average)	-0.419 0.029 -0.173 0.132	0.33 0.12 0.03 0.02
2 *(DP2)* *"Cereals, fats and oils, milk and dairy products, and sugars and snacks"*	Intercept Father's employment status (employee) Marital status (single)	0.687 -0.114 -0.454	0.001 0.01 0.008

3 *(DP3)* *"Alcoholic beverages, fish and seafood, eggs, and meats and meat products"*	Intercept BMI Father's educational level (university graduate)	0.318 0.001 -0.153	0.044 <0.001 0.018
4 *(DP4)* *"Fruits, nuts and seeds"*	Intercept Depression BMI (kg/m^2)	-0.134 0.009 0.01	0.112 0.071 0.015

4. Discussion

This is the first study in Lebanon to examine the link between perceived stress and dietary quality/patterns in women of childbearing age. The relationship between stress and dietary quality/patterns has recently attracted the attention of health researchers, particularly because diet is a major modifiable risk factor for obesity and a variety of chronic diseases [15]. In the present study, dietary quality/patterns analysis was applied instead of individual-nutrient assessment since it allows the exploration of the entire population's diet and is deemed vital in evaluating the association between dietary intake and diet-related diseases [37]. Furthermore, it is difficult to examine the association between stress and single nutrients because they are never taken separately but more as part of a meal, and they metabolically engage with one another [37].

The a priori evaluation of dietary quality revealed a medium adherence to the Mediterranean Diet (~61% of the total sample) with only ~15% of the sample having high adherence and 24% having low adherence. This suggests that women in Lebanon are indeed shifting from the traditional Mediterranean Diet to a more western-type diet. Similar findings were found in the United States, where the majority of the of childbearing age women (18-44 years old) sample (43%) had a medium adherence to the Mediterranean Diet [38], and in the United Kingdom, where the majority of females in the workplace (n = 426) had a medium adherence to the Mediterranean Diet Index (n = 346) [39]. Likewise, our research team investigated dietary quality using the Mediterranean Diet Index across 123 women of childbearing age in the UK and found medium adherence [40]. The Mediterranean Diet has been recognized as offering numerous health benefits [41] and therefore to ensure good diet quality, it is important that nutrition counseling and education are considered as part of a holistic approach to reproductive health care. Ideally this should be enhanced and provided to women of childbearing age with the aim of improving their dietary quality prior to pregnancy.

The a-posteriori dietary analysis (Table 4) provided clearer dietary insight by revealing the food groups that contribute to the dietary patterns of the Lebanese sample of women of childbearing age. In the current study, four dietary patterns (DPs) were identified: "potatoes, vegetables, legumes, soups and sauces, and non-alcoholic beverages" (DP1), "cereals, fats and oils, milk and dairy products, and sugars and snacks" (DP2), "alcoholic beverages, fish and seafood, eggs, and meats and meat products" (DP3), and "fruits and nuts and seeds" (DP4). Psychological stress was not associated with any of the four DPs, which contrasts with what other studies have found [14, 37]. For instance, our previous study among women of childbearing age in the UK found that psychological stress was significantly associated with the "fats and oils, sugar and snacks, alcoholic beverages, red/processed meat, and cereals" DP ($p = 0.005$) and negatively with the "fruits, vegetables, nuts and seeds" DP (p

< 0.001) [14]. Additionally, El-Ansari et al. [37] measured psychological stress through the Perceived Stress Scale and dietary intake through a 12-food item FFQ and reported a significant association between psychological stress and high intake of fat, sugar and snacks, and low intake of fruits, and vegetables among female students in the UK.

The a-priori and a-posteriori dietary approaches of this study showed that there appears to be no relationship between psychological stress and the dietary quality/patterns among the Lebanese sample of childbearing aged women who took part in this study. These findings are consistent with other studies that have looked into the link between stress and diet. However, the evidence is contradictory and appears to reflect a geographical variation as figure 3 shows.

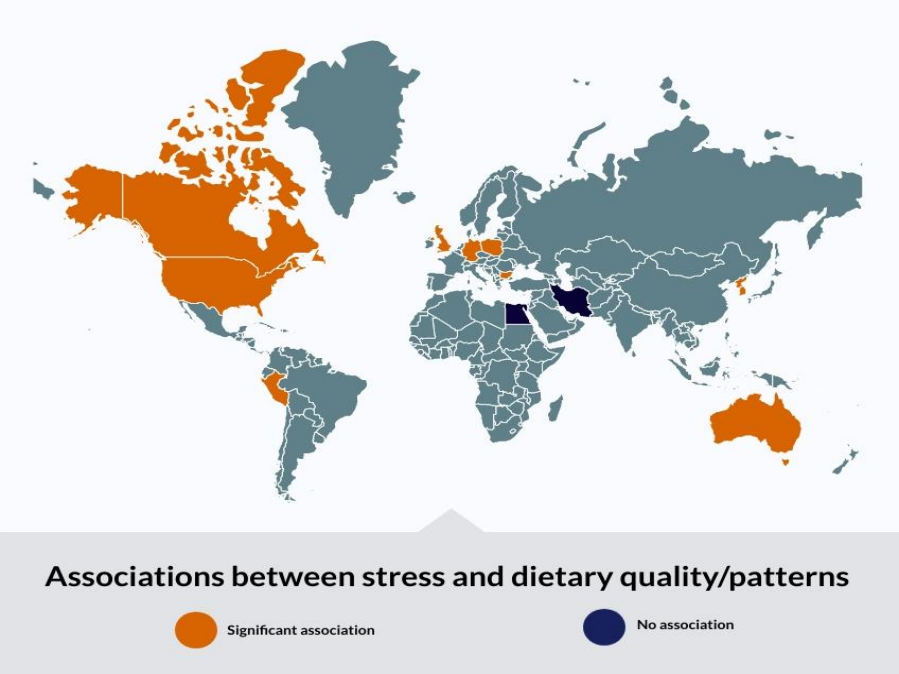


Figure 10: (Chapter 5, fig 3) - World map showing the countries with significant associations (in red orange) versus countries with no significant association (in dark navy blue) between psychological stress and dietary quality/patterns.

As Figure 3 shows, there are countries with significant associations (in red orange) between stress and dietary quality/patterns and countries where there was no significant association (in dark navy blue). This figure was built based on a previous systematic review and meta-analysis that included 24 studies on the association between stress and dietary quality and patterns (food intake and frequency of consumption) [6]. Most studies that found a significant association between stress and diet were from the western countries (e.g., UK, USA, Germany, Poland) whereas the majority of studies that found no association were from the Middle East.

Richardson et al. [19] measured psychological stress using the 14-item PSS and dietary quality using the Healthy Eating Index-2010 among a hundred and one childbearing aged women (aged 18–44 years) and found null association. Similarly, Ferranti et al. [42] found no link between stress and dietary quality among 433 female university and health center employees in the United States. In that study, the Alternate Healthy Eating Index, Mediterranean Diet Index, and Dietary Approach to Stop Hypertension Index were used to assess a-priori dietary quality and the 14-item PSS to assess stress levels of participants. Two further studies among women of childbearing age in Egypt [12] and Iran [43] showed no significant association between dietary quality and psychological stress.

On the other hand, several studies have found a significant association between psychological stress and dietary quality/patterns. For instance, El-Ansari et al. [37] assessed stress levels using the Perceived Stress Scale and nutritional habits using a 12-food item FFQ and discovered that stress was associated with impaired dietary quality, as evidenced by high intake of sugar, snacks, fat, and low intake of unsaturated fats, fruits, and vegetables among British female university students. Furthermore, Isasi et al. [44] discovered that psychological stress was negatively related to dietary quality (Alternate-Healthy Eating Index 2010) among Hispanic/Latina females in the United States. Similarly, Groesz et al. [45] recruited 561 females in the United States and found that highly stressed women had a greater consumption of unhealthy foods (fast food, sweets, etc.) and little consumption of whole grains, fruits, and vegetables. Another study provided a positive correlation between stress and bad food habits [46] among females across three countries (Germany, Poland, and Bulgaria). Additionally, a cross-sectional study among 244 women of childbearing age in the UK has found a negative association between psychological stress and adherence to the Alternate Mediterranean Diet Index (a-priori dietary approach). The study also reported significant associations between psychological stress and the a-posteriori derived dietary patterns where stress was associated with the intake of a dietary pattern was comprised of "fats and oils, processed meats, sugars and snacks, alcohol, and cereals" food groups ($p=0.005$) and negatively with a dietary pattern including "fruits, nuts, vegetables, and seeds" food groups ($p<0.001$) [14]. Habhab et al. [47] examined the relationship between stress, food restraint, and dietary quality/patterns among 40 women of childbearing age, finding that women with poorer dietary quality had a higher psychological stress level. The findings of a systematic review and meta-analysis [6], that investigated the association between psychological stress and dietary quality in childbearing aged women, were also contradicting those of the present study. The systematic literature review included 24 studies (8 with dietary quality as the primary outcome and 16 with food frequency of intake as the primary outcome) with a total of 41,033 individuals. Overall, the 16 studies on food intake and frequency of consumption (n = 33,477) reported that psychological stress was linked to a higher intake of fat, fast food, sweets, processed foods, and a low intake of fruits, vegetables, whole grains, and legumes, as well as a low intake of fruits, vegetables, whole grains, and legumes. The meta-analysis comprised 8 studies (n = 7556) on dietary quality and found a significant negative relationship between stress and dietary quality (r = 0.35, p 0.001, 95% CI (0.56;0.15). Variations in sample sizes, diversity of the instruments used to assess variables, and differences in the population from which the sample was taken could explain discrepancies in findings between prior studies and the current study. In other words, these differences within the methodologies of different studies might affect the accuracy of data and the extent of reporting-error of each tool used to collect data. For instance, most studies on the relationship between psychological stress and dietary quality in women of childbearing age have used 24-hour recalls as the dietary assessment tool [15-17, 19, 44], whereas the adapted EPIC food frequency questionnaire was used in the current study, which measures a wide range of food items and their frequency of consumption over the previous year.

Reflecting on the contradictory nature of the evidence, one might ask whether geographical, sociodemographic-related, or cultural factors pertaining to western or middle eastern countries can derive a diverse association between stress and diet. As previously mentioned, most countries, where a significant association between stress and dietary quality and patterns was observed, were western countries (figure 3) and countries with no significant association were more in the middle east (Lebanon, Egypt, Iran). One reason might be that, unlike the western countries, in the middle east and especially Lebanon, which is a Mediterranean country, the traditional type of diet is a Mediterranean style diet, and this is

shown in our results where most of our sample (61%) had a medium adherence to MD. Additionally, a study by Jomaa 2016 has found that the Lebanese dietary pattern is highly correlated with several dietary quality indices (the Alternative Health Eating Index (AHEI), the alternate Mediterranean diet score (aMED), the Dietary Diversity Score (DDS), the Dietary Approaches to Stop Hypertension (DASH)-style diet score, and the Lebanese Mediterranean Diet index (LMD)) indicating that the Lebanese dietary pattern is of high dietary quality. So, upon stress, women in Lebanon tend to still maintain some level of adherence to the Mediterranean diet (even if with an increased unhealthy foods). Further research is needed to explore the underlying factors that could explain these differences.

In order to better understand the stress/diet relationship, studies have suggested that there is a bidirectional relationship between psychological stress and dietary quality/patterns [37]. For instance, high levels of psychological stress were linked to weight dissatisfaction and other health-risking behaviors such alcohol consumption, binge eating, smoking, and missing breakfast in a group of female students [48]. To alleviate their unpleasant emotions, stressed people tend to consume high energy-dense foods [49]. The lack of eating control, according to Adam et al. [49], is a major factor in these eating behaviors coming from unpleasant emotions and stress. When the ingestion of high-calorie, appealing meals is linked to satisfaction and reward, it is referred to as comfort eating during stressful times [49]. However, some researchers have found no substantial link between perceived stress and dietary quality/patterns, contradicting these claims. This can be explained by the following non-food coping methods, such as spirituality, which have been shown to reduce the impact of psychological stress on eating behavior [50]. Although there are no significant links between psychological stress and dietary quality/patterns in all of these study results, other factors such as stress coping strategies, cultural food traditions, cognitive factors (such as nutrition knowledge), and food cost, may influence dietary patterns and quality and should be further examined [51].

Strengths and Limitations:

This is the first study to investigate the association between psychological stress and dietary quality and patterns among Lebanese women of childbearing age. Dietary quality/patterns were analyzed comprehensively using two methods: a-priori (hypothesis-driven) and a-posteriori (data-driven), both of which provided reliable results and a clearer overview of the study's participants' overall dietary quality/patterns. The methods adopted to assess the variables were standardized and validated, such as the Perceived Stress Scale to assess stress levels [25] and Becks Depression Inventory II to assess depression [27], in addition to the anthropometric and socioeconomic questions [52-54], are another strength of this study. In contrast to most previous research on the association between psychological stress and diet that used diet recalls to estimate dietary intake, this study used the adapted EPIC food frequency questionnaire [22], which is widely regarded as the gold standard dietary assessment tool [21, 55].

On the other side, there are a few limitations that should be acknowledged. Because of the study's cross-sectional methodology, it was difficult to draw and generalise a definitive conclusion about the relationship between psychological stress and dietary quality/patterns among childbearing aged women. Furthermore, the convenience sample was drawn from a population of women of childbearing age in a Lebanese university context, and hence may not be representative of the general population of women of childbearing age in Lebanon. Despite the fact that all variables were measured using validated and standardised tools, the response of participants was self-reported, which could have resulted in inaccuracy of the results. Advanced and more precise tools such as Dual-Energy X-ray Absorptiometry (DEXA), which

assesses the whole-body composition including weight, height, fat mass, and fat-free body mass, would be better in estimating the anthropometric measures of participants [56]. Likewise, the Perceived Stress Scale, which was used to assess participants' psychological stress levels, was self-reported, thus participants may not have accurately recalled stressful occurrences from the previous weeks. In future investigations, a more accurate measure of stress, such as salivary cortisol, should be used [57]. Moreover, food intake biomarkers (such as urine and blood samples) that objectively evaluate an individual's nutritional intake should be used to supplement meal frequency questionnaires and other self-reported dietary intake indicators [58].

5. Conclusion

In the current study, no association was found between stress and diet quality and patterns among a Lebanese sample of childbearing aged women. Recent studies suggest that psychological stress might lead to poorer diet and/or no change in diet depending on several factors such as population, tools used, stress coping strategies, cultural food traditions, and cognitive factors. Further randomised controlled trials with accurate tools are needed to confirm these results and should further aim to identify the underlying factors that could explain the association between psychological stress and dietary quality/patterns among childbearing aged women in Lebanon.

Acknowledgements: As authors, who have used the FETA software for the analysis of the EPIC FFQ data in the present study, we are asked by FETA-software team to acknowledge the following: The EPIC-Norfolk study (DOI 10.22025/2019.110.1105.00004) has received funding from the Medical Research Council (MR/N003284/1 and MC-UU_112015/1) and Cancer Research UK (C864/A14136). We are grateful to all the participants who have been part of the project and to the many members of the study teams at the University of Cambridge who have enabled this research. The authors also acknowledge that figure 3 was designed through Visme website (www.visme.co).

Financial Support: This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of Interest: None.

Authorship: [Conceptualisation and study design, K.K., F.T., and V.H.; methodology, K.K., F.T., V.H., M.B.1, and M.B.2; ethical approval applications preparation: K.K., F.T., V.H., M.B.1, and M.B.2; data collection, K.K., M.B.1, M.B.2; formal data analysis, K.K.; data interpretation, K.K., F.T., and V.H.; writing—original first draft preparation, K.K.; writing—review and editing, K.K., F.T., and V.H.; supervision, F.T. and V.H. All authors have read and agreed to the published version of the manuscript.]

Ethical Standards Disclosure: This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the [Lebanese American University Institutional Review Board] IRB#: LAU.SAS.MB3.27/Nov/2020. Written informed consent was obtained from all subjects/patients.

References:

1. Chamieh M, Moore H, Summerbell C, Tamim H, Sibai A, Hwalla N. Diet, physical activity and socio-economic disparities of obesity in Lebanese adults: findings from a national study. BMC Public Health. 2015;15(1).
2. Costa-Font J, Györi M. The weight of patriarchy? Gender obesity gaps in the Middle East and North Africa (MENA). Social Science & Medicine. 2020;266:113353.
3. Mallat S, Geagea A, Jurjus R, Rizkallah A, Oueidat D, Matar M et al. Obesity in Lebanon: A National Problem. World Journal of Cardiovascular Diseases. 2016;06(06):166-174.
4. El-Kassas G, Ziade F. Exploration of the Dietary and Lifestyle Behaviors and Weight Status and Their Self-Perceptions among Health Sciences University Students in North Lebanon. BioMed Research International. 2016;2016:1-14.
5. Karimi Z, Tavassoli E, Babaei Heydarabadi A. The Relationship Between Perceived Stress Level and Consumption of Fast Foods Among Female Students of Shahrekord University of Medical Sciences. International Journal of Epidemiologic Research. 2019;6(1):30-35.
6. Khaled K, Tsofliou F, Hundley V, Helmreich R, Almilaji O. Perceived stress and diet quality in women of reproductive age: a systematic review and meta-analysis. Nutrition Journal. 2020;19(1).
7. Musaiger A, Al-Mannai M, Tayyem R, Al-Lalla O, Ali E, Kalam F et al. Perceived Barriers to Healthy Eating and Physical Activity among Adolescents in Seven Arab Countries: A Cross-Cultural Study. The Scientific World Journal. 2013;2013:1-11.
8. Boynton A, Neuhouser M, Sorensen B, McTiernan A, Ulrich C. Predictors of Diet Quality among Overweight and Obese Postmenopausal Women. Journal of the American Dietetic Association. 2008;108(1):125-130.
9. Giskes K, van Lenthe F, Avendano-Pabon M, Brug J. A systematic review of environmental factors and obesogenic dietary intakes among adults: are we getting closer to understanding obesogenic environments?. Obesity Reviews. 2010;12(5):e95-e106.
10. Grunberg N, Straub R. The role of gender and taste class in the effects of stress on eating. Health Psychology. 1992;11(2):97-100.
11. Mohamed B, Mahfouz M, Badr M. Food Selection Under Stress Among Undergraduate Students in Riyadh, Saudi Arabia. Psychology research and behavior management. 2020;13:211–221.
12. El Ansari W, Berg-Beckhoff G. Nutritional Correlates of Perceived Stress among University Students in Egypt. International Journal of Environmental Research and Public Health. 2015;12(11):14164-14176.
13. Ahmad O, Sabbah H, Smail L, Hermena E, Al Ghali R. Food consumption frequency and perceived stress and depressive symptoms among female university students in the UAE: A cross-sectional study. [Internet]. 2019 [cited 21 November 2021];. Available from: https://www.researchsquare.com/article/rs-9884/v1
14. Khaled K, Hundley V, Tsofliou F. Poor Dietary Quality and Patterns Are Associated with Higher Perceived Stress among Women of Reproductive Age in the UK. Nutrients. 2021;13(8):2588.
15. Fowles E, Bryant M, Kim S, Walker L, Ruiz R, Timmerman G et al. Predictors of Dietary Quality in Low-Income Pregnant Women. Nursing Research. 2011;60(5):286-294.

16. Fowles E, Stang J, Bryant M, Kim S. Stress, Depression, Social Support, and Eating Habits Reduce Diet Quality in the First Trimester in Low-Income Women: A Pilot Study. Journal of the Academy of Nutrition and Dietetics. 2012;112(10):1619-1625.
17. Widaman A, Witbracht M, Forester S, Laugero K, Keim N. Chronic Stress Is Associated with Indicators of Diet Quality in Habitual Breakfast Skippers. Journal of the Academy of Nutrition and Dietetics. 2016;116(11):1776-1784.
18. Vidal E, Alvarez D, Martinez-Velarde D, Vidal-Damas L, Yuncar-Rojas K, Julca-Malca A et al. Perceived stress and high fat intake: A study in a sample of undergraduate students. PLOS ONE. 2018;13(3):e0192827.
19. Richardson A, Arsenault J, Cates S, Muth M. Perceived stress, unhealthy eating behaviors, and severe obesity in low-income women. Nutrition Journal. 2015;14(1).
20. Hulley S, Cummings S, Browner W, Grady D, Newman T. Designing Clinical Research. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins; 2013.
21. Welch A, Luben R, Khaw K, Bingham S. The CAFE computer program for nutritional analysis of the EPIC-Norfolk food frequency questionnaire and identification of extreme nutrient values. Journal of Human Nutrition and Dietetics. 2005;18(2):99-116.
22. Khaled K, Hundley V, Bassil M, Bazzi M, Tsofliou F. Validation of the European Prospective Investigation into Cancer (EPIC) FFQ for use among adults in Lebanon. Public Health Nutrition. 2021;24(13):4007-4016.
23. WHO Consultation on Obesity (1999: Geneva, Switzerland) & World Health Organization. Obesity: preventing and managing the global epidemic : report of a WHO consultation [Internet]. 2000. Available from: https://apps.who.int/iris/handle/10665/42330
24. Nikolaou C, Hankey C, Lean M. Accuracy of on-line self-reported weights and heights by young adults. European Journal of Public Health. 2017;27(5):898-903.
25. Cohen S, Kamarck T, Mermelstein R. A Global Measure of Perceived Stress. Journal of Health and Social Behavior. 1983;24(4):385.
26. Almadi T, Cathers I, Hamdan Mansour A, Chow C. An Arabic version of the Perceived Stress Scale: Translation and validation study. International Journal of Nursing Studies. 2012;49(1):84-89.
27. Beck A, Steer R, Brown G. BDI-II, Beck depression inventory. 2nd ed. San Antonio: Psychological Corp; 1996.
28. Alansari B. INTERNAL CONSISTENCY OF AN ARABIC ADAPTATION OF THE BECK DEPRESSION INVENTORY-II WITH COLLEGE STUDENTS IN EIGHTEEN ARAB COUNTRIES. Social Behavior and Personality: an international journal. 2006;34(4):425-430.
29. Beck A, Epstein N, Brown G, Steer R. An inventory for measuring clinical anxiety: Psychometric properties. Journal of Consulting and Clinical Psychology. 1988;56(6):893-897.
30. Al-Issa I, Bakal D, Fung T. Beck Anxiety Inventory symptom comparisons between students in Lebanon and Canada. Arab J Psychiatry. 1999;10:24–30.
31. Al-Issa I, Al Zubaidi A, Bakal D, Fung T. Beck Anxiety Inventory symptoms in Arab college students. Arab J Psychiatry. 2000;11:41–47.
32. CRAIG C, MARSHALL A, SJ??STR??M M, BAUMAN A, BOOTH M, AINSWORTH B et al. International Physical Activity Questionnaire: 12-Country

Reliability and Validity. Medicine & Science in Sports & Exercise. 2003;35(8):1381-1395
33. Helou K, El Helou N, Mahfouz M, Mahfouz Y, Salameh P, Harmouche-Karaki M. Validity and reliability of an adapted arabic version of the long international physical activity questionnaire. BMC Public Health. 2017;18(1).
34. Laugero K, Falcon L, Tucker K. Relationship between perceived stress and dietary and activity patterns in older adults participating in the Boston Puerto Rican Health Study. Appetite. 2011;56(1):194-204.
35. Tavolacci M, Ladner J, Grigioni S, Richard L, Villet H, Dechelotte P. Prevalence and association of perceived stress, substance use and behavioral addictions: a cross-sectional study among university students in France, 2009–2011. BMC Public Health. 2013;13(1).
36. Trichopoulou A, Costacou T, Bamia C, Trichopoulos D. Adherence to a Mediterranean Diet and Survival in a Greek Population. New England Journal of Medicine. 2003;348(26):2599-2608.
37. El Ansari W, Adetunji H, Oskrochi R. Food and Mental Health: Relationship between Food and Perceived Stress and Depressive Symptoms among University Students in the United Kingdom. Central European Journal of Public Health. 2014;22(2):90-97.
38. Boghossian N, Yeung E, Mumford S, Zhang C, Gaskins A, Wactawski-Wende J et al. Adherence to the Mediterranean diet and body fat distribution in reproductive aged women. European Journal of Clinical Nutrition. 2013;67(3):289-294.
39. Papadaki A, Wood L, Sebire S, Jago R. Adherence to the Mediterranean diet among employees in South West England: Formative research to inform a web-based, work-place nutrition intervention. Preventive Medicine Reports. 2015;2:223-228.
40. Khaled K, Hundley V, Almilaji O, Koeppen M, Tsofliou F. A Priori and a Posteriori Dietary Patterns in Women of Childbearing Age in the UK. Nutrients. 2020;12(10):2921.
41. Al Wattar B, Dodds J, Placzek A, Beresford L, Spyreli E, Moore A et al. Mediterranean-style diet in pregnant women with metabolic risk factors (ESTEEM): A pragmatic multicentre randomised trial. PLOS Medicine. 2019;16(7):e1002857.
42. Ferranti E, Dunbar S, Higgins M, Dai J, Ziegler T, Frediani J et al. Psychosocial factors associated with diet quality in a working adult population. Research in Nursing & Health. 2013;36(3):242-256.
43. Valipour G, Esmaillzadeh A, Azadbakht L, Afshar H, Hassanzadeh A, Adibi P. Adherence to the DASH diet in relation to psychological profile of Iranian adults. European Journal of Nutrition. 2015;56(1):309-320.
44. Isasi C, Parrinello C, Jung M, Carnethon M, Birnbaum-Weitzman O, Espinoza R et al. Psychosocial stress is associated with obesity and diet quality in Hispanic/Latino adults. Annals of Epidemiology. 2015;25(2):84-89.
45. Groesz L, McCoy S, Carl J, Saslow L, Stewart J, Adler N et al. What is eating you? Stress and the drive to eat. Appetite. 2012;58(2):717-721.
46. Mikolajczyk R, El Ansari W, Maxwell A. Food consumption frequency and perceived stress and depressive symptoms among students in three European countries. Nutrition Journal. 2009;8(1).
47. Habhab S, Sheldon J, Loeb R. The relationship between stress, dietary restraint, and food preferences in women. Appetite. 2009;52(2):437-444.

48. Stice E, Presnell K, Spangler D. Risk factors for binge eating onset in adolescent girls: A 2-year prospective investigation. Health Psychology. 2002;21(2):131-138.
49. Adam T, Epel E. Stress, eating and the reward system. Physiology & Behavior. 2007;91(4):449-458.
50. Musgrave C, Allen C, Allen G. Spirituality and Health for Women of Color. American Journal of Public Health. 2002;92(4):557-560.
51. Azzam I, Gilad S, Limor R, Stern N, Greenman Y. Ghrelin stimulation by hypothalamic–pituitary–adrenal axis activation depends on increasing cortisol levels. Endocrine Connections. 2017;6(8):847-855.
52. Flint E, Webb E, Cummins S. Change in commute mode and body-mass index: prospective, longitudinal evidence from UK Biobank. The Lancet Public Health. 2016;1(2):e46-e55.
53. Prady S, Pickett K, Croudace T, Fairley L, Bloor K, Gilbody S et al. Psychological Distress during Pregnancy in a Multi-Ethnic Community: Findings from the Born in Bradford Cohort Study. PLoS ONE. 2013;8(4):e60693.
54. Bowman S. A comparison of the socioeconomic characteristics, dietary practices, and health status of women food shoppers with different food price attitudes. Nutrition Research. 2006;26(7):318-324.
55. Verkasalo P, Appleby P, Allen N, Davey G, Adlercreutz H, Key T. Soya intake and plasma concentrations of daidzein and genistein: validity of dietary assessment among eighty British women (Oxford arm of the European Prospective Investigation into Cancer and Nutrition). British Journal of Nutrition. 2001;86(3):415-421.
56. Shepherd J, Ng B, Sommer M, Heymsfield S. Body composition by DXA. Bone. 2017;104:101-105.
57. Hellhammer D, Wüst S, Kudielka B. Salivary cortisol as a biomarker in stress research. Psychoneuroendocrinology. 2009;34(2):163-171.
58. Pico C, Serra F, Rodríguez A, Keijer J, Palou A. Biomarkers of Nutrition and Health: New Tools for New Approaches. Nutrients. 2019;11(5):1092.

This chapter has reported the empirical study examining stress and diet in Lebanon. This is the first study to have explored this association among women of reproductive age in Lebanon. This study was needed to complete the whole data set for this PhD project that consist of two studies in UK and in Lebanon. This will allow country comparison and informs the next stage. In the next chapter, phase three of the thesis, data from both countries will be combined to enable further analysis of the explanatory factors.

Chapter 6 Country comparison using the whole data and Structural Equation Modeling

The PhD data set is complete having conducted the studies in UK and Lebanon. The final phase of the project was to understand the association between stress and diet by comparing the data from the two countries together and applying a novel statistical technique: Structural Equation Modeling.

A Structural Equation Modeling approach to examine the influence of stress, sociodemographic, physical variables on diet quality and patterns among women of childbearing age from two countries: UK and Lebanon

Karim Khaled[1]*, Vanora Hundley[2], Fotini Tsofliou[1, 2]

[1]Department of Rehabilitation & Sport Sciences, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth BH8 8AJ, UK; Khaledk@bournemouth.ac.uk (K.K.); ftsofliou@bournemouth.ac.uk (F.T.)

[2]Centre for Midwifery, Maternal & Perinatal Health, Faculty of Health & Social Sciences, Bournemouth University, Bournemouth BH8 8AJ, UK; vhundley@bournemouth.ac.uk

Corresponding author: Karim Khaled, Department of Rehabilitation and Sport Sciences Faculty of Health and Social Sciences Bournemouth Gateway Building, Bournemouth University St Pauls Lane, Bournemouth, BH88AJ, khaledk@bournemouth.ac.uk, 01202966742

Keywords: Psychological stress, stress, diet, diet quality, dietary patterns, women, females, childbearing age, reproductive age, childbearing aged women, Structural equation modeling, modeling, a priori, a posteriori

Abstract

Stress is a major determinant of poor diet quality among young women. Robust research including diverse populations is needed to clarify the relationship between stress and diet in women of childbearing age. The objective of this study was to use structural equation modeling (SEM) to investigate the associations between stress and dietary quality/patterns in a culturally diverse population of women of childbearing age to enable the exploration of the role of country context, socio-economic status, and physical variables. Data from the two countries (UK and Lebanon) were combined and cleaned. Data analysis of the whole dataset was performed, and factor analysis was done to derive the dietary patterns (DPs) of the whole sample. Adherence to Mediterranean diet (MD) was assessed as an indicator of the diet quality of the participants. Based on the literature, a hypothetical model was built linking sociodemographic factors, Body mass index (BMI), physical activity, and stress to dietary quality and patterns. Structural equation modeling was applied to test the hypothetical model and assess the direct and indirect effects of the variables on dietary quality and patterns. Participants mainly had a moderate MD adherence (58%). Factor analysis revealed four DPs: DP,1 included alcohol, cereals, fats and oils, and sugar and snacks food groups; DP,2 included vegetables, legumes and soups and sauces food groups; DP,3 included eggs, fish and seafood, meats, and potatoes food groups; and DP,4 included fruits, nuts and seeds, milk and dairy products, and non-alcoholic beverages food groups. Direct effects results showed that stress was negatively associated with MD adherence, higher income with higher intakeDP,2, being unmarried with greater consumption of DP,3, and age with higher adherence to Mediterranean diet and DP,4, and ethnicity with a lower intake of DP,4 and adherence to MD and higher intake of DP,3. Indirect effects showed

that only country was found to be indirectly affecting dietary quality and patterns through the mediatory effect of stress. Participants from Lebanon were found to have higher stress levels compared to participants from UK, and this contributed to a lower adherence to Mediterranean diet. It was also associated with lower consumption of DP,3 and DP,4, but higher consumption of DP,1. This study shows that the adherence to Mediterranean diet is dependent on stress levels, income, country context, ethnicity, and age.

Background

The is considerable heterogeneity in dietary patterns across the world and this can impact population health [1]. Comparing country dietary patterns can enable us to understand factors that influence food choices and support interventions to improve diet quality [1]. This is particularly important in relation to pregnancy and childbirth where both mother and newborns are affected by dietary choices. A systematic review of the dietary intake of pregnant women in high income countries (e.g., UK, Canada, Australia, Japan, USA) found that women's fiber and polyunsaturated fat intakes were lower than the national recommendations, whereas saturated fat intakes were found to be higher than recommended [2]. The western dietary pattern (high in fat, sugar, and refined/processed foods) reflects a lower diet quality that promotes chronic disease. In contrast, a Lebanese/Mediterranean diet (high in fruits, vegetables, and fresh produces) has been associated with reduced risk of several diseases (e.g., cardiovascular diseases) [3].

Within this context, recent nutrition epidemiology research has found that higher dietary quality (DQ) and healthier dietary patterns (DPs) have been linked to a lower risk of obesity and obesity-related metabolic diseases [4, 5]. Obesity among women of childbearing age has risen rapidly in the last two decades and has been associated with gestational diabetes, preeclampsia, miscarriage, and a variety of cardiovascular illnesses that place both the mother and the baby at danger [6-9]. Ensuring that women of childbearing age are in a good state for pregnancy will benefit both them and the future generations [4,10].

Stress is a major driver of poor diet quality among young women [11, 12]. Females (18– 29 years old) who report high levels of perceived are more likely to consume higher fat foods than non-stressed females [12-14]]. When the consumption of fruits and vegetables was measured in women of childbearing age, it was discovered that stress was associated with reduced intake [15-20]. Moreover, Barrington et al. [21] found that greater levels of perceived psychological stress were linked to higher fast-food intake in young women. However, the analysis was based on a single item scale that was not specific to accurately measure fast food consumption. The approaches taken by studies that looked at stress and diet have been limited with most assessing specific food groups and their relationship with stress, rather than evaluating a whole-food dietary approach.

High-quality studies of rigorous design from different countries (providing cultural and socio-demographical diversity) are needed to address the association between stress and diet in women of childbearing age appropriately [22]. In single countries, participants have same culture, traditions, and nutritional habits which may eventually influence to perceived psychological stress and/or dietary intake [18]. Moreover, there are differences in methodologies and tools which make the comparison difficult [23]. Few studies have recruited participants from different countries, and these have had very similar populations. For example, [18] looked at three countries from Europe: Germany, Poland, Bulgaria (same continent and hence might have similar cultures and sociodemographic status).

Robust research including diverse populations from different countries and continents is needed to clarify the relationship between stress and diet in women of childbearing age. To the best of our knowledge, no previous study has evaluated direct and indirect associations between perceived

stress and dietary quality and patterns simultaneously among women of childbearing age from two countries. This paper reports the use of structural equation modeling (SEM) to investigate the associations between perceived stress and dietary quality and patterns in a culturally diverse population of women of childbearing age (two different countries) to enable the exploration of confounding/explanatory factors such country context, marital status, and socioeconomic status.

Methods:

This study brings together data regarding diet of women of childbearing age in the United Kingdom (Europe) and Lebanon (Middle East), which were collected through an online survey questionnaire.

The study uses structural equation modeling (SEM), a comparatively recent method for assessing conceptual models by quantifying the links and interactions among a network of variables [24,25].

Examining the relationship between diet quality measures and obesity (and the resulting metabolic syndrome) is complicated due to confounders such as socio-demographic characteristics [26]. Age, socioeconomic level, and marital status have all been demonstrated to be early risk-factors for obesity and its associated health complications [27, 28]. Psychological variables, in addition to lifestyle, have been shown to play an important part in the development of obesity and its associated health impacts by inciting various harmful behaviours such as inferior nutritional quality and physical inactivity [29, 30]. Nevertheless, due to unquantified interrelationships and elevated collinearity among psychological factors and other behavioral and lifestyle metrics, the direct and indirect mechanisms underlying the association between psychological factors and diet remain unclear. As a result, rather than focusing on direct links, researchers have been recommended to look into complicated pathways (which include interconnected variables) to obtain a greater understanding and evaluation of the impact of these variables in the growth of health consequences. SEM has the feature of assessing all associated routes at the same time, taking into account the function of independent and/or dependent (i.e., mediator) components in outcome formation [25].

There are five key steps to SEM: 1) Identify the research problem, 2) identify the model, 3) estimate the model, 4) determine the model's goodness of fit, 5) respecify the model if needed [24].

After identifying the research problem in the introduction of this paper as a first step, the hypothetical model was identified in the second step. The model was built according to evidence base found in the literature. The hypothesised model in which dietary quality (adherence to Mediterranean diet) and dietary patterns (derived from factor analysis) were deemed as dependent variables and stress as a mediating variable relating the sociodemographic characteristics, BMI, and physical activity (exogenous variables) to dietary quality and patterns (endogenous variables) is summarized in figure 1.

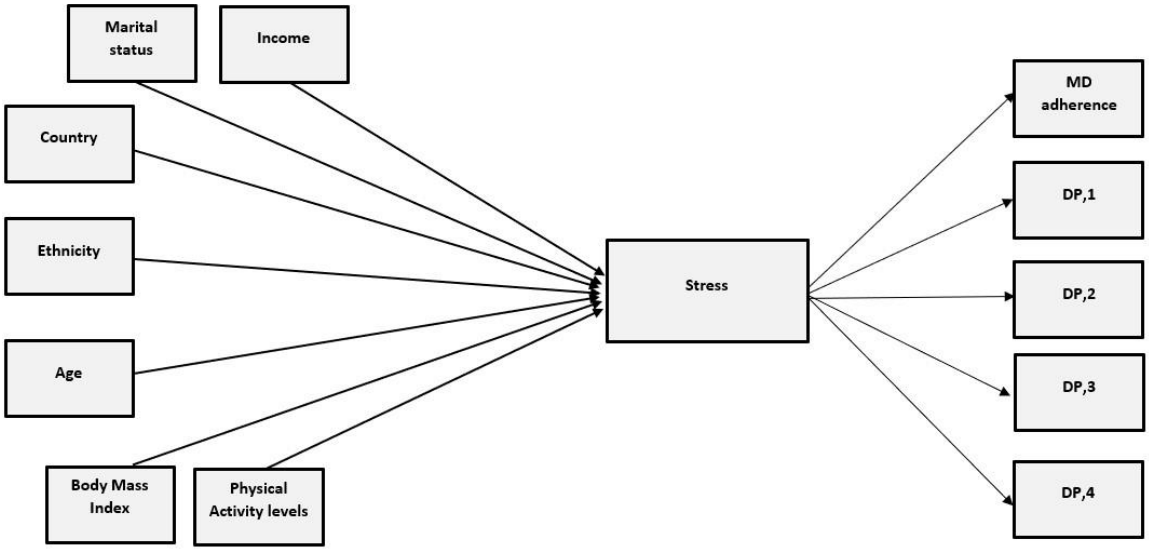


Figure 11: (Chapter 6, fig 1) - General hypothesized model showing stress as a mediating variable relating sociodemographic characteristics, adiposity, physical activity, and country context to dietary quality (Mediterranean Diet (MD) adherence) and patterns (DPs derived from factor analysis). Abbreviations: MD, Mediterranean Diet; DP, Dietary Pattern.

The country of participants along with their sociodemographic characteristics, adiposity measure, and physical activity level were expected to be directly associated with stress, and stress was allowed to predict the dietary quality and patterns.

Previous studies have reported that sociodemographic characteristics are associated with stress. For example, age and ethnicity has been found to be associated with stress where the literature reports that older people tend to have lower stress levels compared to young people and Arabs tend to have higher stress levels compared to White people [31]. Additionally, marital status and income have been linked to stress levels where women who are married and/or have lower income tend to have higher stress levels than those who are single and/or have a high income [32, 33]. The country context/culture could also affect stress. For example, some studies have pointed out that the cultural context affects the types of stressors, the appraisal, the coping strategies, and the mechanisms of coping with stress [34]. Physical activity has been shown to lower the levels of stress and is related to better stress-coping abilities [35]. Conversely, adiposity (greater BMI) has been found to be positively associated with stress levels, where overweight and obese people tend to have poorer metabolic health and increased social problems (like peer/workplace discriminations) along with elevated physiological stress response compared to normal weight people [36, 37]. Regarding the stress/depression and diet association, a recent systematic review and metaanalysis by Khaled et al. 2020 has shown that stress was associated with poorer diet quality and patterns evidenced by increased intake of unhealthy food such as high fat/high sugar foods among women of childbearing age (18-49 years old) [22]. Similarly, many other studies have reported an association between stress and depression and poor dietary quality and patterns in childbearing-aged women [38-41]. Higher age, income, and physical activity levels along with marital status (being married) have been linked to a higher diet quality and healthy patterns [42-45], whereas ethnicity (e.g., African American) and greater adiposity were linked to poorer dietary quality and patterns [46, 47].

Next the model was estimated and tested using data from two countries.

Study Population

Participants were students and staff from two different universities: Bournemouth University (UK) and Lebanese American University (Lebanon). In total, 493 women of childbearing age participated in both studies (n=244 in UK and n=249 in Lebanon). Participants were recruited as a convenience sample of childbearing aged women through classroom visits, flyers and posters, and social networking sites. To participate in the study, participants had to meet the following inclusion criteria: do not have chronic diseases (e.g., cancers, diabetes, cardiovascular diseases, HIV/AIDS, multiple sclerosis, pulmonary diseases, or mental disorders), do not suffer from food intolerance/allergy, are pregnant or breastfeeding, are not on medications that impact appetite, or had not previously had a bariatric surgery. Ethical approval was granted by the Institutional Review Board (or Ethics Committee) of Bournemouth University (protocol code 22344) on January 2020 and the Lebanese American University Institutional Review Board (IRB#: LAU.SAS.MB3.27/Nov/2020).

Variables

Demographic variables along with mental health indicators' scales, self-reported adiposity and physical activity questions, dietary intake assessment tool, and other socio-demographic questions were collected by the online survey questionnaire. Further details can be found elsewhere [38]; a brief description of the variables measured is given below.

Mental Health indicators

Stress was assessed by the Perceived Stress Scale (PSS) [48] which is previously validated in the UK [48] and Lebanon [49]. Becks Depression Inventory II (BDI-II) was used to assess depression levels of participants [50]. and similarly, it has been validated before in both countries [51, 52] . Anxiety levels were assessed in Lebanon using the Beck Anxiety Inventory (BAI) [53] which has been previously validated in the population [54, 55].

Dietary assessment

The European Prospective into Cancer and Nutrition food frequency questionnaire (EPIC FFQ) has been used to assess the dietary intake, quality, and patterns of participants. The EPIC FFQ has been previously validated in the UK [56] and Lebanon [38]. Dietary quality and patterns were derived through a-priori and a-posteriori approaches. The a-priori was based on assessing the adherence to Mediterranean Diet [57], and the a-posteriori was based on performing factor analysis to derive the latent dietary patterns of participants [38].

Physical activity, adiposity measures, and sociodemographic status

The physical activity level of participants was assessed via the International Physical Activity Questionnaire (IPAQ) which has been validated in UK and Lebanon [58,59]. Adiposity measures (weight and height) were self-reported and socio-demographic questions included age, marital status, income, ethnicity, and smoking status.

Statistical Analysis

Statistical analysis and structural equation modeling were done using IBM SPSS statistics version 28 (Chicago, IL, USA) and AMOS version 28 Graphics (SPSS Inc., Chicago, IL, USA). Data from the two countries were combined and cleaned. The normality of the whole dataset was assessed by computing normality plots and deriving descriptive measures of skewness/kurtosis, and proper transformations were applied to enhance fit normality. [60].

The dietary patterns of each sample separately were revealed in previous studies [38, 61]. For purposes of the comparison and combining the data from the two countries, new factor analysis and assessment of adherence to Mediterranean Diet had to be conducted for the whole sample of women of childbearing age from UK and Lebanon.

Adherence to Mediterranean Diet was used as a diet quality index to assess the diet quality of the whole samples from UK and Lebanon. Detailed methodology on assessing the adherence to Mediterranean diet can be found elsewhere [57]. Factor analysis was performed to derive the latent dietary patterns of the total sample, which were included in the structural equation model. Kaiser Meyer Olkin (KMO) and Bartlett's test of sphericity techniques indicated a large KMO of 0.828 (>0.5) and a very significant Bartlett's test of sphericity ($p<0.001$) denoting the appropriateness of conducting factor analysis. A scree plot was drawn to show the number of factors (dietary patterns) with eigenvalue greater than 1 to be retained.

In the third and fourth steps of the analysis, SEM was performed to the model through assessing the model-fit, estimating the path coefficients (hypothesis-testing), and estimating the Squared-multiple-correlations (R^2). To assess the most suitable fittingmodel for the study's data, the following fit-indices were computed: comparative fit index
(CFI) > 0.90, chi-square test ($\chi 2$)/ degrees of freedom (df) ratio < 5, standardized root mean square residual (SRMR) <0.08, Parsimony normed fit index (PNFI) > 0.5, root mean square error of approximation (RMSEA) ≤ 0.08, Parsimony comparative fit index (PCFI) > 0.5, goodness of fit index (GFI) > 0.9, adjusted goodness of fit index (AGFI) > 0.8 [62-65]. Model re-specification was done to enhance the goodness of fit in the fifth step of the analysis and bootstrapping was applied to test the significance of indirect effects [66].

Results:

A descriptive comparison between the two samples (UK and Lebanon) is shown in table 1.

Table 15: (Chapter 6, Table 1) - Comparison of physical, mental, and socioeconomical characteristics of participants across the two countries (UK and Lebanon)

Variables	**Country**	
	UK	***Lebanon***
Age (years)	24.0 (21.0–32.0)	19 (18-21)
Stress score	29 (22.0–33.0)	31.6 (7.1)
BMI (kg/m^2)	23.7 (20.9–27.9)	22.5 (20.1-25.6)
Physical Activity (METs-hr/wk)	1429 (464.3–2824.5)	990 (346.5-2170.5)

Income per year		
Below average Average	119 (49)	160 (64.3)
Above average	99 (40)	52 (20.9)
	26 (11)	37 (14.9)
Marital status		
Married	201 (82)	6 (2.4)
Unmarried	43 (18)	243 (97.6)
Smoking		
Smoker	56 (23)	64 (25.7)
Non-smoker	188 (77)	183 (73.5)
Ethnicity		
White	177 (73)	0 (0)
Black	15 (6)	0 (0)
Asian	33 (14)	0 (0)
Arab or other ethnic groups	17 (7)	249 (100)

METs-h/wk: Metabolic equivalents of tasks-hours per week, BMI: body mass index. Data represent median (interquartile range).

Diet analysis and general characteristics of participants from two countries combined

The adherence to Mediterranean diet of the total sample appeared to be moderate where 58% of participants had a medium adherence to MD, 29% had low adherence, and 13% had high adherence (Table 2). Descriptive data on categorical (ethnicity, marital status, smoking status, and income) and numerical data (stress scores, depression scores, physical activity, BMI, and age) are presented in table 2.

Table 16: (Chapter 6, Table 2) - Descriptive characteristics of the total sample of childbearing-aged women from UK and Lebanon (n= 493).

Variables		Low adherence (MD score: 0-3)	Medium adherence (MD score: 4-6)	High adherence (MD score: 7-9)	Total
Total *		143 (29.0)	288 (58.4)	62 (12.6)	493 (100.0)
N (%)					
Ethnicity *	Arab	36 (14.5)	167 (67.1)	46 (18.4)	249 (50.5)
	Asian	18 (54.5)	14 (42.5)	1 (3.0)	33 (6.7)
	Black	8 (53.3)	6 (40.0)	1 (6.7)	15 (3.0)
	White	81 (41.3)	101 (51.5)	14 (7.2)	196 (39.8)
Marital status *	Married	16 (32.7)	27 (55.1)	6 (12.2)	49 (9.9)
	Unmarried	127 (28.6)	261 (58.8)	56 (12.6)	444 (90.1)

Smoking *	Non-smokers	107 (28.4)	226 (59.9)	44 (11.7)	377 (76.5)
	Smokers	36 (31.0)	62 (53.4)	18 (15.6)	116 (23.5)
Income *	Average Income	65 (42.5)	75 (49.0)	13 (8.5)	153 (31.0)
	High Income	13 (20.6)	43 (68.3)	7 (11.1)	63 (12.8)
	Low Income	65 (23.5)	170 (61.4)	42 (15.1)	277 (56.2)
Median (interquartile range)					
Age ^		21 (19-27)	21 (18-25)	19 (18-24)	21 (19-25)
Stress score ^		31 (26.5-34)	30 (24-35)	31 (27-34)	30 (25.535)
Depression score ^		6 (2.5-13)	9 (4-18)	10 (5-17)	8 (3-16)
Physical activity (hours/week) ^	METs	1039.5 (280.5-2772)	1293 (470-1269.7 28.7) (20.9-2170.5)	1200 (396-2717.2)	
BMI ^		24.34 (20.9-28.7)	22.5 (20.326)	22.94 (20.4-25.7)	22.84 (20.4-26.7)

METs: Metabolic equivalents of tasks (hours per week). *Data for categorical variables are presented as N (%). ^Data for numerical variables are presented as Median (interquartile range).

Factor analysis and scree plot of the combined dataset (women of childbearing age from the two countries) revealed four factors (dietary patterns) (Table 3). The first dietary pattern (DP,1) had the highest factor loadings for alcohol, cereals, fats and oils, and sugar and snacks food groups. Dietary pattern 2 (DP,2) included vegetables, legumes and soups and sauces food groups whereas dietary pattern 3 (DP,3) included eggs, fish and seafood, meats, and potatoes food groups. The last dietary pattern (DP,4) had highest factor loadings for fruits, nuts and seeds, milk and dairy products, and beverages (non-alcoholic).

Table 17: (Chapter 6, Table 3) - Varimax-rotated factor loadings of the 15 food groups on the four factors (dietary patterns)

	Factors (dietary patterns)			
	1	**2**	**3**	**4**
Alcohol (grams per day)	.150			
Cereals (grams per day)	. 812			
Eggs (grams per day)			.469	
Fats and Oils (grams per day)	.840			

Fish and Sea food (grams per day)			.676	
Fruits (grams per day)				.621
Meats (grams per day)			.887	
Milk and dairy products (grams per day)				.349
Non-alcohol beverages (grams per day)				.309
Nuts and seeds (grams per day)				.424
Potatoes (grams per day)			.379	
Soups and sauces (grams per day)		.584		
Sugar and snacks (grams per day)	.627			
Vegetables (grams per day)		.615		
Legumes (grams per day)		.919		

Structural Equation Modeling

Table 4 presents the significant direct and indirect pathways of associations between sociodemographic characteristics, physical activity, BMI, stress, and dietary quality and patterns among childbearing aged women from UK and Lebanon. These are illustrated in figure 2. The path-analysis diagram shows standardized estimates of the total effects with red arrows indicating that the effect has a p value< 0.05 (significant effects).

Stress was directly and negatively associated with the adherence to MD (B= -0.115, p= 0.007), but not with the dietary patterns of the total sample (Table 4).

The country in which participants lived was directly associated with their stress level (B= 0.151, p= 0.007), MD score (B= 0.475, p<0.001), DP,2 (B= 0.225, p<0.001), DP,3 (B= 0.141, p= 0.013), and DP,4 (B= -.245, p<0.001). Being from Lebanon was associated with having higher stress levels, higher adherence to Mediterranean diet, and greater intake of food groups such as vegetables, legumes, and soups and sauces, lower intake of eggs, fish, meats, potatoes, fruits, nuts and seeds, dairy products, and non-alcoholic beverages.

Income was found to affect MD adherence directly and negatively (B= -0.084, p= 0.04), but positively with DP,2 (B= 0.133, p= 0.003). Higher income was associated with a higher intake of vegetables, legumes, and soups and sauces food groups but an overall lower adherence to Mediterranean diet.

Marital status was positively associated only with DP,3 directly (B= 0.114, p= 0.026), and age with MD score (B= 0.12, p= 0.031) and DP,4 (B= 0.183, p= 0.001). In other words, participants who were unmarried had a greater consumption of eggs, fish, meats, and potatoes, and those who were older tend to have higher adherence to Mediterranean diet and intake of fruits, nuts and seeds, dairy products, and nonalcoholic beverages.

Additionally, ethnicity was negatively associated with MD score (B= -0.103, p= 0.029) and DP,4 (B= -0.111, p= 0.022), but positively with DP,3 (B= 0.168, p= 0.029). Participants who were Arabs had a

lower intake of fruits, nuts and seeds, dairy products, and non-alcoholic beverages and lower adherence to MD and a higher intake of eggs, fish and seafood, meats, and potatoes.

BMI was found to be directly and positively associated with DP,3 and DP,4 (B= 0.172, p< 0.001 and B= 0.266, p<0.001, respectively), where participants with greater BMI tended to consume more eggs, fish, potatoes, fruits, meats, nuts and seeds, dairy products, and non-alcoholic beverages.

Among all exogenous variables, only country was found to be indirectly associated with dietary quality and patterns through the mediatory effect of stress (table 4). The country of participants was found to have an indirect effect of MD score (B= -0.017, p= 0.005), DP,1 (B= 0.01, p= 0.011), DP,3 (B= 0.01, p= 0.016), and DP,4 (B= -0.013, p= 0.031) via stress. The greater stress level associated with the country context in the present study played an important role in contributing to dietary quality and patterns. Stress has been found to negatively impact the adherence to Mediterranean diet (diet quality) in addition to dietary patterns that consist of fruits, nuts and seeds, dairy products, and nonalcoholic beverages. Moreover, stress has contributed to a higher consumption of dietary patterns that included fats and oils, sugar and snacks, cereals, and alcohol in addition to eggs, fish, meats, potatoes when participants were from Lebanon compared to UK.

No association was found between any of the other sociodemographic characteristics and dietary quality and patterns of participants, neither between physical activity nor BMI.

The model fit indices showed good fit of the model where CMIN/DF = 3.215, Standardized RMR = 0.0594, RMSEA = 0.067, CFI = 0.896, PNFI = 0.608, PCFI = 0.645, AGFI = 0.911, and GFI = 0.942.

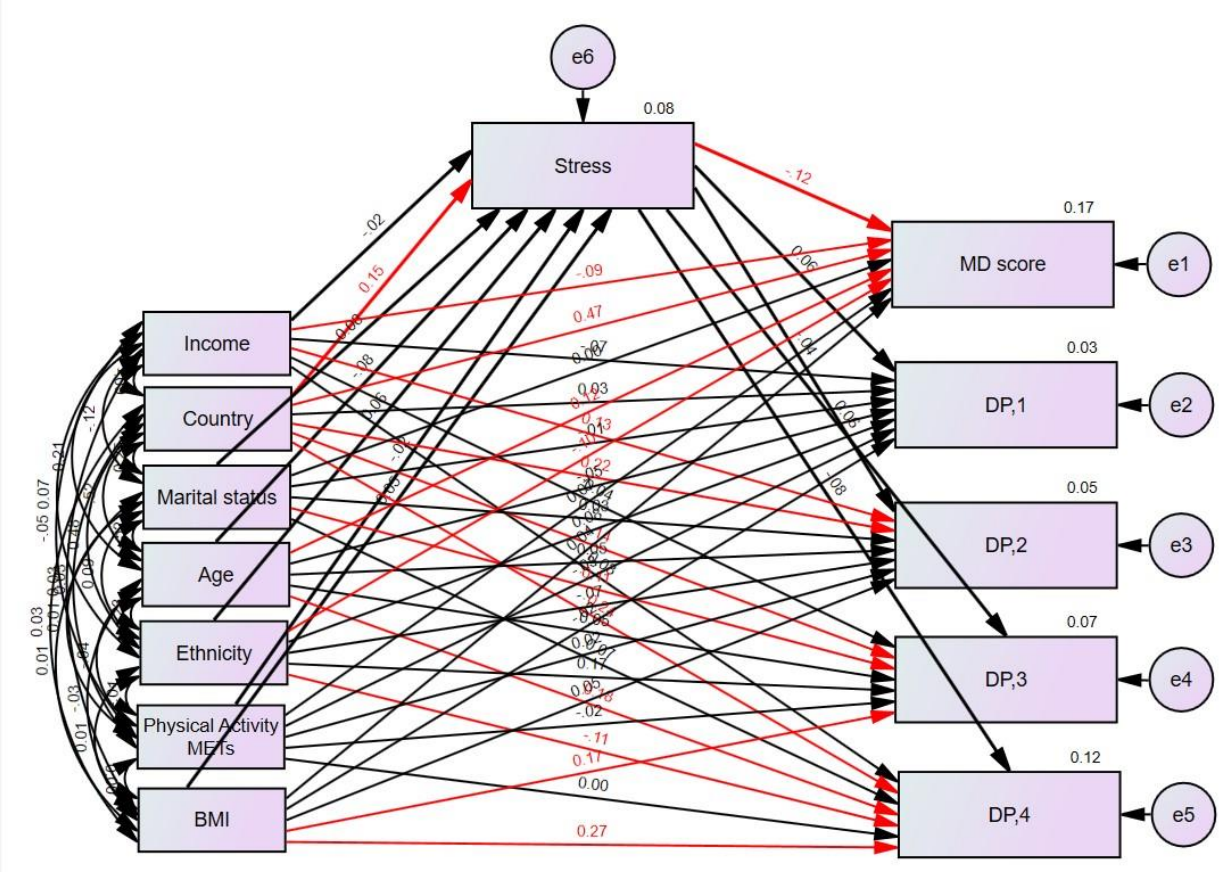


Figure 12: (Chapter 6, fig 2) - Path analysis diagram with standardized estimates demonstrated the total effects (sum of direct and indirect effects) of sociodemographic characteristics, physical activity, and BMI on dietary quality and patterns. Abbreviations: Mets, Metabolic equivalents of tasks (hours per week); BMI, Body Mass Index; MD, Mediterranean Diet; DP, Dietary Pattern. Red arrows are ones with p-value < 0.05

Table 18: (Chapter 6, Table 4) - Statistically significant pathways (direct and indirect) of the association between sociodemographic characteristics and physical activity and BMI and dietary quality and patterns among childbearing-aged women using Structural Equation Modeling.

Model Path	Standardised estimate	SE	P
Direct Effects			
Direct Impact on MD score			
Stress → MD score	-0.115	0.01	0.007
Income → MD score	-0.084	0.108	0.04
Country → MD score	0.475	0.193	<0.001
Age → MD score	0.120	0.14	0.031
Ethnicity → MD score	-0.103	0.133	0.029
Country → stress	0.151	0.859	0.007
Direct Impact on DP,2			
Income → DP,2	0.133	0.06	0.003
Country → DP,2	0.225	0.107	<0.001
Direct Impact on DP,3			
Country → DP,3	-0.141	0.108	0.013
Ethnicity → DP,3	0.168	0.075	0.029
Marital status → DP,3	0.114	0.163	0.026
BMI → DP,3	0.172	0.0	<0.001
Direct Impact on DP,4			
Country → DP,4	0.245	0.093	<0.001
Age → DP,4	0.183	0.007	0.001
Ethnicity → DP,4	-0.111	0.064	0.022
BMI → DP,4	0.266	0.0	<0.001
Indirect Effects via Stress			
Country → MD score	-0.017	0.010	0.005

Country → DP,1	0.01	0.006	0.011
Country → DP,3	0.01	0.006	0.016
Country → DP,4	-0.013	0.008	0.031
Residual covariance			
Ethnicity and Age	-1.026	0.204	<0.001
Ethnicity and Country	0.152	0.016	<0.001
Age and Country	-1.799	0.176	<0.001
Country and Marital	0.038	0.007	<0.001
Marital and Income	-0.025	0.01	0.01
Age and Marital	-1.083	0.105	<0.001
Age and Income	1.013	0.226	<0.001

Abbreviations: Mets, Metabolic equivalents of tasks (hours per week); BMI, Body Mass Index; MD, Mediterranean Diet; DP, Dietary Pattern.

Discussion

Contrary to popular thinking that suggests Lebanon has a healthy diet, country comparison indicates a high level of stress that impacts negatively on diet quality and patterns. Country comparison is important in nutrition epidemiology, especially when standard methodology is used across the different countries, as it relies on a sufficient number of participants which reduces effects of selection bias and provides a clearer insight of the problem [1]. This study advances our understanding of mechanisms through which dietary quality and patterns of women of childbearing age are affected by examining theoretical models of pathways linking sociodemographic characteristics, physical activity, and adiposity to dietary quality and patterns jointly mediated by stress.

In the total sample of childbearing-aged women from UK and Lebanon, we found that stress was negatively associated with the adherence to MD (table 4). This is in line with the findings of other studies, among women of childbearing age, which reported negative associations between stress levels and dietary quality indices (e.g., Alternate Healthy Eating Index 2010 [39], Dietary Quality Index-Pregnancy [40, 41]. On the contrary, few other studies have found no association between stress levels and dietary quality among women in childbearing age [67,68]. However, these studies had a small sample size, used different methodology (e.g., 24-hour recalls for dietary assessment), and were conducted in a single country. Our results have also found that sociodemographic characteristics of participants influenced dietary quality and patterns. Higher income was associated with a higher intake of dietary patterns including vegetables, legumes, and soups and sauces food groups; being unmarried with greater consumption of eggs, fish, meats, and potatoes, and age with higher adherence to Mediterranean diet and intake of fruits, nuts and seeds, dairy products, and non-alcoholic beverages, and ethnicity (being Arab compared to other ethnicity groups of our sample) with a lower intake of fruits, nuts and seeds, dairy products, and non-alcoholic beverages and adherence to MD and a higher intake of eggs, fish and seafood, meats, and potatoes. Previous studies have reported similar findings where higher age and income, have been linked to a higher diet quality and healthy patterns [42-45], whereas ethnicity (e.g., African American) and being unmarried were linked to poorer dietary quality and patterns [46, 47]. Further, the present study found that BMI was positively associated with greater consumption of eggs, fish, potatoes, fruits, meats, nuts and seeds, dairy products, and non-alcoholic

beverages (DP,3 and DP,4). Previous studies have reported that greater adiposity was linked to lower intake of fruits, vegetables, and legumes, and higher intake of high sugary foods, snacks, and high-fat foods [46, 47].

While many factors were found to have a direct effect on diet quality, only country was found to be indirectly associated with dietary quality and patterns through the mediatory effect of stress. Participants from Lebanon were found to have higher stress levels compared to participants from UK, and this contributed to a lower adherence to Mediterranean diet. It was also associated with lower consumption of dietary pattern comprising of eggs, fish, meats, potatoes, fruits, nuts and seeds, dairy products, and non-alcoholic beverages, but higher consumption of dietary pattern comprising of fats and oils, sugar and snacks, cereals, and alcohol. This has not been previously reported in the literature.

The high rate of stress can be explained by the fact that Lebanon, a middle-income country that hosts around two million refugees, has passed through various stressful events during the past decade. These include economic crisis/collapse, COVID-19 pandemic, and the port explosion in Beirut which is the world's biggest nonnuclear explosion of the 21st century [69]. A recent survey found that among 903 adults in Lebanon, 83% reported feeling sad and stressed at almost all times of the day and 11.5% reported having suicidal ideation [70]. Moreover, a recent study has found that Lebanese people had a decreased intake of fruits, vegetables, and water and increased weight gain due to consumption of food high in fat and sugar following the aforementioned stressful events that took place in Lebanon [71]. Due to the economic crisis, Lebanon was not able to import medicines and medical equipment, and this has led to higher levels of stress among the population which remained untreated [72].

It is worth acknowledging that the present study has some limitations. This study included childbearing-aged women from university settings (in both UK and Lebanon) which makes it difficult to generalise the results to the whole population of childbearingaged women. Since the data, collected through surveys, were self-reported (e.g., dietary intake, weight, height, and all other variables), potential biases from misreporting of these variables may have occurred.

Regardless of the few limitations mentioned, this paper represents the first study to examine the association between stress, dietary quality and patterns, sociodemographic characteristics, along with adiposity and physical activity among women of childbearing age using structural equation modeling. To the best of our knowledge, the mediation role of stress in the relation between sociodemographic characteristics, adiposity, and physical activity with dietary quality and patterns, specifically among childbearing aged women, has not been tested before. Moreover, including data from two different countries/continents has filled the gap in the literature, where many papers have previously recommended that new studies include a diverse population when assessing the association between diet and other predictors (e.g., stress, sociodemographic parameters) [18]. Confidence in the study results is acquired by the relatively big sample size, applying a powerful statistical technique, and using a consistent methodology across the two countries (UK and Lebanon) which avoided bias. By simultaneously modeling mediating pathways, the present study's analyses were able to derive the total, direct, and indirect effects of the different predictors of dietary quality and patterns, advancing prior literature that has examined the association between diet and specific variables/predictors in isolation. The sample size of present study was relatively big (n=493), and this was highly desirable since Structural Equation Modeling technique is highly dependent on the sample size [63, 25]. Additionally, the studies in UK and Lebanon have used validated and standardized tools to obtain the data (such as dietary intake, stress levels, physical activity), which is also an important strength of the present study. Furthermore, the present study applied two approaches of dietary analyses: the a-priori (hypothesis-driven) and the a-posteriori (data-driven), which describe more precisely the overall dietary quality and patterns of women of childbearing age in both UK and

Lebanon, whereas most previous studies in the literature have measured the intakes of individual nutrients (e.g., selenium) or foods/food groups (e.g., fat, sugar, fruits).

In conclusion, the present study used structural equation modeling for country comparison of the association between stress and diet among women of childbearing age, and the findings suggest that the difference in dietary quality and patterns against the country context can be explained by stress. Moreover, this study shows that the adherence to Mediterranean diet is dependent on stress levels, income, country context, ethnicity, and age. Randomised control trial and longitudinal cohort studies are needed to confirm the findings of this study.

Financial Support: This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflict of Interest: None.

Authorship: [Conceptualisation and study design, K.K., F.T., and V.H.; methodology, K.K., F.T., V.H.; data collection, K.K.; formal data analysis, K.K.; data interpretation, K.K., F.T., and V.H.; writing—original first draft preparation, K.K.; writing—review and editing, K.K., F.T., and V.H.; supervision, F.T. and V.H. All authors have read and agreed to the published version of the manuscript.]

Ethical Standards Disclosure: None

References:

1. Imamura F, Micha R, Khatibzadeh S, Fahimi S, Shi P, Powles J et al. Dietary quality among men and women in 187 countries in 1990 and 2010: a systematic assessment. The Lancet Global Health. 2015;3(3):e132-e142.
2. Blumfield M, Hure A, Macdonald-Wicks L, Smith R, Collins C. Systematic review and meta-analysis of energy and macronutrient intakes during pregnancy in developed countries. Nutrition Reviews. 2012;70(6):322-336.
3. Jomaa L, Hwalla N, Itani L, Chamieh M, Mehio-Sibai A, Naja F. A Lebanese dietary pattern promotes better diet quality among older adults: findings from a national crosssectional study. BMC Geriatrics. 2016;16(1).
4. Martin J, Moran L, Teede H, Ranasinha S, Lombard C, Harrison C. Exploring Diet Quality between Urban and Rural Dwelling Women of Reproductive Age. Nutrients. 2017;9(6):586.
5. Thangaratinam S, Rogozinska E, Jolly K, Glinkowski S, Roseboom T, Tomlinson J et al. Effects of interventions in pregnancy on maternal weight and obstetric outcomes: meta-analysis of randomised evidence. BMJ. 2012;344(may16 4):e2088-e2088.
6. CMACE. Maternal obesity in the UK: findings from a national project: maternal, Confidential Enquiry; 2010.

7. Poston L, Caleyachetty R, Cnattingius S, Corvalán C, Uauy R, Herring S et al. Preconceptional and maternal obesity: epidemiology and health consequences. The Lancet Diabetes & Endocrinology. 2016;4(12):1025-1036.

8. Reynolds R, Allan K, Raja E, Bhattacharya S, McNeill G, Hannaford P et al. Maternal obesity during pregnancy and premature mortality from cardiovascular event in adult offspring: follow-up of 1 323 275 person years. BMJ. 2013;347(aug13 1):f4539-f4539.

9. Kanguru L, McCaw-Binns A, Bell J, Yonger-Coleman N, Wilks R, Hussein J. The burden of obesity in women of reproductive age and in pregnancy in a middle-income setting: A population based study from Jamaica. PLOS ONE. 2017;12(12):e0188677.

10. Organization WH. Rural poverty and health systems in the WHO European region. WHO Regional Office for Europe: Copenhagen; 2010.

11. Bayram N, Bilgel N. The prevalence and socio-demographic correlations of depression, anxiety and stress among a group of university students. Social Psychiatry and Psychiatric Epidemiology. 2008;43(8):667-672.

12. Wichianson J, Bughi S, Unger J, Spruijt-Metz D, Nguyen-Rodriguez S. Perceived stress, coping and night-eating in college students. Stress and Health. 2009;25(3):235240.

13. Habhab S, Sheldon J, Loeb R. The relationship between stress, dietary restraint, and food preferences in women. Appetite. 2009;52(2):437-444.

14. O'Connor D, Jones F, Conner M, McMillan B, Ferguson E. Effects of daily hassles and eating style on eating behavior. Health Psychology. 2008;27(1, Suppl):S20-S31.

15. El Ansari W, Adetunji H, Oskrochi R. Food and Mental Health: Relationship between Food and Perceived Stress and Depressive Symptoms among University Students in the United Kingdom. Central European Journal of Public Health. 2014;22(2):90-97.

16. Papier K, Ahmed F, Lee P, Wiseman J. Stress and dietary behaviour among firstyear university students in Australia: Sex differences. Nutrition. 2015;31(2):324-330.

17. Hinote B, Cockerham W, Abbott P. Psychological distress and dietary patterns in eight post-Soviet republics. Appetite. 2009;53(1):24-33.

18. Mikolajczyk R, El Ansari W, Maxwell A. Food consumption frequency and perceived stress and depressive symptoms among students in three European countries. Nutrition Journal. 2009;8(1).

19. Roohafza H, Sarrafzadegan N, Sadeghi M, Rafieian-Kopaei M, Sajjadi F, Khosravi-Boroujeni H. The association between stress levels and food consumption among Iranian population. Arch Iran Med. 2013;16(3):145–8

20. Tseng M, Fang C. Stress Is Associated with Unfavorable Patterns of Dietary Intake Among Female Chinese Immigrants. Annals of Behavioral Medicine. 2011;41(3):324332.

21. Barrington W, Ceballos R, Bishop S, McGregor B, Beresford S. Perceived Stress, Behavior, and Body Mass Index Among Adults Participating in a Worksite Obesity Prevention Program, Seattle, 2005–2007. Preventing Chronic Disease. 2012;9.

22. Khaled K, Tsofliou F, Hundley V, Helmreich R, Almilaji O. Perceived stress and diet quality in women of reproductive age: a systematic review and meta-analysis. Nutrition Journal. 2020;19(1).

23. Liu C, Xie B, Chou C, Koprowski C, Zhou D, Palmer P et al. Perceived stress, depression and food consumption frequency in the college students of China seven cities. Physiology & Behavior. 2007;92(4):748-754.

24. Beran T, Violato C. Structural equation modeling in medical research: a primer. BMC Research Notes. 2010;3(1).

25. Kline R. Principles and Practice of Structural Equation Modeling, Third Edition. New York: Guilford Publications; 2011.

26. Gao S, Beresford S, Frank L, Schreiner P, Burke G, Fitzpatrick A. Modifications to the Healthy Eating Index and its ability to predict obesity: the Multi-Ethnic Study of Atherosclerosis. The American Journal of Clinical Nutrition. 2008;88(1):64-69.

27. Sadeghi M, Talaei M, Parvaresh Rizi E, Dianatkhah M, Oveisgharan S, Sarrafzadegan N. Determinants of incident prediabetes and type 2 diabetes in a 7-year cohort in a developing country: The Isfahan Cohort Study. Journal of Diabetes. 2014;7(5):633-641.

28. Hadaegh F, Derakhshan A, Zafari N, Khalili D, Mirbolouk M, Saadat N et al. Prediabetes tsunami: incidence rates and risk factors of pre-diabetes and its different phenotypes over 9 years of follow-up. Diabetic Medicine. 2015;34(1):69-78.

29. Gunn J, Ayton D, Densley K, Pallant J, Chondros P, Herrman H et al. The association between chronic illness, multimorbidity and depressive symptoms in an Australian primary care cohort. Social Psychiatry and Psychiatric Epidemiology. 2010;47(2):175-184.

30. Wardle J, Chida Y, Gibson E, Whitaker K, Steptoe A. Stress and Adiposity: A MetaAnalysis of Longitudinal Studies. Obesity. 2011;19(4):771-778.

31. Robinson A, Benzies K, Cairns S, Fung T, Tough S. Who is distressed? A comparison of psychosocial stress in pregnancy across seven ethnicities. BMC Pregnancy and Childbirth. 2016;16(1).

32. Garima M, Kiran U. Impact of Marital Status on Mental Health of Working Women. Medicine. 2014;.

33. Algren M, Ekholm O, Nielsen L, Ersbøll A, Bak C, Andersen P. Associations between perceived stress, socioeconomic status, and health-risk behaviour in deprived neighbourhoods in Denmark: a cross-sectional study. BMC Public Health. 2018;18(1).

34. Aldwin C. Culture, Coping and Resilience to Stress. Centre for Bhutan Studies; 2004.

35. Koo K, Kim C. The effect of the type of physical activity on the perceived stress level in people with activity limitations. Journal of Exercise Rehabilitation. 2018;14(3):361366.

36. van der Valk E, Savas M, van Rossum E. Stress and Obesity: Are There More Susceptible Individuals?. Current Obesity Reports. 2018;7(2):193-203.

37. Tomiyama A. Stress and Obesity. Annual Review of Psychology. 2019;70(1):703718.

38. Khaled K, Hundley V, Tsofliou F. Poor Dietary Quality and Patterns Are Associated with Higher Perceived Stress among Women of Reproductive Age in the UK. Nutrients. 2021;13(8):2588.

39. Isasi C, Parrinello C, Jung M, Carnethon M, Birnbaum-Weitzman O, Espinoza R et al. Psychosocial stress is associated with obesity and diet quality in Hispanic/Latino adults. Annals of Epidemiology. 2015;25(2):84-89.

40. Fowles E, Bryant M, Kim S, Walker L, Ruiz R, Timmerman G et al. Predictors of Dietary Quality in Low-Income Pregnant Women. Nursing Research. 2011;60(5):286294.

41. Fowles E, Stang J, Bryant M, Kim S. Stress, Depression, Social Support, and Eating Habits Reduce Diet Quality in the First Trimester in Low-Income Women: A Pilot Study. Journal of the Academy of Nutrition and Dietetics. 2012;112(10):1619-1625.

42. Khaled K, Hundley V, Almilaji O, Koeppen M, Tsofliou F. A Priori and a Posteriori Dietary Patterns in Women of Childbearing Age in the UK. Nutrients. 2020;12(10):2921.

43. Si Hassen W, Castetbon K, Cardon P, Enaux C, Nicolaou M, Lien N et al. Socioeconomic Indicators Are Independently Associated with Nutrient Intake in French Adults: A DEDIPAC Study. Nutrients. 2016;8(3):158.

44. Lee S. Effects of marital transitions on changes in dietary and other health behaviours in US women. International Journal of Epidemiology. 2004;34(1):69-78.

45. Elder S, Roberts S. The Effects of Exercise on Food Intake and Body Fatness: A Summary of Published Studies. Nutrition Reviews. 2008;65(1):1-19.

46. Hill A, Nunnery D, Ammerman A, Dharod J. Racial/Ethnic Differences in Diet Quality and Eating Habits Among WIC Pregnant Women: Implications for Policy and Practice.
American Journal of Health Promotion. 2019;34(2):169-176.

47. Robinson E, Boyland E, Chisholm A, Harrold J, Maloney N, Marty L et al. Obesity, eating behavior and physical activity during COVID-19 lockdown: A study of UK adults. Appetite. 2021;156:104853.

48. Cohen S, Kamarck T, Mermelstein R. A Global Measure of Perceived Stress. Journal of Health and Social Behavior. 1983;24(4):385.

49. Almadi T, Cathers I, Hamdan Mansour A, Chow C. An Arabic version of the Perceived Stress Scale: Translation and validation study. International Journal of Nursing Studies. 2012;49(1):84-89.

50. Beck A, Steer R, Brown G. Manual for the Beck Depression Inventory-II. 2nd ed. San Antonio, TX, USA: Psychological Corporation; 1996.

51. Wang Y, Gorenstein C. Psychometric properties of the Beck Depression InventoryII: a comprehensive review. Revista Brasileira de Psiquiatria. 2013;35(4):416-431.

52. Alansari B. INTERNAL CONSISTENCY OF AN ARABIC ADAPTATION OF THE BECK DEPRESSION INVENTORY-II WITH COLLEGE STUDENTS IN EIGHTEEN ARAB COUNTRIES. Social Behavior and Personality: an international journal. 2006;34(4):425-430.

53. Beck A, Epstein N, Brown G, Steer R. An inventory for measuring clinical anxiety: Psychometric properties. Journal of Consulting and Clinical Psychology. 1988;56(6):893-897.

54. Al-Issa I, Bakal D, Fung T. Beck Anxiety Inventory symptom comparisons between students in Lebanon and Canada. Arab J Psychiatry. 1999;10:24–30.

55. Al-Issa, Al-Zubaidi A, Bakal D, Fung T. Beck Anxiety Inventory symptoms in Arab college students. Arab J Psychiatry. 2000;11:41–47.

56. Verkasalo P, Appleby P, Allen N, Davey G, Adlercreutz H, Key T. Soya intake and plasma concentrations of daidzein and genistein: validity of dietary assessment among eighty British women (Oxford arm of the European Prospective Investigation into Cancer and Nutrition). British Journal of Nutrition. 2001;86(3):415-421.

57. Trichopoulou A, Costacou T, Bamia C, Trichopoulos D. Adherence to a Mediterranean Diet and Survival in a Greek Population. New England Journal of Medicine. 2003;348(26):2599-2608.

58. CRAIG C, MARSHALL A, SJ??STR??M M, BAUMAN A, BOOTH M, AINSWORTH B et al. International Physical Activity Questionnaire: 12-Country Reliability and Validity. Medicine & Science in Sports & Exercise. 2003;35(8):1381-1395.

59. Helou K, El Helou N, Mahfouz M, Mahfouz Y, Salameh P, Harmouche-Karaki M. Validity and reliability of an adapted arabic version of the long international physical activity questionnaire. BMC Public Health. 2017;18(1).

60. Rani Das K. A Brief Review of Tests for Normality. American Journal of Theoretical and Applied Statistics. 2016;5(1):5.

61. Khaled K, Hundley V, Tsofliou F. The Association between Psychological Stress and Dietary Quality and Patterns in 1 Women of Childbearing Age from a University Population in Lebanon. British Journal of Nutrition. 2022; (In Press).

62. Hu L, Bentler P. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling: A Multidisciplinary Journal. 1999;6(1):1-55.

63. Schumacker R, Lomax R. A Beginner's Guide to Structural Equation Modeling. 4th ed. Routledge; 2016.

64. Browne M, Cudeck R. Alternative Ways of Assessing Model Fit. Sociological Methods & Research. 1992;21(2):230-258.

65. Meyers L, Gamst G, Guarino A. Applied multivariate research. Thousand Oaks [etc.]: Sage Publ.; 2017.

66. Taverner D, Paredes S, Ferré R, Masana L, Castro A, Vallvé J. Assessment of arterial stiffness variables in patients with rheumatoid arthritis: A mediation analysis. Scientific Reports. 2019;9(1).

67. Ferranti EP, Dunbar SB, Higgins M, Dai J, Ziegler TR, Frediani JK, et al. Psychosocial factors associated with diet quality in a working adult population. Res Nurs Health. 2013;36(3):242–56.

68. El Ansari W, Berg-Beckhoff G. Nutritional Correlates of Perceived Stress among University Students in Egypt. International Journal of Environmental Research and Public Health. 2015;12(11):14164-14176.

69. Farran N. Mental health in Lebanon: Tomorrow's silent epidemic. Mental Health & Prevention. 2021;24:200218.

70. No closure for Beirut blast trauma survivors without justice- Embrace [Internet]. Embracelebanon.org. 2022 [cited 6 May 2022]. Available from: https://embracelebanon.org/News/Details/5

71. Cheikh Ismail L, Hashim M, Mohamad M, Hassan H, Ajab A, Stojanovska L et al. Dietary Habits and Lifestyle During Coronavirus Pandemic Lockdown: Experience From Lebanon. Frontiers in Nutrition. 2021;8.

72. Islam Z, Gangat S, Mohanan P, Rahmat Z, Chbib D, Marfani W et al. Mental health impacts of Lebanon's economic crisis on healthcare workers amidst COVID-19. The International Journal of Health Planning and Management. 2021;37(2):1160-1165.

This chapter has reported the structural equation modeling used to explore the impact of context (country) on factors influencing diet. This is a new methodological approach in the nutrition field. In the final chapter, the findings of the doctoral work will be reviewed in light of their contribution to knowledge and implications for practice.

Chapter 7 Discussion

This chapter will review the main findings of the thesis and the contribution that the doctoral work makes to the existing body of knowledge. The implications of this new knowledge will be considered for the nutrition profession. Moreover, the strengths and limitations of the thesis are discussed. Finally, recommendations and directions for future research will be outlined.

7.1 Achievement of doctoral aims and objectives

The thesis set out to explore the association between stress and dietary quality and patterns among women of reproductive age from two countries within a university setting. The first study that took place in the UK was successfully completed (objective o1), and it showed that stress was negatively associated with healthy diet quality and patterns. The study in Lebanon was conducted after validating the European Prospective Investigation into Cancer food frequency questionnaire (EPIC FFQ) for use among Lebanese adults. The project's aim to validate the EPIC FFQ was achieved, and the main stress/diet study that took place in Lebanon, which was conducted afterwards, found no association between stress and diet quality and patterns among Lebanese women of reproductive age (objective o2). A country comparison final study, that was not simple to perform since Structural Equation Modeling (SEM) was used in the analysis, achieved the final objective (o3). SEM is a complicated, but novel, statistical technique that was applied to the whole dataset collected from the two countries (UK and Lebanon). This final study demonstrated interesting findings that answered the novel questions of this PhD and showed that country context had an indirect effect on diet quality and patterns of reproductive-aged women which was mediated by the high stress levels.

7.2 Contribution of the doctorate to the existing body of knowledge

This thesis has presented a series of studies each offering new knowledge in relation to women's diet and factors influencing it. This is timely given the UK government's recognition of the need for a greater focus on women's health in order to address inequalities (Women's Health Strategy, 2022).

The preconception stage of women's life cycle offers an important opportunity for women to change their overall health behaviour (Khaled 2021). This leads to women entering pregnancy in good health, which gives benefits for both the mother and the baby. Therefore, looking at the diet-stress relationship in this age group will provide evidence which can inform the development of a lifestyle intervention to improve diet quality. Moreover, conducting the study in different countries also increases the awareness of the governments about dietary health of women of reproductive age and about one of the predictors of diet quality and patterns: stress.

To prevent morbidity and mortality caused by diet-related diseases, it is essential to understand the modifiable dietary factors. In the recent literature, no studies on the association of diet quality and stress specifically focused on women of reproductive age. This was the first study to examine this association among women of reproductive age in the UK. The findings suggest that stress was negatively associated with dietary quality and patterns. Participants from the UK with low adherence to Mediterranean diet had a higher level of stress compared to groups of medium and high adherence to Mediterranean diet. Additionally, stress was positively associated with DP-1 (fats and oils, sugars, snacks, alcoholic-beverages, red/processed meat, and cereals) and negatively with DP-3 (fruits, vegetables, nuts and seeds). Overall, stress was associated with poorer diet quality/patterns among reproductive-aged women in the UK.

In Lebanon, the evidence on the association between stress and diet is scarce. This PhD project provided a new insight of the association between stress and diet among women of reproductive age in Lebanon. In Lebanon, the findings were different from those in the UK study. No association was found between stress and adherence to Mediterranean diet, neither between stress nor any of the dietary patterns that were revealed from factor analysis.

The final study in this thesis offers a new insight into how modifiable dietary factors interact and how these can be influenced by the country in which the participants live by conducting a country comparison study using the data from the two countries. Structural equation modeling revealed that country had an impact on the dietary quality and patterns indirectly via the meditating effect of stress. The higher stress level associated

with participants being from Lebanon played an important role in contributing to dietary quality and patterns. The findings showed that stress has negatively affected the adherence to diet quality (adherence to Mediterranean diet) and the diet patterns that consisted of fruits, nuts and seeds, dairy products, and non-alcoholic beverages. Additionally, stress has positively impacted the dietary patterns that included consumption of fats and oils, sugar and snacks, cereals, and alcohol in addition to eggs, fish, meats, potatoes when participants were from Lebanon compared to UK.

The project findings add new evidence to the literature. While most studies on stress and diet quality focused on data from a single country such as USA (Fulkerson et al. 2004), UK (El Ansari et al. 2014), and China (Liu et al. 2007), very few studies assessed this association across a diverse population. Moreover, it is usually hard to compare findings from studies conducted in single countries due to differences in methodologies and measures. There have been calls for research looking on diet and stress across a diverse population (Mikolajczyk et al. 2009). Therefore, the current study bridged these knowledge gaps and reported the outcomes from two different countries (UK and Lebanon).

The thesis also contributed new knowledge in relation to research methods. This is the first study to validate the European Prospective Investigation into Cancer (EPIC) food frequency questionnaire (FFQ), which is a gold-standard dietary assessment tool, in the Middle East and North Africa region for use among adults in Lebanon. There has been calls in previous studies about the need of developing/validating new dietary assessment tools in Lebanon since there is lack of rigour dietary food frequency questionnaires (Khaled et al. 2021).

Although SEM has been used in nutrition (Hartwell et al. 2019, Huang et al. 2021, Khodarahmi et al. 2019, Moyo et al. 2021), it is not widely used. This study has demonstrated that country comparisons enable new insights. Contrary to popular perception about Lebanon being a Mediterranean country that follows a healthy diet, the use of SEM for country comparison revealed a high level of stress that impacted negatively on diet quality and patterns. Applying SEM is important in nutrition epidemiology, especially when conflicting results are found in the literature and

direct/indirect effects on diet need to be understood to provide a clear insight of the problem (Imamura et al. 2015). The final study indicated possible pathways through which dietary quality/patterns of women of reproductive age from the two countries were influenced through hypothetical models of pathways that linked sociodemographic characteristics, physical activity, and adiposity measures to dietary quality/patterns jointly mediated by stress.

7.3 Strengths and Limitations of the research

The biggest strength of this thesis is that it has bridged the gap in literature regarding the association between stress and diet quality and patterns in women of reproductive age. The project recruited a reasonable number of participants from two different countries (in two different continents) which enabled the exploration of stress and diet relationship across diverse populations with different traditions, lifestyles, and socioeconomic properties. Further, this PhD project has assessed the dietary quality by assessing the adherence to Mediterranean diet among participants from each country separately and then the diet quality of the whole sample of women of reproductive age combined. Similarly, the dietary patterns of participants were derived through performing factor analysis as the data driven a-posteriori approach of dietary analysis for each sample and for the whole sample from both countries. This enabled a greater understanding the diet of these women since using one of these dietary analysis methods on its own has some limitations. Therefore, combining the two dietary analyses approaches has enriched this project and provided a more robust overview of the actual diet of reproductive-aged women from two countries. This was even more important when both approaches were used to investigate the association between stress and dietary quality and patterns among reproductive-aged women. A clearer insight was granted when the association was examined not only between stress and the adherence to Mediterranean diet, but also with the different dietary patterns that were revealed by factor analysis (for example the “vegetarian-like” dietary pattern that was revealed from factor analysis among the UK sample of women of reproductive age) of the different food groups that were calculated from the EPIC food frequency questionnaires. Additionally, this PhD project has assessed various variables (e.g., sociodemographic factors, physical activity, dietary intake) using standardised and validated tools and questionnaires. When it comes to the most interesting part of this project, structural equation modeling, which enabled the combination of the whole PhD

data, has the spotlight. Applying structural equation modeling have been a great strength of this PhD, as nutrition epidemiological studies that have used structural equation modeling are very limited in number. Most studies have used bivariate and regression analysis to evaluate the stress/diet relationship, but this is old school and is not enough to understand factors that have direct/indirect/mediating roles in affecting he dietary intake/patterns of women of reproductive age. Therefore, the last study of this PhD has provided a novel contribution to the literature in understanding the effect of sociodemographic characteristics, adiposity, and physical activity along with stress on dietary quality and patterns in reproductive-aged women from two different countries.

On the other hand, this PhD project has some limitations. For example, the studies were all cross-sectional in design which might hinder deriving accurate conclusions about the association between stress and diet. A randomised controlled trial design is needed to confirm the results. Further, the samples recruited throughout the different studies of thesis PhD were from a university population. However, it was not possible for this PhD project to avoid convenience sampling due to time and resources constraints. Although the tools and questionnaires that were used in the surveys were all standardised and validated, misreporting might have occurred as these responses were self-reported. Future studies should measure variables with the help of professionals (e.g., dieticians to assess body weight and height) using accurate scales and tools. Although the scales used in the studies of this thesis were considered gold standards (such as EPIC FFQ and perceived stress scale), they do not provide accurate demonstrations of what is intended to be measured. Additional resources would have enabled nutritional biomarkers to be used to assess dietary intake and salivary/blood cortisol levels to measure stress. This would have yielded more trust-worthy results. However, these measures usually need a great funding/resource and plenty of time to seek ethical approval, which was not feasible for a PhD project which has limited time and resources.

7.4 Implications for practice

My main objective in this PhD project was to address the scarce research evidence on the association between psychological perceived stress and diet in women of reproductive age. I have done so by specifically assessing stress levels in addition to dietary intake of women of childbearing age from UK and Lebanon, with measurement

of other confounding factors such as sociodemographic characteristics, physical activity, and BMI which have been previously found to affect the dietary quality and patterns in adults.

Therefore, the major practical contribution of this piece of research is that it provides much needed empirical data on the actual dietary quality and patterns of women of reproductive age for two countries, their stress levels, in addition to data on BMI and other characteristics. This information is crucial given that, to the best of my knowledge, no study has explored the stress and diet association in women of reproductive age across different countries from different continents (Europe and the Middle East). The stress/diet findings will allow health policymakers, nutritionists, dietitians, trainers, nutrition-consultants, mental health practitioner including psychologists, psychotherapists, counsellors, therapists, and others, to implement plans and strategic initiatives, tools and actions based on the stress/diet relationship. For example, organisations who develop policy documents will be informed that sometimes stress will affect diet quality negatively and will lead to higher consumption of fats, sugars, snacks, and decreased consumption of legumes, vegetables, fruits, and seafood. This will allow these organisations to redesign their nutrition-promoting policies and include stress-regulation as it plays a significant role in nutritional health, especially in women of reproductive age. Thus, my PhD project has responded to the call made by other studies regarding the limitations of research about stress and diet (Mikolajczyk et al. 2009).

Building on the contributions to the existing body of knowledge, this work has significant implications for helping others to successfully change their dietary quality/patterns. It provides a reminder for nutritionists, dietitians, and health practitioners of the importance of psychological factors, especially stress, when implementing diet plans and lifestyle changes for patients. This is highly relevant at a time when the obesity rates are high across the globe (Fruh et al. 2017) and there is an alarming need to promote a healthy lifestyle to lower these rates (Teixeira et al. 2017). This work provides information on the complex interaction of factors when thinking about enhancing the dietary quality and healthy eating patterns of women of reproductive age. This is undoubtedly something that needs attention, given the relatively poor dietary quality and unhealthy patterns observed among women and the increased adiposity which

continues through pregnancy and causes various harmful complications to the mother and the baby.

The need to improve the nutrition curriculum across the educational sectors has recently been recommended (Follong et al. 2021, Xu et al. 2021). The findings of this thesis provide a timely reminder, that whilst the nutrition curriculum (undergraduate and postgraduate) is covering a wide range of topics, there are gaps that need to be filled. These include the psychological aspect of nutrition, how it influences food intake, and how to use it in practice is quite crucial and should be delivered as a whole module for students to stay up to date with advances in the nutrition field. This thesis confirms the importance of stress and the role associated with diet that it plays.

If the findings of this thesis are applied to the professional guidelines, the implications to practice are extremely strong, given the importance of consuming healthy diet especially after the COVID-19 pandemic (Moscatelli et al. 2021). There is scarce information on stress and diet by the professional bodes in nutrition (e.g., association of nutrition, scientific advisory committee in nutrition). Including guidelines about stress and diet, especially in women of reproductive age, is something that needs to be developed for people to consider.

After the COVID-19 pandemic, the mental health became a key area (Clay et al. 2021, McKinlay et al. 2022, Voltmer et al. 2021). If stress levels remain high, there will be a massive decline in the diet quality among women of reproductive age. This is because, as this thesis indicates, reproductive-aged women's poor diet quality and unhealth patterns are linked with increased stress levels. Therefore, strategies to reduce the associated risks of poor diet will be needed, and so the psychological factors need more care. Future dietary interventions should consider combined efforts from both nutritionists/dietitians and psychologists to work together on diet and its behavioural/psychological aspect, given the importance of interdisciplinary research.

7.5 Implications for future research

This PhD project raises several opportunities for future research, in terms of study development and modelling analysis. Further research will definitely be crucial to refine and elaborate the novel findings of this project.

This PhD project has identified a number of novel and useful dietary patterns of women of reproductive age in UK and Lebanon. Additionally, it clarified the nature of the association between stress and diet and the role of country, sociodemographic characteristics, physical activity, and adiposity within this association using Structural equation modeling.

Moreover, the model discussed in the last paper of this PhD can be used to create a number of research questions/hypotheses for future research. Some research questions/hypotheses include the following:

- Is there a significant association between the country context and stress levels among women of reproductive age? And if yes, which type of stress (acute vs chronic)?
- Is there a significant correlation between the country context and the overall diet of women of reproductive age?
- Which factors of country context play a role in the associations above? (e.g., cultural, social, environmental)
- How are all the variables in the three previous questions associated when accurate methods are used to assess stress (e.g., salivary/blood cortisol) and dietary intake (e.g., nutritional biomarkers)?

Future research should address the project's limitations in examining the association between stress and diet along all other variables across a wider sample through population research. Such research, which should assess association between stress and diet taking into consideration several other factors and predictors of dietary quality and patterns, could also examine the mechanisms by which stress affects diet among women and use these to allow interventions to be implemented to prevent the poor diet and its health consequences among women of reproductive age.

Conclusion

Diet has a significant role in addressing the challenges in women's health. It is a modifiable factor, but there has been limited attention paid to diet in relation to maternal health. In this PhD project, I have sought to respond to several research questions related to how dietary quality and patterns of women of reproductive age are affected by different factors. I have included various variables in the analysis to test their relationship with diet. This thesis makes an original contribution to the existing literature by advancing the knowledge of the association between stress and diet among an important population group: women of reproductive age. Furthermore, this doctoral work provides evidence to support the implementation of an evidence-based stress/diet intervention to be used with reproductive-aged women, supporting their health and experiences before, during, and after pregnancy.

References:

Adam, T. and Epel, E., 2007. Stress, eating and the reward system. *Physiology & Behavior*, 91 (4), 449-458.

Barfield, W. and Warner, L., 2011. Preventing Chronic Disease in Women of Reproductive Age: Opportunities for Health Promotion and Preventive Services. *Preventing Chronic Disease*, 9.

Barrington, W., Beresford, S., McGregor, B. and White, E., 2014. Perceived Stress and Eating Behaviors by Sex, Obesity Status, and Stress Vulnerability: Findings from the Vitamins and Lifestyle (VITAL) Study. *Journal of the Academy of Nutrition and Dietetics*, 114 (11), 1791-1799

Bartley, K., Underwood, B. and Deckelbaum, R., 2005. A life cycle micronutrient perspective for women"s health. *Am J Clin Nutr*, 81, 1188S–1193S.

Bayram, N. and Bilgel, N., 2008. The prevalence and socio-demographic correlations of depression, anxiety and stress among a group of university students. *Social Psychiatry and Psychiatric Epidemiology*, 43 (8), 667-672.

Block, J., He, Y., Zaslavsky, A., Ding, L. and Ayanian, J., 2009. Psychosocial Stress and Change in Weight Among US Adults. *American Journal of Epidemiology*, 170 (2), 181-192.

Cohen, S., Janicki-Deverts, D. and Miller, G., 2007. Psychological stress and disease. *JAMA*, 298 (14), 1685-7.

De Vriendt, T., Clays, E., Huybrechts, I., De Bourdeaudhuij, I., Moreno, L., Patterson, E., Molnár, D., Mesana, M., Beghin, L., Widhalm, K., Manios, Y. and De Henauw, S., 2011. European adolescents' level of perceived stress is inversely related to their diet quality: the Healthy Lifestyle in Europe by Nutrition in Adolescence study. *British Journal of Nutrition*, 108 (02), 371-380.

Drewnowski, A. and Speter, S., 2004. Poverty and obesity: the role of energy density and energy costs. *Am J Clin Nutr*, 79, 6-16.

Elder, S. and Roberts, S., 2008. The Effects of Exercise on Food Intake and Body Fatness: A Summary of Published Studies. *Nutrition Reviews*, 65 (1), 1-19.

El Ansari, W., Adetunji, H. and Oskrochi, R., 2014. Food and Mental Health: Relationship between Food and Perceived Stress and Depressive Symptoms among University Students in the United Kingdom. *Central European Journal of Public Health*, 22 (2), 90-97.

Epel, E., Lapidus, R., McEwen, B. and Brownell, K., 2001. Stress may add bite to appetite in women: a laboratory study of stress-induced cortisol and eating behavior. *Psychoneuroendocrinology*, 26 (1), 37-49.

Ferranti, E., Dunbar, S., Higgins, M., Dai, J., Ziegler, T., Frediani, J., Reilly, C. and Brigham, K., 2013. Psychosocial factors associated with diet quality in a working adult population. *Research in Nursing & Health*, 36 (3), 242-256.

Fink, G., 2010. *Stress: Definition and history. Stress Science: Neuroendocrinology.*. Amsterdam: Academic Press, pp.3-9.

Follong, B., Verdonschot, A., Prieto-Rodriguez, E., Miller, A., Collins, C. and Bucher, T., 2021. Nutrition across the curriculum: a scoping review exploring the integration of nutrition education within primary schools. Nutrition Research Reviews, 1-16.

Fowles, E., Stang, J., Bryant, M. and Kim, S., 2012. Stress, Depression, Social Support, and Eating Habits Reduce Diet Quality in the First Trimester in Low-Income Women: A Pilot Study. *Journal of the Academy of Nutrition and Dietetics*, 112 (10), 1619-1625.

Fruh, S., 2017. Obesity: Risk factors, complications, and strategies for sustainable long-term weight management. Journal of the American Association of Nurse Practitioners, 29 (S1), S3-S14.

Fulkerson, J., Sherwood, N., Perry, C., Neumark-Sztainer, D. and Story, M., 2004. Depressive symptoms and adolescent eating and health behaviors: a multifaceted view in a population-based sample. *Preventive Medicine*, 38 (6), 865-875

Garfin, D., Thompson, R. and Holman, E., 2018. Acute stress and subsequent health outcomes: A systematic review. Journal of Psychosomatic Research, 112, 107-113

Gardiner, P., Nelson, L., Shellhaas, C., Dunlop, A., Long, R., Andrist, S. and Jack, B., 2008. The clinical content of preconception care: nutrition and dietary supplements. *American Journal of Obstetrics and Gynecology*, 199 (6), S345-S356.

Habhab, S., Sheldon, J. and Loeb, R., 2009. The relationship between stress, dietary restraint, and food preferences in women. *Appetite*, 52 (2), 437-444.

Hartwell, M., Khojasteh, J., Wetherill, M., Croff, J. and Wheeler, D., 2019. Using Structural Equation Modeling to Examine the Influence of Social, Behavioral, and Nutritional Variables on Health Outcomes Based on NHANES Data: Addressing Complex Design, Nonnormally Distributed Variables, and Missing Information. *Current Developments in Nutrition*, 3 (5).

Harnisch, J., Harnisch, P. and Harnisch, D., 2012. Family Medicine Obstetrics: Pregnancy and Nutrition. *Primary Care: Clinics in Office Practice*, 39 (1), 39-54.

Hill, A., Nunnery, D., Ammerman, A. and Dharod, J., 2019. Racial/Ethnic Differences in Diet Quality and Eating Habits Among WIC Pregnant Women: Implications for Policy and Practice. *American Journal of Health Promotion*, 34 (2), 169-176.

Huang, Z., Huang, B. and Huang, J., 2021. The Relationship between Nutrition Knowledge and Nutrition Facts Table Use in China: A Structural Equation Model. *International Journal of Environmental Research and Public Health*, 18 (12), 6307.

Hu, F., 2002. Dietary pattern analysis: a new direction in nutritional epidemiology. *Current Opinion in Lipidology*, 13 (1), 3-9.

Imamura, F., Micha, R., Khatibzadeh, S., Fahimi, S., Shi, P., Powles, J. and Mozaffarian, D., 2015. Dietary quality among men and women in 187 countries in 1990 and 2010: a systematic assessment. *The Lancet Global Health*, 3 (3), e132-e142.

Jacobs, D. and Steffen, L., 2003. Nutrients, foods, and dietary patterns as exposures in research: a framework for food synergy. *Am J Clin Nutr*, 78, 513S.

Jacques, P. and Tucker, K., 2001. Are dietary patterns useful for understanding the role of diet in chronic disease?. *Am J Clin Nutr*, 73, 1–2.

Jastreboff, A., Sinha, R., Lacadie, C., Small, D., Sherwin, R. and Potenza, M., 2012. Neural Correlates of Stress- and Food Cue-Induced Food Craving in Obesity: Association with insulin levels. *Diabetes Care*, 36 (2), 394-402.

Kanguru, L., Bezawada, N., Hussein, J. and Bell, J., 2014. The burden of diabetes mellitus during pregnancy in low- and middle-income countries: a systematic review. *Global Health Action*, 7 (1), 23987.

Kant, A., 2004. Dietary patterns and health outcomes. *Journal of the American Dietetic Association*, 104 (4), 615-635.

Khaled, K., Hundley, V. and Tsofliou, F., 2021. Poor Dietary Quality and Patterns Are Associated with Higher Perceived Stress among Women of Reproductive Age in the UK. *Nutrients*, 13 (8), 2588.

Khaled, K., Hundley, V., Bassil, M., Bazzi, M. and Tsofliou, F., 2021. Validation of the European Prospective Investigation into Cancer (EPIC) FFQ for use among adults in Lebanon. *Public Health Nutrition*, 24 (13), 4007-4016.

Khodarahmi, M., Asghari-Jafarabadi, M. and Abbasalizad Farhangi, M., 2019. A structural equation modeling approach for the association of a healthy eating index with metabolic syndrome and cardio-metabolic risk factors among obese individuals. *PLOS ONE*, 14 (7), e0219193.

Koga, F., Kitagami, S., Izumi, A., Uemura, T., Takayama, O., Koga, T. and Mizoguchi, T., 2020. Relationship between nutrition and reproduction. Reproductive Medicine and Biology, 19 (3), 254-264.

Lee, S., 2004. Effects of marital transitions on changes in dietary and other health behaviours in US women. *International Journal of Epidemiology*, 34 (1), 69-78.

Lee, M. and Fried, S., 2014. The glucocorticoid receptor, not the mineralocorticoid receptor, plays the dominant role in adipogenesis and adipokine production in human adipocytes. *International Journal of Obesity*, 38 (9), 1228-1233.

Lewis, G., 2007. The Confidential Enquiry into Maternal and Child Health (CEMACH). Saving mothers' lives: reviewing maternal deaths to make

motherhood safer. The seventh report of the confidential enquiries into maternal deaths in the United Kingdom. *CEMACH*.

Liu, C., Xie, B., Chou, C., Koprowski, C., Zhou, D., Palmer, P., Sun, P., Guo, Q., Duan, L., Sun, X. and Anderson Johnson, C., 2007. Perceived stress, depression and food consumption frequency in the college students of China seven cities. *Physiology & Behavior*, 92 (4), 748-754.

Lowe, M. and Kral, T., 2006. Stress-induced eating in restrained eaters may not be caused by stress or restraint. *Appetite*, 46 (1), 16-21.

Lumley, J., Watson, L., Watson, M. and Bower, C., 2001. Periconceptional supplementation with folate and/or multivitamins for preventing neural tube defects. *Cochrane Database Syst. Rev*, 4 (CD001056, doi:10.1002/14651858.CD001056).

McCann, B., Warnick, G. and Knopp, R., 1990. Changes in plasma lipids and dietary intake accompanying shifts in perceived workload and stress. *Psychosomatic Medicine*, 52 (1), 97-108.

McKinlay, A., Fancourt, D. and Burton, A., 2022. Factors affecting the mental health of pregnant women using UK maternity services during the COVID-19 pandemic: a qualitative interview study. BMC Pregnancy and Childbirth, 22 (1).

Meule, A. and Vögele, C., 2013. The Psychology of Eating. Frontiers in Psychology, 4.

Mikolajczyk, R., El Ansari, W. and Maxwell, A., 2009. Food consumption frequency and perceived stress and depressive symptoms among students in three European countries. *Nutrition Journal*, 8 (1).

Mimura, C. and Griffiths, P., 2008. A Japanese version of the Perceived Stress Scale: cross-cultural translation and equivalence assessment. *BMC Psychiatry*, 8 (1).

Moscatelli, F., Sessa, F., Valenzano, A., Polito, R., Monda, V., Cibelli, G., Villano, I., Pisanelli, D., Perrella, M., Daniele, A., Monda, M., Messina, G. and Messina, A., 2021. COVID-19: Role of Nutrition and Supplementation. Nutrients, 13 (3), 976.

Moyo, G., Montenegro-Montenegro, E., Stickley, Z., Egal, A. and Oldewage-Theron, W., 2021. A Structural Equation Modelling Approach to Examine the Relationship between Socioeconomic Status, Diet Quality and Dyslipidaemia in South African Children and Adolescents, 6–18 Years. *International Journal of Environmental Research and Public Health*, 18 (23), 12825.

MURAYAMA, N., 2014. Health Disparities and Food System. *Journal of Food System Research*, 21 (2), 77-86.

Ng, D. and Jeffery, R., 2003. Relationships Between Perceived Stress and Health Behaviors in a Sample of Working Adults. *Health Psychology*, 22 (6), 638-642.

O'Connor, D., Jones, F., Conner, M., McMillan, B. and Ferguson, E., 2008. Effects of daily hassles and eating style on eating behavior. *Health Psychology*, 27 (1, Suppl), S20-S31.

Oliver, G., Wardle, J. and Gibson, E., 2000. Stress and Food Choice: A Laboratory Study. *Psychosomatic Medicine*, 62 (6), 853-865.

Panagiotakos, D., Pitsavos, C. and Stefanadis, C., 2009. α-Priori and α-Posterior Dietary Pattern Analyses Have Similar Estimating and Discriminating Ability in Predicting 5-Y Incidence of Cardiovascular Disease: Methodological Issues in Nutrition Assessment. *Journal of Food Science*, 74 (7), H218-H224.

Panth, N., Gavarkovs, A., Tamez, M. and Mattei, J., 2018. The Influence of Diet on Fertility and the Implications for Public Health Nutrition in the United States. *Frontiers in Public Health*, 6.

Pasquali, R., 2012. The hypothalamic-pituitary-adrenal axis and sex hormones in chronic stress and obesity: pathophysiological and clinical aspects. *Annals of the New York Academy of Sciences*, 1264 (1), 20-35.

Pendleton, V., Willems, E., Swank, P., Poston, W., Goodrick, G., Reeves, R. and Foreyt, J., 2001. Negative Stress and the Outcome of Treatment for Binge Eating. *Eating Disorders*, 9 (4), 351-360.

Quatromoni, P., 2002. The internal validity of a dietary pattern analysis. The Framingham Nutrition Studies. *Journal of Epidemiology & Community Health*, 56 (5), 381-388.

Richardson, A., Arsenault, J., Cates, S. and Muth, M., 2015. Perceived stress, unhealthy eating behaviors, and severe obesity in low-income women. *Nutrition Journal*, 14 (1).

Robinson, E., Boyland, E., Chisholm, A., Harrold, J., Maloney, N., Marty, L., Mead, B., Noonan, R. and Hardman, C., 2021. Obesity, eating behavior and physical activity during COVID-19 lockdown: A study of UK adults. *Appetite*, 156, 104853.

Rosmond, R., 2003. Stress induced disturbances of the HPA axis: a pathway to Type 2 diabetes?. *Med Sci Monit.*, 9 (2), RA35–9. 3321.

Rutters, F., Nieuwenhuizen, A., Lemmens, S., Born, J. and Westerterp-Plantenga, M., 2009. Acute Stress-related Changes in Eating in the Absence of Hunger. *Obesity*, 17 (1), 72-77.

Si Hassen, W., Castetbon, K., Cardon, P., Enaux, C., Nicolaou, M., Lien, N., Terragni, L., Holdsworth, M., Stronks, K., Hercberg, S. and Méjean, C., 2016. Socioeconomic Indicators Are Independently Associated with Nutrient Intake in French Adults: A DEDIPAC Study. *Nutrients*, 8 (3), 158.

Silvestris, E., Lovero, D. and Palmirotta, R., 2019. Nutrition and Female Fertility: An Interdependent Correlation. *Frontiers in Endocrinology*, 10.

Sims, R., Gordon, S., Garcia, W., Clark, E., Monye, D., Callender, C. and Campbell, A., 2008. Perceived stress and eating behaviors in a community-based sample of African Americans. *Eating Behaviors*, 9 (2), 137-142.

Sobal, J. and Stunkard, A., 1989. Socioeconomic status and obesity: A review of the literature. *Psychological Bulletin*, 105 (2), 260-275.

Tanentsapf, I., Heitmann, B. and Adegboye, A., 2011. Systematic review of clinical trials on dietary interventions to prevent excessive weight gain during pregnancy among normal weight, overweight and obese women. *BMC Pregnancy and Childbirth*, 11 (1).

Teegarden, S. and Bale, T., 2008. Effects of stress on dietary preference and intake are dependent on access and stress sensitivity. *Physiology & Behavior*, 93 (4-5), 713-723.

Temel, S., van Voorst, S., Jack, B., Denktaş, S. and Steegers, E., 2013. Evidence-Based Preconceptional Lifestyle Interventions. *Epidemiologic Reviews*, 36 (1), 19-30.

Teixeira, P. and Marques, M., 2017. Health Behavior Change for Obesity Management. Obesity Facts, 10 (6), 666-673.

Thangaratinam, S., Rogozińska, E., Jolly, K., Glinkowski, S., Roseboom, T., Tomlinson, J., Kunz, R., Mol, B., Coomarasamy, A. and Khan, K., 2012. Effects of Interventions in Pregnancy on Maternal Weight and Obstetric Outcomes. *Obstetrical & Gynecological Survey*, 67 (10), 603-604.

Torres, S. and Nowson, C., 2007. Relationship between stress, eating behavior, and obesity. *Nutrition*, 23 (11-12), 887-894.

Turrell, G. and Kavanagh, A., 2006. Socio-economic pathways to diet: modelling the association between socio-economic position and food purchasing behaviour. *Public Health Nutrition*, 9 (3), 375-383.

Vidal, E., Alvarez, D., Martinez-Velarde, D., Vidal-Damas, L., Yuncar-Rojas, K., Julca-Malca, A. and Bernabe-Ortiz, A., 2018. Perceived stress and high fat intake: A study in a sample of undergraduate students. *PLOS ONE*, 13 (3), e0192827.

Voltmer, E., Köslich-Strumann, S., Walther, A., Kasem, M., Obst, K. and Kötter, T., 2021. The impact of the COVID-19 pandemic on stress, mental health and coping behavior in German University students – a longitudinal study before and after the onset of the pandemic. BMC Public Health, 21 (1).

Wesołowska, E., Jankowska, A., Trafalska, E., Kałużny, P., Grzesiak, M., Dominowska, J., Hanke, W., Calamandrei, G. and Polańska, K., 2019. Sociodemographic, Lifestyle, Environmental and Pregnancy-Related Determinants of Dietary Patterns during Pregnancy. International Journal of Environmental Research and Public Health, 16 (5), 754.

Wichianson, J., Bughi, S., Unger, J., Spruijt-Metz, D. and Nguyen-Rodriguez, S., 2009. Perceived stress, coping and night-eating in college students. *Stress and Health*, 25 (3), 235-240.

Women's Health Strategy: Call for Evidence [online]. GOV.UK. Available from: https://www.gov.uk/government/consultations/womens-health-strategy-call-for-evidence/womens-health-strategy-call-for-evidence#fnref:1 [Accessed 10 May 2022].

Xu, Y., Sawadogo-Lewis, T., King, S., Mitchell, A. and Roberton, T., 2021. Integrating nutrition into the education sector in low- and middle-income countries: A framework for a win–win collaboration. Maternal & Child Nutrition, 17 (3).

Zellner, D., Loaiza, S., Gonzalez, Z., Pita, J., Morales, J., Pecora, D. and Wolf, A., 2006. Food selection changes under stress. *Physiology & Behavior*, 87 (4), 789-793.

Zellner, D., Saito, S. and Gonzalez, J., 2007. The effect of stress on men's food selection. *Appetite*, 49 (3), 696-699.

Appendices:

Appendix 1 – Online Ethics Checklist from Bournemouth University.

Bournemouth University

Research Ethics Checklist

About Your Checklist	
Ethics ID	22344
Date Created	25/09/2018 12:38:19
Status	Approved
Date Approved	03/12/2018 11:59:27
Date Submitted	29/11/2018 14:16:37
Risk	High

Researcher Details	
Name	Karim Khaled
Faculty	Faculty of Health & Social Sciences
Status	Postgraduate Research (MRes, MPhil, PhD, DProf, EngD, EdD)
Course	Postgraduate Research - HSS
Have you received funding to support this research project?	No
Please list any persons or institutions that you will be conducting joint research with, both internal to BU as well as external collaborators.	University of Texas (USA), Lebanese American University (Lebanon)

Project Details	
Title	Association between Diet Quality and Stress in Women of Reproductive Age from a University population in Three Countries: UK, USA, and Lebanon

Start Date of Project	14/02/2018
End Date of Project	14/02/2021
Proposed Start Date of Data Collection	07/01/2019
Original Supervisor	Fotini Tsofliou
Approver	Research Ethics Panel

Summary - no more than 600 words (including detail on background methodology, sample, outcomes, etc.)

Background: Diet quality of women of reproductive age is a major determinant of their weight status and health during pregnancy. Obesity during pregnancy exhibits deleterious consequences on the mother and the offspring. Stress has been linked with low diet quality but no study assessed this link in women of reproductive age and across a diverse population.

Aims: Investigate the association between stress and diet quality in women of reproductive age from three different countries: USA, UK, and Lebanon.

Design: A cross sectional study involving 966 women of reproductive age from UK, USA, and Lebanon.

Methods: An online questionnaire survey examining the correlation between stress and diet will be sent to participants. Diet quality and patterns will be estimated via the validated EPIC Food Frequency Questionnaire (Welch et al. 2005). The survey will measure psychological stress and depression through the 14-item Perceived Stress Scale (PSS) (Cohen et al. 1983) and the 21- item Beck Depression Inventory II (BDI-II) (Beck et al. 1996). Adiposity measures will include self-reported weight, Height, and Waist circumference. Physical Activity will be measured using the International Physical Activity Questionnaire (IPAQ) (Craig et al. 2003). Additionally, the survey will include socioeconomic questions.

Discussion: This study is the first to assess the relationship between stress and diet in women of reproductive age and from three different settings.

NOTE: This is the first phase of the PhD project. The second phase is still under planning and will take place **only in the UK** after the data analysis of phase 1. Phase 2 will need some participants from phase 1 who will develop the diet/stress association. Therefore, in the online survey, which will be sent to UK sample, there will be a section asking participants if they would like to participate in phase 2 later. If they are interested in phase 2, they will be asked to kindly provide their email address so that they can be contacted later before launching phase 2 where they will give consent to participate in addition to details about phase 2.

Filter Question: Does your study involve Human Participants?

Participants

Describe the number of participants and specify any inclusion/exclusion criteria to be used

Power calculation based on correlation sample size method yielded a sample size of 966 participants.Inclusion criteria•Females at birth.•18-49 years old.•Students and staff.Exclusion criteria•Not females at birth.•Under 18 or above 49 years old.•Suffering from a chronic disease.•Having food intolerance or allergy.•Pregnant/breastfeeding.•Are on any medication known to affects appetite or have undergone bariatric surgery.

Do your participants include minors (under 16)?	
Are your participants considered adults who are competent to give consent but considered vulnerable?	No
Is a Disclosure and Barring Service (DBS) check required for the research activity?	No

Recruitment	
Please provide details on intended recruitment methods, include copies of any advertisements.	
Flyers, which will describe the study and provide contact details for participants to contact if they wish to participate, will be put on university walls on both campuses. Additionally, I will advertise for the study using social media (Facebook, Twitter, Instagram, Whatsapp, Tumblr) through Bournemouth University groups, pages, and accounts. Participants will then be approached via emails. The emails will include the Participant Information Sheet (PIS) and a link to the online survey.	
Do you need a Gatekeeper to access your participants?	No

Data Collection Activity	
Will the research involve questionnaire/online survey? If yes, don't forget to attach a copy of the questionnaire/survey or sample of questions.	Yes
How do you intend to distribute the questionnaire?	
online,other	
If online, do you intend to use a survey company to host and collect responses?	No
If Other, please provide details.	

The online survey will be hosted through the Bristol online Survey (BOS) system.	
Will the research involve interviews? If Yes, don't forget to attach a copy of the interview questions or sample of questions	
Will the research involve a focus group? If yes, don't forget to attach a copy of the focus group questions or sample of questions.	No
Will the research involve the collection of audio materials?	No
Will your research involve the collection of photographic materials?	No
Will your research involve the collection of video materials/film?	No
Will the study involve discussions of sensitive topics (e.g. sexual activity, drug use, criminal activity)?	No
Will any drugs, placebos or other substances (e.g. food substances, vitamins) be administered to the participants?	No
Will the study involve invasive, intrusive or potential harmful procedures of any kind?	No
Could your research induce psychological stress or anxiety, cause harm or have negative consequences for the participants or researchers	Yes

	(beyond the risks encountered in normal life)?	
	Please provide details and measures taken to minimise risks	
	Participants who may encounter a psychological distress will be advised to contact the Bournemouth University student well-being or Samaritans. A direct link and contact details of the Bournemouth University student well-being and Samaritans will be provided to participants in the survey, and it will be made clear that if participants feel stressed, they could contact these two organisations.	
	Will your research involve prolonged or repetitive testing?	No

Consent

Describe the process that you will be using to obtain valid consent for participation in the research activities. If consent is not to be obtained explain why.

The landing page of the online survey will contain a consent form. Participants who do not wish to participate in the survey will be automatically directed to the last page of the survey that will thank them for their interest and time. Participants will be advised that their participation in the study is voluntary, and they can withdraw from the study at any time knowing that non-participation or withdrawal will not affect them in any way.

Do your participants include adults who lack/may lack capacity to give consent (at any point in the study)?	
Will it be necessary for participants to take part in your study without their knowledge and consent?	No

Participant Withdrawal

At what point and how will it be possible for participants to exercise their rights to withdraw from the study?

The Participant Information Sheet, which will be sent to participants by email with the link to the online survey, and the consent form, which is included in the landing page of the online survey, will inform participants that their participation in the study is voluntary, and they can withdraw from the study at any time knowing that non-participation or withdrawal will not affect them in any way, and they will still have their names included in the prize draw that will be done.

If a participant withdraws from the study, what will be done with their data?

Participants who wish to withdraw will not be affected in anyway. They will be excluded from the data collection and data analysis; however, they will still have their names included in the prize draw that will be done.

Participant Compensation

Will participants receive financial compensation (or course credits) for their participation?	No
Will financial or other inducements (other than reasonable expenses) be offered to participants?	Yes

Please provide details

The emails that will be sent to participants, which will include the link to the online survey and PIS, will mention that participants who complete the survey will have their names included in a prize draw of £100 Amazon voucher in each of the three countries to enhance recruitment.

Research Data

Will identifiable personal information be collected, i.e. at an individualised level in a form that identifies or could enable identification of the participant?	No
Will research outputs include any identifiable personal information i.e. data at an individualised level in a form which identifies or could enable identification of the individual?	
Have you considered and addressed the need for 'data minimisation'?	Yes

Please give brief details of how you will address the need for data minimisation or explain why you do not think this relates to the personal information you will be collecting.

Storage, Access and Disposal of Research Data	
Where will your research data be stored and who will have access during and after the study has finished.	
Once your project completes, will any anonymised research data be stored on BU's Online Research Data Repository "BORDaR"?	I don't know

Dissemination Plans	
Will you inform participants of the results?	

Final Review	
Are there any other ethical considerations relating to your project which have not been covered above?	

Risk Assessment	
Have you undertaken an appropriate Risk Assessment?	Yes

Filter Question: Will your research study take place outside the UK and/or specifically target a country outside the UK?

Additional Details	
List the European and/or Overseas country where the research will take place	
United States of AmericaLebanon	
Are you currently a resident of the country named above?	
Do you intend to remain in/visit the country named above to undertake the research?	

By participating in this research, are there any potential risks to participants?	
Does the country in which you are conducting research require that you obtain internal ethical approval (other than BU ethical approval)?	Yes
Please state the approving authority	
University of Texas (Institutional Review Board)Lebanese American University (Institutional Review Board)	

Filter Question: Does your study require review and approval through another external Ethics Committee (not HRA/NHS Approvals)?

Additional Details	
Please identify the approving authority	University of Texas (Institutional Review Board)Lebanese American University (Institutional Review Board)
Do you also require Bournemouth University ethical approval?	Yes

Attached documents
consent form.docx - attached on 07/11/2018 11:24:59
Survey UK .docx - attached on 07/11/2018 11:25:20
Participant Information Sheet Template.docx - attached on 29/11/2018 14:15:57
Response to Ethics panel feedback2.docx - attached on 29/11/2018 14:16:25

Approved Amendments	
Message	I have mentioned previously that I will close my survey in May 2019, however, I want to re-open it again in September 2019 because I need a higher number of participants.So I need to amend my ethics checklist to state that the survey will reopen in September 2019.
Date Submitted	20/08/2019 12:20
Comment	Hi Karim,This is now approved - please ensure that participants are given the new prize draw terms and conditions document that contains the December closing date.Many thanks,Suzy (Research Ethics, RDS)
Date Approved	27/08/2019 09:10
Approved By	Suzy Wignall

Approved Amendments	
Message	Hi,My supervisor in the University of Texas ,Dr Helmreich has suggested that we put flyers for the validation study (the study that precedes the main stress/diet study) in another site other than the University of Texas in order to enhance participation and recruitment. So, the flyers will be hung also in the school of nursing at Houston Baptist University (Texas) (flyers of the validation study, not the main stress/diet study).
Date Submitted	07/10/2019 12:28
Comment	
Date Approved	07/10/2019 12:31

Approved By	Suzy Wignall

Approved Amendments	
Message	Regarding my recruitment. In my ethics application i said that i will recruit participants by posters. However, recruitment is going very slow. That's why i will need to go to some classes (with coordination with some lecturers) to ask students if they can fill in the survey. So I will be doing classroom visits along with hanging posters.
Date Submitted	12/11/2019 10:25
Comment	
Date Approved	12/11/2019 11:02
Approved By	Suzy Wignall

Approved Amendments	
Message	In USA (University of Texas) and Lebanon (Lebanese American University), I will validate the EPIC food frequency questionnaire against 3 24-hour recalls before conducting the main stress diet study in both countries.
Date Submitted	19/11/2019 16:01
Comment	
Date Approved	20/11/2019 08:25
Approved By	Suzy Wignall

Approved Amendments	
Message	I have previously mentioned that i will be closing the survey on Christmas 2019, however because i did not get enough sample size, i need to extend the survey and keep it open until May 2020.
Date Submitted	25/01/2020 11:32
Comment	
Date Approved	27/01/2020 10:03
Approved By	Suzy Wignall

Appendix 2 – Consent form (Lebanon)

Consent to participate in a Survey/Questionnaire

Association between Diet Quality and Stress in Women of Reproductive Age from a University Population in Three Countries: UK, USA, and Lebanon (Lebanon Study)

I would like to invite you to participate in a research project by completing the following survey. I am a Karim Khaled, a nutrition PhD student at Bournemouth University, United Kingdom, and I would like you to participate in this survey as part of a PhD project in collaboration with the Lebanese American University (LAU). The purpose of this survey is to investigate the association between stress and diet quality in women of reproductive age (18-49 years old) from three different countries: USA, UK, and Lebanon. The survey includes questions about diet, physical activity, stress and psychological status, demographics, and body measurements. It will take around 30 to 40 minutes to complete

There are no known risks, harms or discomforts associated with this study beyond those encountered in normal daily life. Whilst there are no immediate benefits for those people participating in the project, it is hoped that this work will shed the light on the association between psychological stress and diet quality of women of reproductive age. According to the results, stress reduction strategies can be implemented in order to enhance the diet quality, and thus reduce adiposity, in women of reproductive age.

By continuing with the survey, you agree with the following statements:

1. I have been given sufficient information about this research project.
2. I understand that my answers will not be released to anyone and my identity will remain anonymous. My name will not be written on the questionnaire nor be kept in any other records.
3. When the results of the study are reported, I will not be identified by name or any other information that could be used to infer my identity. Only researchers will have access to view any data collected during this research however data cannot be linked to me.
4. I understand that I may withdraw from this research any time I wish and that I have the right to skip any question I don't want to answer.
5. I understand that my refusal to participate will not result in any penalty or loss of benefits to which I otherwise am entitled to.
6. I have been informed that the research abides by all commonly acknowledged ethical codes and that the research project has been reviewed and approved by the Institutional Review Board at the Lebanese American University

7. I understand that if I have any additional questions, I can ask the research team listed below.
8. I have read and understood all statements on this form.
9. I voluntarily agree to take part in this research project by completing the following survey.

If you have any questions, you may contact:

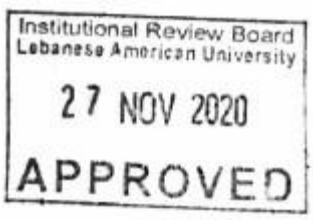
Name (PI)	Phone number	Email address
Maya Bassil	+961 1 786456	mbassil@lau.edu.lb
Karim Khaled	0096171686797/00447460111598	khaledk@bournemouth.ac.uk

If you have any questions about your rights as a participant in this study, or you want to talk to someone outside the research, please contact the:

Institutional Review Board Office,

Lebanese American University

3rd Floor, Dorm A, Byblos
Campus Tel: 00 961 1 786456
ext. (2546) irb@lau.edu.lb



Appendix 3 – Institutional Review Board Approval Exemption form

LAU
الجامعة اللبنانية الأميركية
Lebanese American University
Institutional Review Board (IRB)
لجنة الأخلاقيات

NOTICE OF IRB APPROVAL – EXEMPT STATUS

To: Ms. Mira Bazzi
Dr. Maya Bassil
Associate Professor
School of Arts & Sciences

APPROVAL ISSUED: 27 November 2020
EXPIRATION DATE: 27 November 2022
REVIEW TYPE: EXEMPT CATEGORY B

Date: November 27, 2020
RE: ***IRB #:*** *LAU.SAS.MB3.27/Nov/2020*
Protocol Title: *Association between Diet Quality and Stress in Women of Reproductive Age from a University Population in Three Countries: UK, USA, and Lebanon (Lebanon Study)*

Your application for the above referenced research project has been reviewed by the Lebanese American University, Institutional Review Board (LAU IRB). This research project qualifies as exempt under the category noted in the Review Type

This notice is limited to the activities described in the Protocol Exempt Application and all submitted documents listed on page 2 of this letter. **Final reviewed consent documents or recruitment materials and data collection tools released with this notice are part of this determination and must be used in this research project.**

CONDITIONS FOR ALL LAU NOTICE OF IRB EXEMPTION DETERMINATION

LAU RESEARCH POLICIES: *All individuals engaged in the research project must adhere to the approved protocol and all applicable LAU IRB Research Policies. PARTICIPANTS must NOT be involved in any research related activity prior to IRB notice date or after the expiration date.*

EXEMPT CATEGORIES: *Activities that are exempt from IRB review are not exempt from IRB ethical review and the necessity for ethical conduct.*

PROTOCOL EXPIRATION: PROTOCOL EXPIRATION: *The LAU IRB notice expiry date for studies that fall under Exemption is 2 years after this notice, as noted above. If the study will continue beyond this date, a request for an extension must be submitted at least 2 weeks prior to the Expiry date.*

MODIFICATIONS AND AMENDMENTS: *Certain changes may change the review criteria and disqualify the research from exemption status; therefore, any proposed changes to the previously IRB reviewed exempt study must be reviewed and cleared by the IRB before implementation.*

RETENTION: *Study files must be retained for a period of 3 years from the date of project completion.*

IN THE EVENT OF NON-COMPLIANCE WITH ABOVE CONDITIONS, THE PRINCIPAL INVESTIGATOR SHOULD MEET WITH THE REPRESENTATIVES OF THE IRB OFFICE IN ORDER TO RESOLVE SUCH CONDITIONS. IRB CLEARANCE CANNOT BE GRANTED UNTIL NON-COMPLIANT ISSUES HAVE BEEN RESOLVED.

If you have any questions concerning this information, please contact the IRB office by email at irb@lau.edu.lb

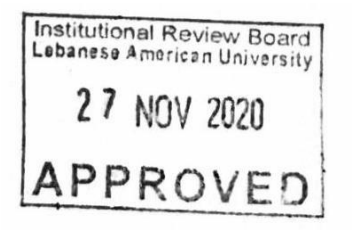
The IRB operates in compliance with the national regulations pertaining to research under the Lebanese Minister of Public Health's Decision No.141 dated 27/1/2016 under LAU IRB Authorization reference 2016/3708, the international guidelines for Good Clinical Practice, the US Office of Human Research Protection (45CFR46) and the Food and Drug Administration (21CFR56). LAU IRB U.S. Identifier as an international institution: FWA00014723 and IRB Registration # IRB00006954 LAUIRB#1

Dr. Joseph Stephan
Chair, Institutional Review Board

DOCUMENTS SUBMITTED:

LAU IRB Exempt Protocol Application	Received 16 November 2020
Research Proposal Submission Form - edms	Submitted 26 November 2020, Approved 27 November 2020
Research Proposal	Received 16 November 2020
Informed Consent	Received 16 November 2020
Questionnaire	Received 16 November 2020
Link to online survey	Received 24 November 2020

IRB Comments sent: 17 November 2020 25 November 2020 25 November 2020	PI response to IRB's comments dated: 24 November 2020 25 November 2020 26 November 2020
CITI Training – Maya Bassil	Cert.# 36232839 Dated (10 April 2020)
CITI Training – Mira Bazzi	Cert.# 35037844 Dated (24 January 2020)
CITI Training – Karim Khaled	Cert.# 30111291 Dated (22 January 2019)



Appendix 4 – Protocol for the Validation study in Lebanon

"Validation of the European Prospective Investigation into Cancer (EPIC) Food Frequency Questionnaire for use with Adults in Lebanon**"**

principal investigator: Maya Bassil

Other investigators: Karim Khaled, LAU alumni and PhD student at Bournemouth University, UK

Institution(s) responsible for the running of the study: Lebanese American University, Lebanon and Bournemouth University, United Kingdom

1. Synopsis

Evidence shows that there is absence of applying unified methodologies in nutrition epidemiological studies. Food frequency questionnaire (FFQ) is a commonly used tool to assess dietary intake of populations. In Lebanon, nutrition epidemiology is considered poor due to the scarcity of rigorous and representative FFQs. The European Prospective Investigation of Cancer food-frequency questionnaire (*EPIC FFQ) is considered a gold standard dietary assessment tool in nutrition epidemiological studies and has been validated in many countries but not in Lebanon.* The objective of this study is to validate an existing tool, the EPIC food frequency questionnaire, against 3 24-hour recalls in a new country context, Lebanon. The sample consists of healthy students and staff at the Lebanese American University who will be recruited by posters and emails that explain details about the study. The validation of the EPIC FFQ will be done through an online survey where participants will be asked to fill out three 24-hour recalls and the EPIC FFQ on different days. Additionally, sociodemographic and physical

characteristics will be measured in the survey. . Validity of the Adapted EPIC FFQ will be assessed against the average energy and/or macro and micronutrient intake of the 24-hour recalls via Spearman's correlation coefficients.). Energy adjusted nutrient intakes will be calculated by regression method. The Bland-Altman plots will be performed to estimate agreement between the FFQ and 24 hour recalls. The use of EPIC FFQ has been proposed in the literature, but has not yet been validated in adults in Lebanon.

2. Background Information and Introduction *

The rate of obesity has increased alarmingly in the past twenty years across all age groups, especially among young adults (Filozof et al. 2001, Vidal et al. 2018). It is recognised that obesity has reached epidemic proportions in the United States of America (USA) and Europe (Sibai et al. 2010).The Middle East (ME) is no exception, where obesity reaches at some points higher rates than USA and Europe (Sibai et al. 2010). The prevalence of obesity in the ME, especially the Arab Gulf States, is growing rapidly; 75% of adults are considered obese (Ng et al. 2011). Lebanon is a middle income Middle Eastern country having food ingredients that are representative of the Mediterranean diet (El-Kassas et al. 2016). Traditionally, the Lebanese cuisine has included cereals and legumes, fresh vegetables, along with sea food, meat, or chicken, filled or mixed with olive oil and herbs, ending up with common dishes known as "mezze" and "stews". However, Lebanon has experienced a dietary transition with the traditional Mediterranean diet being substituted by a westernised diet in the past few years (El-Kassas et al. 2016). The traditional Mediterranean diet consisted of fruits, vegetables, seeds, whole grains, non-refined cereals, olive oil, and vegetable protein has shifted to a westernised dietary pattern based on animal proteins, low fiber, refined grains, and high in sugar and saturated fats (Bonaccio et al. 2012, Naja et al. 2011). This change in eating pattern increased obesity rates and consequently, the prevalence of nutrition-related diseases (e.g metabolic syndrome, diabetes, cancer, and heart diseases) has grown among the

Lebanese population over the last decade as reported in epidemiological studies (Mallat et al. 2016, Nasreddine et al. 2012).

Nutrition epidemiological studies can be defined as research that assesses the relationship between food/nutrition and health outcomes measured through standardised and validated dietary tools (Satija et al. 2015). For such studies, accurate methods to assess short-term or long-term dietary intake are needed. However, comprehensive dietary methods are often expensive, time consuming and require a high commitment from participants (Willett et al. 2013). There are several dietary assessment methods including: a) diet records that requires participants to report everything they consumed over several days/weeks, b) 24-hour recalls that involve individuals to report their food intake in the past 24 hours, c) food frequency questionnaires, d) nutrition biomarkers such as urinary nitrogen or blood lipid profile that corroborate findings of dietary intake (Satija et al. 2015). Food frequency questionnaires offer some advantages compared to other dietary assessment methods as they allow the measurement of dietary intake over a long period of time and can assess the past intake in a large population group (Anon 2019). Additionally, they are the easiest method to administer, least expensive tool, and exert the lowest burden on participants compared to the other methods (Cade et al. 2002, Subar et al. 2004).

Self-administered food frequency questionnaires (FFQ) ask respondents about the frequency and often about the portion size of a limited number of usually consumed foods. Within large health surveys, which primarily give a broad representative overview of the actual health situation within a specified population, the dietary assessment methods should be feasible to apply next to assessments of other health relevant topics (Willett et al. 2013). FFQs measure usual intake over a middle or long-term period, which is highly relevant for the survey objective of monitoring usual behaviour. Their ability to compare groups or rank persons according to their intake of major food groups is often sufficient for health survey purposes and therefore FFQs are often the method of choice for such surveys (Cade et al. 2002). However, only a limited number of foods can be included in an FFQ, for feasibility reasons and to limit the burden for participants. This predefined food list may

have to be adapted to the population of interest and to actual food habits (Cade et al. 2002). Like all dietary assessment methods, FFQs are prone to measurement errors and it is highly recommended to validate them specifically in the population under study (Cade et al. 2002, Willett et al. 2013).

One disadvantage of the food frequency questionnaire is that it should be culture and population specific (Anon 2019). This means that it is not suitable for use in cross-cultural or across different countries unless it has been adapted/validated in different settings and comparable foods are included in the questionnaire (Anon 2019). Moreover, it is prone to error and misreporting due to long term recall and since it includes a fixed list of different foods, chances of omissions exist (Satija et al. 2015).

The European Prospective Investigation into Cancer food-frequency questionnaire (EPIC FFQ) has been widely used for dietary assessment in the United Kingdom (UK) (Welch et al. 2005). It represents a gold standard assessment tool of the diet in nutrition epidemiological studies. The EPIC FFQ has been validated for use in adolescents and adults in the UK (Bingham et al. 1997, McKeown et al. 2001, Leitz et al. 2002), in patient groups (celiac disease patients) (Mazzeo et al. 2016), and in other European countries such as Italy (Bonaccio et al. 2017) providing a reasonable assessment of habitual diet; however, no validation study of the EPIC FFQ has been done in the MENA region. Although food frequency questionnaires are commonly used in the USA and European countries, nutrition epidemiology in the MENA (Middle East and North Africa) region and Lebanon is considered poor due to the scarcity of rigour and representative dietary questionnaires, specifically food frequency questionnaires (Papazian et al. 2016). Additionally, comparing international data of dietary patterns and food intake is often hindered by the lack of common instrument to assess food intake. Consequently, studies from different countries cannot be compared due to the heterogeneity of dietary questionnaires used. To data, no data is available on dietary patterns across different continents using a common food frequency questionnaire.

3. Objectives *

- The objective of this study is to validate an existing tool, the EPIC food frequency questionnaire, in a new country context, Lebanon.

4. Project timelines and flow chart

It is important to highlight project timelines if the study will be conducted over a period of time and multiple factors are expected

5. Study Methodology *

The study will explore the validity of the EPIC FFQ compared to three 24 hour recalls in a sample of adults who are students and staff at the Lebanese American University (LAU). This will be done through an online survey.

6. Study population*

- *Subjects*

Sample Size

The sample consists of adults >18 years old who are students and staff at the Lebanese American University (LAU) in Lebanon. The sample was chosen since this study is part of a PhD project that involves investigating the association between stress and diet quality in women of reproductive age (18-49 years old) at three universities in three different countries, including LAU.

The sample size for the validation study was calculated using a standard formula for correlation coefficients (Willet et al. 1998). The number of participants required is 100. This number is also recommended by professionals in this field who confirm that 100 individuals are required to assess the agreement between tools used to evaluate dietary intakes (Cade et al. 2002, Willett et al. 1998).

The inclusion criteria of this study are adults who are:

- >18 years old.

- Students and staff.

The Exclusion criteria of this study include adults who are:

- Suffering from a chronic disease such as: Cancer, Crohn's Disease, Diabetes, Heart Disease, HIV/AIDS/ Multiple sclerosis, Asthma, COPD, Cystic fibrosis, or mental health disorder.
- Having food intolerance or allergy.
- Pregnant/breastfeeding.
- On any medication known to affects appetite or have undergone bariatric surgery.

Recruitment Protocol

Potential participants will be approached via their student/staff emails. The emails will include the link to the online survey and a Participant Information Sheet (PIS) explaining the study procedure and objectives and that the participation in this study is voluntary and anonymous. The emails will also inform subjects that by participating in the study, their emails or telephone numbers (which will be taken anonymously without knowing which email/telephone number belongs to which data) will be included in a prize draw. Additionally, posters about the research will be placed in LAU.

Consent will be ascertained on the landing page of the online survey. Participants will be advised that their participation in the study is voluntary, and they can withdraw at any time knowing that non-participation or withdrawal will not affect them in any way. On the last page of the survey, participants will have the chance to provide their emails or telephone numbers, that will be included in the prize draw, through a separate link (to ensure anonymity).

Incentives

To facilitate recruitment and participants' motivation, incentives will be used. In the online survey, there will be a section where participants will have the chance to provide their emails or telephone numbers in order to enter a prize draw that will include four Amazon vouchers (25$ each).

7. Study procedure *

The validation study of the EPIC FFQ will be conducted among adults in Lebanon who are students and staff at the Lebanese American University (LAU) using three 24-hour dietary recalls as reference method (Brunst et al. 2015, Carithers et al. 2009).

Participants will be invited to an online survey where they will be asked to fill out three 24-hour recalls: two on weekdays and one on a weekend day providing qualitative (e.g. type of food) and quantitative (e.g. portion) details. The researcher will include guidance in the online survey on how to use the 24 hour recalls and that they must be filled out on different days. One week after completing the 24 hour recalls, participants will be asked to fill in the adapted version of the EPIC FFQ. Additionally, the survey will collect the demographic characteristics of participants.

Participants will be followed up and reminded to complete the 24 hour recalls and the FFQ through their emails/telephone numbers that they will provide in the prize draw section.

Measures

EPIC FFQ

The EPIC-FFQ consists of 130 food items and one additional question for milk (131 items) (Appendix 1). The tool will be adapted to reflect the Lebanese diet. To adapt the EPIC FFQ to the Lebanese diet, the researcher (Lebanese) will substitute some foods from the original EPIC FFQ with foods that are commonly consumed in Lebanon. In order to retain its international

comparability, most foods items from the original EPIC FFQ will stay the same in each of the sections. Since students and staff at LAU are from different religions (Christians and Muslims), food items like pork and alcohol intake will be kept unchanged, unlike other validation studies that take place in other Arab countries where pork and alcohol sections are excluded because participants are solely Muslims. The frequency of dietary intake of the adapted FFQ will remain the same as the original version: never or less than once per month, 1-3 times per month, once a week, 2-4 times per week, 5-6 times per week, once a day, 2-3 time per day, 4-5 times per day, more than 6 times per day.

To ensure that adaptation is correct and improve content and face validity, the adapted version of the EPIC FFQ will be cross checked by nutrition academic staff at LAU. Additionally, before the main validation study, the adapted version of EPIC FFQ will be completed by 10 adults in Lebanon as a pilot study. This step is essential to confirm the time required to complete the questionnaire and that questions are easy to understand and instructions are easy to follow. Also, any feedback from participants will be taken into consideration. Further, adaptation of foods will be done based on similar products/brands found in the Lebanese market, if required after the pilot study.

24-hour recalls

The three 24 hour recalls (24-HR) aim to collect dietary data about foods and drinks consumed over the past 24 hours. Participants will be followed up in order to fill out the second 24-HR on a weekday two days after completing the first one while the third 24-HR to be completed in the weekend of the same week so that the data collected is representative of the individual's overall dietary intake. Additionally, in the online survey, participants will be instructed to complete the FFQ one week after completing the third 24-hour recall.

Socioeconomic and Physical characteristics

- Self-reported age, body weight, height, education, income, race, and marital status will describe the sociodemographic characteristics of participants.

8. Data Management *

All the information we collect during the course of the research will be kept strictly in accordance with current data protection legislation. Research is a task that we perform in the public interest, as part of our core function as a university. Bournemouth University (BU) is a Data Controller of your information which means that we are responsible for looking after your information and using it appropriately. BU's Research Participant Privacy Notice sets out more information about how we fulfil our responsibilities as a data controller and about your rights as an individual under the data protection legislation. We ask you to read this Notice so that you can fully understand the basis on which we will process your information.

9. Statistical Analysis

The mean daily intake of the three 24-hour recalls will be derived and used in the analysis as the average intake reported in the recalls. Validity of the Adapted EPIC FFQ will be assessed against the average energy and/or macro and micronutrient intake of the 24-hour recalls via Spearman's correlation coefficients (Brunst et al. 2015, El Kinany et al. 2018). Energy adjusted nutrient intakes will be calculated by regression method. The Bland-Altman plots will be performed to estimate agreement between the FFQ and 24 hour recalls (Bartlett et al. 2008, Bland et al. 1999). The average values of FFQ and 24-hour recalls will be plotted against the intake difference between these methods, and limits of agreements will be done to show how big the disagreement between them is. Misreporting of Energy Intake (EI) will be evaluated for each participant based on the ratio of EI to Basal Metabolic Rate (BMR) (Black et al. 2000) and the ratio of EI to Estimated Energy Requirement (EER) (Huang et al. 2005). Participants will be considered under-reporters or over-reporters if their ratio was below or above the 95%

confidence limits for agreement between EI: BMR and EI: EER (Murakami et al. 2015).

10. Quality assurance, monitoring & safety

✓ *This study has a minimal risk and data is anonymous.*

11. Ethical Issues*

Ethical approval will be sought through the Lebanese American University Institutional Review Board (IRB) in December 2019.

12. Dissemination of Results and Publication policy

Publication

No one will be able to be identified in any external reports or publications about the research without your specific consent. Otherwise information will only be included in these materials in an anonymous form, i.e. no one will not be identifiable.

Research results will be published in an academic journal, but no individual will be identified.

13. Archiving

Security and access controls

BU will hold the information we collect about you in hard copy in a secure location and on a BU password protected secure network where held electronically.

Except where it has been anonymised your personal information will be accessed and used only by appropriate, authorised individuals and when this is necessary for the purposes of the research or another purpose identified in

the Privacy Notice. This may include giving access to BU staff or others responsible for monitoring and/or audit of the study who need to ensure that the research is complying with applicable regulations.

The information collected about you may be used in an anonymous form to support other research projects in the future and access to it in this form will not be restricted. It will not be possible for you to be identified from this data. Anonymised data will be added to BU's Data Repository (a central location where data is stored) and which will be publicly available.

14. References *

1. Anon., 2018c. *Maternal Obesity* [online]. Thelancet.com. Available from: https://www.thelancet.com/series/maternal-obesity [Accessed 1 May 2018].

2. Anon., 2019. *Pre-diabetes Modifiable Risk Factors* [online]. www.heart.org. Available from: https://www.heart.org/en/health-topics/diabetes/understand-your-risk-for-diabetes/prediabetes-modifiable-risk-factors [Accessed 25 Jan 2019].

3. Anon., 2019. *Strengths and Weaknesses - Nutritools* [online]. Nutritools.org. Available from: https://www.nutritools.org/strengths-and-weaknesses [Accessed 25 Jan 2019].

4. Anon., 2023. Stressed nation: 74% of UK 'overwhelmed or unable to cope' at some point in the past year [online]. Mental Health Foundation. Available from: https://www.mentalhealth.org.uk/about-us/news/survey-stressed-nation-UK-overwhelmed-unable-to-cope [Accessed 24 Feb 2023].

5. Bartlett JW, Frost C. Reliability, repeatability and reproducibility: analysis of measurement errors in continuous variables. Ultrasound

Obstet Gynecol. 2008;31(4):466–75. 25. Bland JM, Altman DG. Measuring agreement in method comparison studies. Stat Methods Med Res. 1999;8(2):135–60.

6. Bingham, S., Gill, C., Welch, A., Cassidy, A., Runswick, SA., Oakes, S., 1997. Validation of dietary assessment methods in the UK arm of EPIC using weighed records, and 24-hour urinary nitrogen and potassium and serum vitamin C and carotenoids as biomarkers. *Int. J. Epidemiol*, 26 (1), 137–151

7. Black, A., 2000. Critical evaluation of energy intake using the Goldberg cut-off for energy intake:basal metabolic rate. A practical guide to its calculation, use and limitations. *International Journal of Obesity*, 24 (9), 1119-1130.

8. Boghossian, N., Yeung, E., Mumford, S., Zhang, C., Gaskins, A., Wactawski-Wende, J. and Schisterman, E., 2013. Adherence to the Mediterranean diet and body fat distribution in reproductive aged women. *European Journal of Clinical Nutrition*, 67 (3), 289-294.

9. Bonaccio, M., Di Castelnuovo, A., Costanzo, S., Pounis, G., Persichillo, M., Cerletti, C., Donati, M., de Gaetano, G. and Iacoviello, L., 2017. Mediterranean-type diet is associated with higher psychological resilience in a general adult population: findings from the Moli-sani study. *European Journal of Clinical Nutrition*, 72 (1), 154-160.

10. Bonaccio M, Iacoviello L, de Gaetano G, Moli-Sani Investigators. The Mediterranean diet: the reasons for a success. Thromb Res 2012 Mar;129(3): 401e4.

11. Brunst, K., Kannan, S., Ni, Y., Gennings, C., Ganguri, H. and Wright, R., 2015. Validation of a Food Frequency Questionnaire for Estimating Micronutrient Intakes in an Urban US Sample of Multi-Ethnic Pregnant Women. *Maternal and Child Health Journal*, 20 (2), 250-260.

12. Bunniss, S. and Kelly, D. R., 2010. Research paradigms in Medical Education Research. Medical Education, 44 (4), 358–366.

13. Cade J., Thompson, R., Burley, V. and Warm, D., 2002. Development, validation and utilisation of food-frequency questionnaires – a review. *Public Health Nutrition*, 5 (4), 567-587.

14. Carithers, T., Talegawkar, S., Rowser, M., Henry, O., Dubbert, P., Bogle, M., Taylor, H. and Tucker, K., 2009. Validity and Calibration of Food Frequency Questionnaires Used with African-American Adults in the Jackson Heart Study. *Journal of the American Dietetic Association*, 109 (7), 1184-1193.e2.

15. Centre for Maternal and Child Enquiries (CMACE). Maternal obesity in the UK: Findings from a national project. London: CMACE, 2010

16. Crossan, F., 2003. Research philosophy: towards an understanding. Nurse Researcher, 11 (1), 46-55.

17. Collis, J. and Hussey, R., 2003. Business research: A practical guide for undergraduate and postgraduate students. New York: Palgrave Macmillan.

18. Creswell, J. W., 2014. Research design: Qualitative, quantitative, and mixed method approaches. Los Angeles: Sage.

19. Crotty, M., 2021. The foundations of social research: Meaning and perspective in the research process. London: Routledge.

20. Easterby-Smith, M., Thorpe, R., and Lowe, A., 2001. Management research: An introduction. London: SAGE.

21. Easterby-Smith, M., Thorpe, R. and Jackson, P., 2012. Management research. London: SAGE.

22. El-Kassas, G. and Ziade, F., 2016. Exploration of the Dietary and Lifestyle Behaviors and Weight Status and Their Self-Perceptions among Health Sciences University Students in North Lebanon. *BioMed Research International*, 2016, 1-14.

23. El Kinany, K., Garcia-Larsen, V., Khalis, M., Deoula, M., Benslimane, A., Ibrahim, A., Benjelloun, M. and El Rhazi, K., 2018. Adaptation and validation of a food frequency questionnaire (FFQ) to assess dietary intake in Moroccan adults. *Nutrition Journal*, 17 (1).

24. Fade, S. A., 2003. Communicating and judging the quality of qualitative research: The need for a new language. Journal of Human Nutrition and Dietetics, 16 (3), 139–149.

25. Farran N. Mental health in Lebanon: Tomorrow's silent epidemic. Ment Health Prev. 2021 Dec;24:200218. doi: 10.1016/j.mhp.2021.200218. Epub 2021 Sep 24. PMID: 34660191; PMCID: PMC8503814.

26. Ferranti, E., Dunbar, S., Higgins, M., Dai, J., Ziegler, T., Frediani, J., Reilly, C. and Brigham, K., 2013. Psychosocial factors associated with

diet quality in a working adult population. *Research in Nursing & Health*, 36 (3), 242-256.

27. Filozof, C., Gonzalez, C., Sereday, M., Mazza, C. and Braguinsky, J., 2001. Obesity prevalence and trends in Latin-American countries. *Obesity Reviews*, 2 (2), 99-106.

28. Guo, X., Warden, B.A., Paeratakul, S. & Bray, G.A. (2004) Healthy Eating Index and obesity. Eur. J. Clin. Nutr. 58, 1580–1586.

29. Huang, T., Roberts, S., Howarth, N. and McCrory, M., 2005. Effect of Screening Out Implausible Energy Intake Reports on Relationships between Diet and BMI. *Obesity Research*, 13 (7), 1205-1217.

30. Hu, F., 2002. Dietary pattern analysis: a new direction in nutritional epidemiology. *Current Opinion in Lipidology*, 13 (1), 3-9.

31. Jomaa, L., Hwalla, N., Itani, L., Chamieh, M., Mehio-Sibai, A. and Naja, F., 2016. A Lebanese dietary pattern promotes better diet quality among older adults: findings from a national cross-sectional study. *BMC Geriatrics*, 16 (1).

32. Kiefte-de Jong JC, Mathers JC, Franco OH. Nutrition and healthy ageing: the key ingredients. Proc Nutr Soc. 2014;73(02):249–59.

33. Kneebone, R., 2002. Total internal reflection: An essay on paradigms. Medical Education, 36 (6), 514–518.

34. Lietz G, Barton KL, Longbottom PJ, Anderson AS, 2002. Can the EPIC food-frequency questionnaire be used in adolescent populations? *Public Health Nutrition,* 5 (6), 783-789.

35. Liu, S., Buring, J.E., Sesso, H.D., Rimm, E.B., Willett, W.C. & Manson, J.E. (2002) A prospective study of dietary fiber intake and risk of cardiovascular disease among women. J. Am. Coll. Cardiol. 39, 49–56.

36. Mallat, S., Geagea, A., Jurjus, R., Rizkallah, A., Oueidat, D., Matar, M., Tawilah, J., Berbari, A. and Jurjus, A., 2016. Obesity in Lebanon: A National Problem. *World Journal of Cardiovascular Diseases*, 06 (06), 166-174.

37. Martin, J., Moran, L., Teede, H., Ranasinha, S., Lombard, C. and Harrison, C., 2017. Exploring Diet Quality between Urban and Rural Dwelling Women of Reproductive Age. *Nutrients*, 9 (6), 586.

38. Mazzeo, T., Roncoroni, L., Lombardo, V., Tomba, C., Elli, L., Sieri, S., Grioni, S., Bardella, M., Agostoni, C., Doneda, L., Brighenti, F. and Pellegrini, N., 2016. Evaluation of a Modified Italian European Prospective Investigation into Cancer and Nutrition Food Frequency Questionnaire for Individuals with Celiac Disease. *Journal of the Academy of Nutrition and Dietetics*, 116 (11), 1810-1816.

39. McKeown, N., Day, N., Welch, A., Runswick, S., Luben, R., Mulligan, A., McTaggart, A. and Bingham, S., 2001. Use of biological markers to validate self-reported dietary intake in a random sample of the European Prospective Investigation into Cancer United Kingdom

Norfolk cohort. *The American Journal of Clinical Nutrition*, 74 (2), 188-196.

40. Mozaffarian, D., Rosenberg, I., and Uauy, R., 2018. History of modern nutrition science—implications for current research, dietary guidelines, and food policy. BMJ.

41. Murakami, K. and Livingstone, M., 2015. Prevalence and characteristics of misreporting of energy intake in US adults: NHANES 2003–2012. *British Journal of Nutrition*, 114 (08), 1294-1303.

42. Naja F, Nasreddine L, Itani L, Chamieh MC, Adra N, Sibai AM, et al. Dietary patterns and their association with obesity and sociodemographic factors in a national sample of Lebanese adults. Public Health Nutr 2011 Sep;14(9): 1570e8.

43. Nasreddine, L., Naja, F., Chamieh, M., Adra, N., Sibai, A. and Hwalla, N., 2012. Trends in overweight and obesity in Lebanon: evidence from two national cross-sectional surveys (1997 and 2009). *BMC Public Health*, 12 (1).

44. Newby P, Tucker KL. Empirically derived eating patterns using factor or cluster analysis: a review. Nutr Rev. 2004;62(5):177–203.

45. Ng SW, Zaghloul S, Ali HI, Harrison G, Popkin BM: The prevalence and trends of overweight, obesity and nutrition-related non-communicable diseases in the Arabian Gulf States. Obes Rev 2011, 12:1–13.

46. Papazian, T., Hout, H., Sibai, D., Helou, N., Younes, H., El Osta, N. and Khabbaz, L., 2016. Development, reproducibility and validity of a food frequency questionnaire among pregnant women adherent to the Mediterranean dietary pattern. *Clinical Nutrition*, 35 (6), 1550-1556.

47. Park, Y., Konge, L. and Artino, A., 2020. The Positivism Paradigm of Research. Academic Medicine, 95 (5), 690-694.

48. Polit, D. F. and Beck, C. T., 2006. Essentials of nursing research: Methods, appraisal, and utilization. Philadelphia: Lippincott Williams & Wilkins.

49. Popper, K. R., 2014. The logic of Scientific Discovery. Mansfield Centre, CT: Martino Publishing.

50. Poston, L., Caleyachetty, R., Cnattingius, S., Corvalán, C., Uauy, R., Herring, S. and Gillman, M., 2016. Preconceptional and maternal obesity: epidemiology and health consequences. *The Lancet Diabetes & Endocrinology*, 4 (12), 1025-1036.

51. Remenyi, D., 2010. Doing research in business and management: An introduction to process and method. London: Sage.

52. Reynolds, R., Allan, K., Raja, E., Bhattacharya, S., McNeill, G., Hannaford, P., Sarwar, N., Lee, A., Bhattacharya, S. and Norman, J., 2013. Maternal obesity during pregnancy and premature mortality from cardiovascular event in adult offspring: follow-up of 1 323 275 person years. *BMJ*, 347 (aug13 1), f4539-f4539.

53. Satija, A., Yu, E., Willett, W. and Hu, F., 2015. Understanding Nutritional Epidemiology and Its Role in Policy. *Advances in Nutrition*, 6 (1), 5-18.

54. Saunders, M., Lewis, P., and Thornhill, A., 2009. Research methods for business students. Harlow: Financial Times Prentice Hall.

55. Saunders, M., Lewis, P., and Thornhill, A., 2012. Research methods for business students. Harlow: Pearson.

56. Schubert, L., Gallegos, D., Foley, W., and Harrison, C., 2011. Re-imagining the 'social' in the nutrition sciences. Public Health Nutrition, 15 (2), 352–359.

57. Scrinis, G., 2020. Reframing malnutrition in all its forms: A critique of the tripartite classification of malnutrition. Global Food Security, 26, 100396.

58. Sekaran, U. and Bougie, R. J., 2016. Research methods for business: A skill building approach Seventh Edition. John Wiley & Sons.

59. Sibai A, Nasreddine L, Mokdad AH, Adra N, Tabet M, Hwalla N: Nutrition transition and cardiovascular disease risk factors in Middle East and North Africa countries: reviewing the evidence. Ann Nutr Metab 2010, 57:193–203.

60. Subar, AF. 2004. Developing dietary assessment tools. *J Am Diet Assoc*,104, 769-770.

61. Swanson, R. A. and F., H. I. I. I. E., 2005. Research in organizations: Foundations and Methods of Inquiry. California: BK.

62. Tande, D.L., Magel, R. & Strand, B.N. (2009) Healthy Eating Index and abdominal obesity. Public Health Nutr. 13, 208– 214.

63. Thiele S, Mensink G, Beitz R. Determinants of diet quality. Public Health Nutr. 2004;7(01):29–37.

64. Varpio, L. and MacLeod, A., 2020. Philosophy of science series. Academic Medicine, 95 (5), 686–689.

65. Verkasalo, P., Appleby, P., Allen, N., Davey, G., Adlercreutz, H. and Key, T., 2001. Soya intake and plasma concentrations of daidzein and genistein: validity of dietary assessment among eighty British women (Oxford arm of the European Prospective Investigation into Cancer and Nutrition). *British Journal of Nutrition*, 86 (03), 415.

66. Vidal, E., Alvarez, D., Martinez-Velarde, D., Vidal-Damas, L., Yuncar-Rojas, K., Julca-Malca, A. and Bernabe-Ortiz, A., 2018. Perceived stress and high fat intake: A study in a sample of undergraduate students. *PLOS ONE*, 13 (3), e0192827.

67. Walliman, N. Research Methods: The Basics: 2nd edition (1st ed.)., 2010. Routledge. https://doi.org/10.4324/9780203836071

68. Wang, Y. & Beydoun, M.A. (2007) The obesity epidemic in the United States – gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. Epidemiol. Rev. 29, 6–28.

69. Webber, K. and Lee, E., 2011. The diet quality of adult women participating in a behavioural weight-loss programme. *Journal of Human Nutrition and Dietetics*, 24 (4), 360-369.

70. Welch, A., Luben, R., Khaw, K. and Bingham, S., 2005. The CAFE computer program for nutritional analysis of the EPIC-Norfolk food frequency questionnaire and identification of extreme nutrient values. *Journal of Human Nutrition and Dietetics*, 18 (2), 99-116.

71. Williams, L., 2016. Research in dietetic practice and education: Insights from the sociological perspective. Nutrition & Dietetics, 73 (3), 217–219.

72. Willett, W., 1998. *Nutritional Epidemiology.* New York, Oxford: Oxford University Press.

73. Willett, W., 2013. *Nutritional epidemiology*. 2nd ed. New York [etc.]: Oxford University Press.

74. Wolongevicz, D.M., Zhu, L., Pencina, M.J., Kimokoti, R.W., Newby, P.K., D' Agostino, R.B. & Millen, B.E. (2009) Diet quality and obesity in women: the Framingham Nutrition Studies. Br. J. Nutr.103, 1223–1229.

75. World Health Organization, 2000. *Obesity: Preventing and Managing the Global Epidemic*. Geneva: World Health Organization.

76. World Health Organization, 2010. Rural Poverty and Health Systems in the WHO European Region; WHO Regional; Office for Europe: Copenhagen, Denmark.

77. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies
with 128.9 million participants. Lancet 2017.
DOI: http://dx.doi.org/10.1016/S0140-6736(17)32129-3

Appendix 5 – IRB exempt application for validation study

Please use this application if you are requesting exemption from IRB review as stated in exempt categories listed below. The "Document Submission Checklist" below provides a general guide regarding the required documents to be submitted with this application. For any assistance, please contact the Office of the IRB at irb@lau.edu.lb

Do not complete this form if the research involves pregnant women, fetuses, prisoners or children as the project does not fit exemption. It is important to note that the IRB makes the final determination of exempt status.

1. RESEARCH PROJECT INFORMATION

Name of Principal Investigator (PI): Maya Bassil

Research Project / Study Title: Validation of the European Prospective Investigation into Cancer (EPIC) Food Frequency Questionnaire for use with Adults in Lebanon

Location (s) where the study will be conducted: LAU (Beirut and Byblos campuses)

(identify all locations where the study will be conducted under your supervision)

For data collection sites/locations other than LAU, have you attached a signed and dated letter giving approval for data collection at that site/location? ☐ Yes; please submit along with this application ☐ No; please justify:

Research Personnel

The PI must list the names of the personnel to be involved in the research in below space and include with this application the NIH Certificate of Completion training for each personnel

Karim Khaled	

Study Administrator/Coordinator *(if different from PI and responsible for IRB submissions)*

Name: Fotini Tsofliou	Title: Programme Lead: MSc Nutrition and Behaviour, Senior Lecturer Nutrition
Phone #: +44 (0)1202 961583	Email: ftsofliou@bournemouth.ac.uk

DOCUMENT SUBMISSION CHECKLIST — PROTOCOL EXEMPT APPLICATION

One **Original Hard Copy** and one **Electronic Copy** of each of the following items are required, as applicable:

☐ *Completed and signed Research Project Submission Form (GSR) – Only for Faculty Research Projects*

☐ *Completed IRB Protocol Exempt Application – Signed by Advisor, if Submission is for a Student Project*

☐ *LAU Medical Center-Rizk Hospital Signature page - For research to be conducted at hospital*

☐ *Other study related material such as research proposal, data collection forms, informed consents, information sheet, questionnaire, survey, interview and/or telephone scripts, etc.*

☒ *Human Subject Protection training certificate for all study personnel, valid within 3 years from date on certificate (Protecting Human Subject Research Participants)*

2. TYPE OF RESEARCH *(check only one)*

☐ **Departmental Research**
(not externally sponsored)

☐ **Undergraduate Research**
(Senior thesis/independent study)

☐ **Graduate Study Research**
(Graduate thesis/dissertation)

☒ **Externally Sponsored Research**

3. TARGETED POPULATION

A. Number of Participants

i) Expected number of participants **that will be enrolled** under your supervision: 105

ii) For collaborative research, **the total number** of participants to be enrolled (including (i) above):

Note: Please note that the expected number of participants noted above to be enrolled under your supervision will be for which the LAU IRB approval will be granted.

Age Range of Participants	**Gender**
Adults (18 yrs+), Age range : >18 yrs to yrs)	☒ Females/Males ☐ Females only ☐ Males only

Type of Participants *(check all that apply)*

☐ Inpatients	☒ LAU Students	☐ LAUMC-RH Staff
☐ Outpatients	☐ LAU Faculty	☐ Other *(please specify)*:
☐ Healthy volunteers, Non LAU	☒ LAU Staff	

4. RESEARCH METHODS AND ACTIVITIES

Check all research activities that apply. ***Attach a copy of all materials to be used including oral scripts. Please note that for all prospective data collection, an information sheet or informed consent must be included.***

☐ Retrospective Record review

☐ Specimen research *(existing at time of application)*

☐ Existing data, not publicly available
☐ Existing data, publicly available
☐ Focus groups
☐ Interviews
☐ Observation of participants
☐ Taste-testing
☐ Audio recording
☐ Video or image recording
☐ Others, specify:

☐ Surveys and questionnaires to be distributed as hard copy and to be completed manually

☒ Surveys and questionnaires to be sent by email or social media as a link to an electronic platform, please specify:

- ☐ LAU BLUE
- ☐ Survey Monkey
- ☐ Google Form
- ☒ Others: Bristol Online Surveys (BOS)

If the survey will be sent via an electronic platform, please provide the link to the uploaded survey, if available:

If the survey will be sent via an electronic platform by email or through social media, please include the content of the email or social media post that will accompany the link to the survey:

The link to the survey will be sent by emails that will include the link to the online survey and a Participant Information Sheet (PIS) explaining the study procedure and objectives and that the participation in this study is voluntary and anonymous. The emails will also inform subjects that a prize draw will be done after data collection to enhance recruitment. In the online survey, participants will be asked to provide their emails through a separate link to ensure that the data collected is anonymous; the researcher cannot identify which data belongs to which email address.

5. ACCESS FOR USE - SURVEY OR QUESTIONNAIRE TOOLS

Please check the appropriate box for access to use the specific survey/questionnaire in your project. Documentation should be detailed and referenced in your research proposal or attached as part of this application

☒ I created the survey / questionnaire

☐ Survey / Questionnaire is available as Open Access

☐ Survey / Questionnaire - I have received permission from the author to be able to use the Survey/ Questionnaire

☐ Survey / Questionnaire - I have paid the author to be able to have access to the Survey / Questionnaire

6. PUBLICATION OR PRESENTATION OF STUDY RESULTS

Will research data be disseminated? (i.e. journal, dissertations, etc.) ☒ Yes ☐ No

If yes, specify: As it is part of a PhD project, this study will be included in the PhD Thesis and will get published.

7. PROJECT SUMMARY (please complete all sections)

Purpose of the study (briefly state the purpose of the study along with the objectives):

The purpose of the survey is to validate an existing tool, the EPIC food frequency questionnaire, in a new country context, Lebanon.

Recruitment of Participants (describe who the targeted participants are):

The sample consists of adults >18 years old who are students and staff at the Lebanese American University (LAU) in Lebanon. The sample was chosen since this study is part of a PhD project that involves investigating the association between stress and diet quality in women of reproductive age (18-49 years old) at three universities in three different countries, including LAU.

Describe how you will approach participants (face-to-face, email, flyer, links, etc.):

Potential participants will be approached via their student/staff emails. The emails will include the link to the online survey and a Participant Information Sheet (PIS) explaining the study procedure and objectives and that the participation in this study is voluntary and anonymous. The emails will also inform subjects that by participating in the study, their emails or telephone numbers (which will be taken anonymously without knowing which email/telephone number belongs to which data) will be included in a prize draw. Additionally, posters about the research will be placed in LAU. Consent will be ascertained on the landing page of the online survey. Participants will be advised that their participation in the study is voluntary, and they can withdraw at any time knowing that non-participation or withdrawal will not affect them in any way. On the last page of the survey, participants will have the chance to provide their emails or telephone numbers, that will be included in the prize draw, through a separate link (to ensure anonymity).

Describe the tools that will be used, their validation and source; and specify the plan for data collection and recording.

The validation study of the EPIC FFQ will be conducted among adults in Lebanon who are students and staff at the Lebanese American University (LAU) using three 24-hour dietary recalls as reference method (Brunst et al. 2015, Carithers et al. 2009).

Participants will be invited to an online survey where they will be asked to fill out three 24-hour recalls: two on weekdays and one on a weekend day providing qualitative (e.g. type of food) and quantitative (e.g. portion) details. The researcher will include guidance in the online survey on how to use the 24 hour recalls and that they must be filled out on different days. One week after completing the 24 hour recalls, participants will be asked to fill in the adapted version of the EPIC FFQ. Additionally, the survey will collect the demographic characteristics of participants.

Participants will be followed up and reminded to complete the 24 hour recalls and the FFQ through their emails/telephone numbers that they will provide in the prize draw section. EPIC FFQ.

The EPIC-FFQ consists of 130 food items and one additional question for milk (131 items) (Appendix 1). The tool will be adapted to reflect the Lebanese diet. To adapt the EPIC FFQ to the Lebanese diet, the researcher (Lebanese) will substitute some foods from the original EPIC FFQ with foods that are commonly consumed in Lebanon. In order to retain its international comparability, most foods items from the original EPIC FFQ will stay the same in each of the sections. Since students and staff at LAU are from different religions (Christians and Muslims), food items like pork and alcohol intake will be kept unchanged, unlike other validation studies that take place in other Arab countries where pork and alcohol sections are excluded because participants are solely Muslims. The frequency of dietary intake of the adapted FFQ will remain the same as the original version: never or less than once per month, 1-3 times per month, once a week, 2-4 times per week, 5-6 times per week, once a day, 2-3 time per day, 4-5 times per day, more than 6 times per day.

To ensure that adaptation is correct and improve content and face validity, the adapted version of the EPIC FFQ will be cross checked by nutrition academic staff at LAU. Additionally, before the main validation study, the adapted version of EPIC FFQ will be completed by 10 adults in Lebanon as a pilot study. This step is essential to confirm the time required to complete the questionnaire and that questions are easy to understand and instructions are easy to follow. Also, any feedback from participants will be taken into consideration. Further, adaptation of foods will be done based on similar products/brands found in the Lebanese market, if required after the pilot study.

24-hour recalls

The three 24 hour recalls (24-HR) aim to collect dietary data about foods and drinks consumed over the past 24 hours. Participants will be followed up in order to fill out the second 24-HR on a weekday two days after completing the first one while the third 24-HR to be completed in the weekend of the same week so that the data collected is representative of the individual's overall dietary intake. Additionally, in the online survey, participants will be instructed to complete the FFQ one week after completing the third 24-hour recall.

Describe the methods to be followed for the protection of participant information such as privacy, confidentiality and anonymity:

All the information we collect about participants during the course of the research will be kept strictly in accordance with current data protection legislation. Research is a task that we perform in the public interest, as part of our core function as a university. Bournemouth University (BU) is a Data Controller of your information which means that we are responsible for looking after participants' information and using it appropriately. BU's Research Participant Privacy Notice sets out more information about how we fulfil our responsibilities as a data controller and about participants' rights as an individual under the data protection legislation. We ask participants to read this Notice so that they can fully understand the basis on which we will process their information.

Publication

Participants will not be able to be identified in any external reports or publications about the research without their specific consent. Otherwise their information will only be included in these materials in an anonymous form, i.e. they will not be identifiable.

Research results will be published in an academic journal, but no individual will be identified.

Security and access controls

BU will hold the information we collect about participants in hard copy in a secure location and on a BU password protected secure network where held electronically.

Except where it has been anonymised their personal information will be accessed and used only by appropriate, authorised individuals and when this is necessary for the purposes of the research or another purpose identified in the Privacy Notice. This may include giving access to BU staff or others responsible for monitoring and/or audit of the study who need to ensure that the research is complying with applicable regulations.

The information collected about participants may be used in an anonymous form to support other research projects in the future and access to it in this form will not be restricted. It will not be possible for participants to be identified from this data. Anonymised data will be added to BU's Data Repository (a central location where data is stored) and which will be publicly available.

Describe any foreseeable risks to subjects presented by the proposed study and the precautions you will take to minimize such risks:

Since it is an online survey, there will be minimal risk for participants.

8. EXEMPTION CATEGORIES

(Please select the category that exempts this study from continuing IRB review as per 45CFR 56.101b)

☐ **A. Research conducted in established or commonly accepted educational settings involving normal educational practices such as:**

(i) research on regular and special instructional strategies, or

(ii) research on the effectiveness of or the comparison between instructional techniques, curricula or classroom management methods.

☐ **B. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement),**
survey procedures, interview procedures or observation of public behavior, unless:

(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and

(ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

NOTE: *Survey or interview procedures or observations of public behavior involving children cannot be exempted, with the exception of observations of public behavior when the investigator(s) do not participate in the activities being observed.*

8. EXEMPTION CATEGORIES

(Please select the category that exempts this study from continuing IRB review as per 45CFR 56.101b)

☐ **C. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement),**
survey procedures, interview procedures, or observation of public behavior that is not exempt
under part B. of this section, if:

(i) the human subjects are elected or appointed public officials or candidates for public office; or

(ii) federal statute(s) require(s) without exception that the confidentiality of personally identifiable information will be maintained throughout the research and thereafter.

☐ **D. Research involving the collection or study of existing data, documents, records, pathological or**
diagnostic specimens, if these sources are publicly available or if the information is recorded by the
investigator in such a manner that subjects cannot be identified, directly or through identifiers
linked to the subjects.

☐ **E. Research and demonstration projects which are conducted by or subject to the approval of**
Department or Agency heads, and which are designed to study, evaluate, or otherwise examine:

(i) public benefit/service programs;

(ii) procedures for obtaining benefits/services under those programs;

(iii) possible changes in or alternatives to those programs or procedures; or

(iv) possible changes in payment methods and/or levels of those programs.

☐ **F. Taste and food quality evaluation and consumer acceptance studies,**

(i) if wholesome foods without additives are consumed or

(ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the U.S. Food and Drug Administration or approved by the federal health authority/food inspection agency.

9. PRINCIPAL INVESTIGATOR ASSURANCE

As a Principal Investigator/ Student Principal Investigator, by submitting this application:

- I accept ultimate responsibility for the protection of the rights and welfare of the human
  subjects and the conduct of this study including adherence to the ethical guidelines set forth in the Belmont Report, Declaration of Helsinki and Nuremburg Code
- I agree to comply with all applicable IRB policies and procedures, as well as with all relevant local and international laws regarding the protection of human subjects in research
- I accept responsibility for adhering to the project stated in this application, in the case of any changes that will impact the exemption status, I understand that I must re-submitted to the IRB for review
- I understand that any research-related material is subject to an audit by the IRB
- I certify that the proposed research is not currently being conducted and will not begin until IRB response / approval has been obtained
- I have completed the human subject protection training requirement and ensure that all investigators and personnel involved in this research have completed the human subject training requirements
- I certify that the information provided in this application is complete and accurate

10. PROJECT FACULTY ADVISOR ASSURANCE (if submission is by a Student Principal Investigator)

As the Project Faculty Advisor where the above research will be conducted, I have read the attached protocol submitted to the IRB and will ensure appropriate education and supervision of the student investigator.

Name of Project Faculty Advisor	**Signature**	**Date**

Appendix 6 – Participant Information Sheet

Bournemouth University

Participant Information Sheet

The title of the research project

Association between Diet Quality and Stress in Women of Reproductive Age from a University population in Three Countries: UK, USA, and Lebanon

Invitation to take part

You are being invited to take part in a survey being conducted by Karim Khaled, a PhD student assessing the relationship between diet quality and stress in women of reproductive age. Before you decide 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 others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the project?

The purpose of the survey is to identify the diet quality of women of reproductive age and its association with stress.

Why have I been chosen?

You have been chosen since this survey will be conducted among Bournemouth University students and staff.
The inclusion criteria of this study are women who are:

- Females at birth
- 18-49 years old.
- Students and staff.

The Exclusion criteria of this study include ones who are:

- Not females at birth.
- Under 18 or above 49 years old.
- Suffering from a chronic disease such as: Cancer, Crohn's Disease, Diabetes, Heart Disease, HIV/AIDS/ Multiple sclerosis, Asthma, COPD, Cystic fibrosis, or mental health disorder.
- Having food intolerance or allergy.
- Pregnant/breastfeeding.
- Are on any medication known to affects appetite or have undergone bariatric surgery.

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 given this information sheet to keep and be asked to sign a participant agreement form. You can withdraw from participation while filling out the online survey at any time and without giving a reason. If you decide to withdraw we will usually remove any data collected about you from the study. Once the online survey has been filled out and finished, you may not be able to withdraw since your data will be anonymous, so your identity cannot be determined, and it may not be possible to identify your data within the anonymous dataset. Therefore, if you wish to withdraw from the study, you can simply stop answering the questions of the survey and exit the web page. We hope that you will choose to participate in the survey, but you do not have to do so. Non-participation will not affect you in any way.

What would taking part involve?

The procedure involves filling an online survey that will approximately take 20 minutes. To participate in this survey simply click the link below to take you to the web site:

https://bournemouth.onlinesurveys.ac.uk/phd-uk

The landing page explains the survey further and you will be given the opportunity to consent to participation at that point.

What are the advantages and possible disadvantages or risks of taking part?

Whilst there are no immediate benefits for those people participating in the project, it is hoped that this work will shed the light on the effect of stress on diet quality. According to the results, stress coping strategies can be used in order to ensure a better diet quality for women of reproductive age.

What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

In the survey, you will be asked to fill out questions about your food intake in the past year and some questions about how stressed/ depressed you have been in the past month in addition to socioeconomic questions and anthropometric measurement questions such as weight, height, and waist circumference. Please note that once the survey has been completed and submitted, it will be impossible to communicate the scores calculated from your response to depression and stress questions and other questions to you because data will be anonymised.

Filling out this survey will achieve the objective of the research since the research aims to investigate the association between diet quality and stress in women of reproductive age.

How will my information be kept?

All the information we collect about you during the course of the research will be kept strictly in accordance with current data protection legislation. Research is a task that we perform in the public interest, as part of our core function as a university. Bournemouth University (BU) is a Data Controller of your information which means that we are responsible for looking after your information and using it appropriately. BU's Research Participant Privacy Notice sets out more information about how we fulfil our responsibilities as a data controller and about your rights as an individual under the data protection legislation. We ask you to read this Notice so that you can fully understand the basis on which we will process your information.

Publication

You will not be able to be identified in any external reports or publications about the research without your specific consent. Otherwise your information will only be included in these materials in an anonymous form, i.e. you will not be identifiable.

Research results will be published in an academic journal, but no individual will be identified.

Security and access controls

BU will hold the information we collect about you in hard copy in a secure location and on a BU password protected secure network where held electronically.

Except where it has been anonymised your personal information will be accessed and used only by appropriate, authorised individuals and when this is necessary for the purposes of the research or another purpose identified in the Privacy Notice. This may include giving access to BU staff or others responsible for monitoring and/or audit of the study who need to ensure that the research is complying with applicable regulations.

The information collected about you may be used in an anonymous form to support other research projects in the future and access to it in this form will not be restricted. It will not be possible for you to be identified from this data. Anonymised data will be added to BU's Data Repository (a central location where data is stored) and which will be publicly available.

Has the research been approved?

This research has been reviewed and approved in line with BU's research ethics code of practice.

Contact for further information

If you have any questions or would like further information, please contact:

Karim Khaled (Bournemouth University) - khaledk@bournemouth.ac.uk
Vanora Hundley (Bournemouth University) - vhundley@bournemouth.ac.uk
Fotini Tsofliou (Bournemouth University) - ftsofliou@bournemouth.ac.uk

In case of complaints
Any concerns about the study should be directed to Karim Khaled (khaledk@bournemouth.ac.uk). If you concerns have not been answered by Karim Khaled, you should contact Professor Stephen Tee, the Executive Dean of the Faculty of Health and Social Sciences at Bournemouth University by email to researchgovernance@bournemouth.ac.uk.

Finally

We hope that you will take the opportunity to participate in the survey.
The survey will stay open until September 2019.

Thank you for considering taking part in this research project.

Appendix 7 – Online survey preview

ONLINE SURVEY

Page 1

Consent to participation *(Please find attached "Page 1-a" in the Appendix)*

This survey is being conducted by Karim Khaled, a nutrition PhD student at Bournemouth University (BU) under the supervision of Professor Vanora Hundley and Dr Fotini Tsofliou as part of a PhD project. You are invited to participate in this project that will investigate the association between diet quality and stress among BU female students of reproductive age, who have not reached menopause.

Your participation in the study is voluntary. We hope that you will choose to complete the survey, but you do not have to do so. If you decide to participate in this survey, you may withdraw at any time. Non-participation or withdrawal will not affect you in any way.

The procedure involves completing an online survey that will take few minutes. Your responses are confidential and anonymous.

Only I, and my supervisory team, will be able to access the study data. Anonymised data collected in this study may be used in future reports, such as academic journals and conference presentations. However, all details are anonymous and no individual will be identifiable through such publication of data. For the protection of yourself and the researchers conducting this study, this research has been reviewed and approved in line with Bournemouth University's research ethics code of practice.

If you have any questions about the survey, please contact:
Karim Khaled (Bournemouth University) - khaledk@bournemouth.ac.uk
Vanora Hundley (Bournemouth University) - vhundley@bournemouth.ac.uk
Fotini Tsofliou (Bournemouth University) - ftsofliou@bournemouth.ac.uk

Clicking on the "agree" button below indicates that:

- Agree to participate in the survey
- Disagree- do not wish to participate

(Participants who tick on "Disagree" box will be automatically directed to the end page of the survey where there is a thank you statement (Please see Page 9 in the Appendix))

Participants will be also asked to tick boxes to check if they are within the inclusion criteria of this study and hence eligible to participate *(Please see Page 1-b in Appendix)*

Page 2

EPIC Food Frequency Questionnaire *(Please see Part of Page 2 in the Appendix)*

Each food item will have the following frequency options of the average use in the last year on the right hand side of each food item:

Never or less than once/month

1-3 per month

Once a week

2-4 per week

5-6 per week

Once a day

2-3 per day

4-5 per day

6+ per day

Food items:

Meat and Fish (Medium servings)

Beef: roast, steak, mince, stew or casserole

Beef burgers

Pork: roast, chops, stew or slices

Lamb: roast, chops or stew

Chicken or other poultry eg. turkey

Bacon

Ham

Corned beef, spam, luncheon meats

Sausages

Savoury pies, eg. meat pie, pork pie, pasties, steak & kidney pie, sausage rolls

Liver, liver pate, liver sausage

Fried fish in batter, as in fish and chips

Fish fingers, fish cakes

Other white fish, fresh or frozen, eg. cod, haddock, plaice, sole, halibut

Oily fish, fresh or canned, eg. mackerel, kippers, tuna, salmon, sardines, herring

Shellfish, eg. crab, prawns, mussels

Fish roe, taramasalata

Bread and Savoury Biscuits (one slice or biscuit)

White bread and rolls

Brown bread and rolls

Wholemeal bread and rolls

Cream Crackers, cheese biscuits

Crispbread, eg. Ryvita

Cereals (one bowl)

Porridge, Readybrek

Breakfast cereal such as cornflakes, muesli etc.

Potatoes, Rice, and Pasta (medium servings)

Boiled, mashed, instant or jacket potatoes

Chips

Roast potatoes

Potato salad

White rice

Brown rice

White or green pasta, eg. spaghetti, macaroni, noodles

Wholemeal pasta

Lasagne, moussaka

Pizza

Dairy Products and Fats

Single or sour cream (tablespoon)

Double or clotted cream (tablespoon)

Low-fat yoghurt, fromage frais (125g carton)

Full-fat or Greek yoghurt (125g carton)

Dairy desserts (125g carton)

Cheese, eg. Cheddar, Brie, Edam (medium servings)

Cottage cheese, low-fat soft cheese (medium servings)

Eggs as boiled, fried, scrambled, etc. (one)

Quiche (medium servings)

Low calorie, low-fat salad cream (tablespoon)

Salad cream, mayonnaise (tablespoon)

French dressing (tablespoon)

Other salad dressing (tablespoon)

The following on bread or vegetables:

- Butter (teaspoon)
- Block margarine, eg. Stork, Krona (teaspoon)
- Polyunsaturated margarine (tub), eg. Flora, sunflower (teaspoon)
- Other soft margarine, dairy spreads (tub), eg. Blue Band, Clover (teaspoon)
- Low fat spread (tub), eg. Outline, Gold (teaspoon)
- Very low fat spread (tub) (teaspoon)

Sweets and Snacks (medium serving)

Sweet biscuits, chocolate, eg. digestive (one)

Sweet biscuits, plain, eg. Nice, ginger (one)

Cakes eg. fruit, sponge, home baked

Cakes eg. fruit, sponge, ready-made

Buns, pastries eg. scones, flapjacks, home baked

Buns, pastries eg. croissants, doughnuts, ready-made

Fruit pies, tarts, crumbles, home baked

Fruit pies, tarts, crumbles, ready-made

Sponge puddings, home baked

Sponge puddings, ready-made

Milk puddings, eg. rice, custard, trifle

Ice cream, choc ices

Chocolates, single or squares

Chocolate snack bars eg. Mars, Crunchie

Sweets, toffees, mints

Sugar added to tea, coffee, cereal (teaspoon)

Crisps or other packet snacks, eg. Wotsits

Peanuts or other nuts

Soups, Sauces, and Spreads

Vegetable soups (bowl)

Meat soups (bowl)

Sauces, eg. white sauce, cheese sauce, gravy (tablespoon)

Tomato Ketchup (tablespoon)

Pickles, chutney (tablespoon)

Marmite, Bovril (teaspoon)

Jam, marmalade, honey (teaspoon)

Peanut butter (teaspoon)

Drinks

Tea (cup)

Coffee, instant or ground (cup)

Coffee, decaffeinated (cup)

Coffee whitener, eg. coffer-mate (teaspoon)

Cocoa, hot chocolate (cup)

Horlicks, Ovaltine (cup)

Wine (glass)

Beer, lager or cider (half a pint)

Port, sherry, vermouth, liqueurs (glass)

Spirits, eg. gin, brandy, whisky, vodka (single)

Low calorie or diet fizzy soft drinks (glass)

Fizzy soft drinks, eg. Coca-cola, lemonade (glass)

Pure fruit juice (100%) eg. orange, apple juice (glass)

Fruit squash or cordial (glass)

Fruit For seasonal fruits marked*, please estimate your average use when the fruit is in season

Apple (1 fruit)

Pears (1 fruit)

Oranges, satsumas, mandarins (1fruit)

Grapefruit (half)

Bananas (1 fruit)

Grapes (medium serving)

Melon (1 slice)

Peaches, plums apricots (1 fruit)

Strawberries, raspberries, kiwi fruit (medium serving)

Tinned fruit (medium serving)

Dried fruit, eg. raisins, prunes (medium serving)

Vegetables Fresh, frozen or tinned (medium serving)

Carrots

Spinach

Broccoli, spring greens, kale

Brussels sprouts

Cabbage

Peas

Green beans, broad beans, runner beans

Marrow, courgettes

Cauliflower

Parsnips, turnips, swedes

Leeks

Onions

Garlic

Mushrooms

Sweet peppers

Beansprout

Green salad, lettuce, cucumber, celery

Watercress

Tomatoes

Sweetcorn

Beetroot

Coleslaw

Avocado

Baked beans

Dried lentils, beans, peas

Tofu, soy meat, TVP, Vegeburger

Are there any OTHER foods which you ate more than once a week? If yes, please list below

Yes No, if yes please specify food, usual serving size, number of times eaten each week.

What type of milk did you most often use?

Full cream, silver

Skimmed/blue

Dried milk

Semi-skimmed, red/white

Channel Islands, gold

Soya

None

Other, specify

How much milk did you drink each day, including milk with tea, coffee, cereals etc?

None

Quarter of a pint

Half a pint

Three quarters of a pint

One pint

More than one pint

Do you usually eat breakfast cereal (excluding porridge and Ready Brek mentioned earlier)?

Do you usually eat breakfast cereal (excluding porridge and Ready Brek mentioned earlier)?

Yes/No?

If yes, which brand and type of breakfast cereal including muesli, did you usually eat? List the one or two types most often used. For example, Brand: Kellogg's, Type: cornflakes.

What kind of fat did you most often use for frying, roasting, grilling etc?

Butter

Lard/dripping

Vegetable oil

Solid vegetable fat

Margarine

None

If you used vegetable oil, please give type eg. corn, sunflower

What kind of fat did you most often use for baking cakes etc?

Butter

Lard/dripping

Vegetable oil

Solid vegetable fat

Margarine

None

If you used margarine, please give the name or type eg. Flora, Stork

How often did you eat food that was fried at home?

Daily

1-3 times a week

4-6 times a week

Less than once a week

Never

How often did you eat fried food away from home?

Daily

1-3 times a week

4-6 times a week

Less than once a week

Never

What did you do with the visible fat on your meat?

Ate most of the fat

Ate some of the fat

Ate as little as possible

Did not eat meat

How often did you eat grilled or roast meat (times a week)?

How well cooked did you usually have grilled or roast meat?

Well done/dark brown

Medium

Lightly cooked/ rare

Did not eat meat

How often did you add salt to food while cooking?

Always

Usually

Sometimes

Rarely

Never

How often did you add salt to any food at the table

Always

Usually

Sometimes

Rarely

Never

Did you regularly use a salt substitute (eg LoSalt)?

Yes/No, if yes, which brand?

During the course of last year, on average, how many times a week did you eat the following foods?

Vegetables (not including potatoes) *Medium serving

Salads *Medium serving

Fruit and fruit products (not including fruit juice) *Medium serving or 1 fruit

Fish and fish products *Medium serving

Meat, meat products and meat dishes (including bacon, ham and chicken) *Medium serving

Have you taken any vitamins, minerals, fish oils, fibre or other food supplements during the past year?

Yes/No/Don't know

If yes, please complete the table below, if you have taken more than 5 types of supplement please put the most frequently consumed brands first.

Name and Brand (Please list full name, brand and strength

Dose (please state number of pills, capsules or teaspoons consumed)

Average frequency Tick one box per line to show how often on average you consumed supplements:

Never or less than once a month

1-3 per month

Once a week

2-4 per week

5-6 per week

Once a day

2-3 per day

4-5 per day

6+ per day

Page 3

International Physical Activity Questionnaire *(Please see Page 3 in the Appendix)*

1- Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling? (If No vigorous physical activities, skip the next question)

1-a. How much time did you usually spend doing vigorous physical activities on one of those days? (Hours/day or Minutes/day)

2- Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking. (If No moderate physical activities, skip the next question)

2-a. How much time did you usually spend doing moderate physical activities on one of those days? (Hours/day or Minutes/day)

3- Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

3-a. How much time did you usually spend walking on one of those days? (Hours/day or Minutes/day)

4- The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television. During the last 7 days, how much time did you spend sitting on a week day? (Hours/day or Minutes/day)

Page 4

Perceived Stress Scale *(Please see page 4 in Appendix)*

1-In the last month, how often have you been upset because of something that happened unexpectedly?

2-In the last month, how often have you felt that you were unable to control the important things in your life?

3- In the last month, how often have you felt nervous or stressed?

4- In the last month, how often have you dealt successfully with irritating life hassles?

5- In the last month, how often have you felt that you were effectively coping with important changes that were occurring in your life?

6- In the last month, how often have you felt confident about your ability to handle your personal problems?

7- In the last month, how often have you felt that things are going your way?

8- In the last month, how often have you felt that you could not cope with all the things you had to do?

9- In the last month, how often have you been able to control irritations in your life?

10- In the last month, how often have you felt that you were on the top of things?

11- In the last month, how often have you been angered because of things that happened that were outside your control?

12- In the last month, how often have you been thinking of things that you have to accomplish?

13- In the last month, how often have you been able to control the way you spend you time?

14- In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

Participants will tick one of the following five options on each of the above 14 questions.

Never

Almost Never

Sometimes

Fairly Often

Very Often

Page 5

Beck's Depression Inventory *(Please see part of page 5 in the Appendix)*

1.

0 I do not feel sad.

1 I feel sad

2 I am sad all the time and I can't snap out of it.

3 I am so sad and unhappy that I can't stand it.

2.

0 I am not particularly discouraged about the future.

1 I feel discouraged about the future.

2 I feel I have nothing to look forward to.

3 I feel the future is hopeless and that things cannot improve.

3.

0 I do not feel like a failure.

1 I feel I have failed more than the average person.

2 As I look back on my life, all I can see is a lot of failures.

3 I feel I am a complete failure as a person.

4.

0 I get as much satisfaction out of things as I used to.

1 I don't enjoy things the way I used to.

2 I don't get real satisfaction out of anything anymore.

3 I am dissatisfied or bored with everything.

5.

0 I don't feel particularly guilty

1 I feel guilty a good part of the time.

2 I feel quite guilty most of the time.

3 I feel guilty all of the time.

6.

0 I don't feel I am being punished.

1 I feel I may be punished.

2 I expect to be punished.

3 I feel I am being punished.

7.

0 I don't feel disappointed in myself.

1 I am disappointed in myself.

2 I am disgusted with myself.

3 I hate myself.

8.

0 I don't feel I am any worse than anybody else.

1 I am critical of myself for my weaknesses or mistakes.

2 I blame myself all the time for my faults.

3 I blame myself for everything bad that happens.

9.

0 I don't have any thoughts of killing myself.

1 I have thoughts of killing myself, but I would not carry them out.

2 I would like to kill myself.

3 I would kill myself if I had the chance.

10.

0 I don't cry any more than usual.

1 I cry more now than I used to.

2 I cry all the time now.

3 I used to be able to cry, but now I can't cry

11.

0 I am no more irritated by things than I ever was.

1 I am slightly more irritated now than usual.

2 I am quite annoyed or irritated a good deal of the time.

3 I feel irritated all the time.

12.

0 I have not lost interest in other people.

1 I am less interested in other people than I used to be.

2 I have lost most of my interest in other people.

3 I have lost all of my interest in other people.

13.

0 I make decisions about as well as I ever could.

1 I put off making decisions more than I used to.

2 I have greater difficulty in making decisions more than I used to.

3 I can't make decisions at all anymore.

14.

0 I don't feel that I look any worse than I used to.

1 I am worried that I am looking old or unattractive.

2 I feel there are permanent changes in my appearance that make me look unattractive

3 I believe that I look ugly.

15.

0 I can work about as well as before.

1 It takes an extra effort to get started at doing something.

2 I have to push myself very hard to do anything.

3 I can't do any work at all.

16.

0 I can sleep as well as usual.

1 I don't sleep as well as I used to.

2 I wake up 1-2 hours earlier than usual and find it hard to get back to sleep.

3 I wake up several hours earlier than I used to and cannot get back to sleep.

17.

0 I don't get more tired than usual.

1 I get tired more easily than I used to.

2 I get tired from doing almost anything.

3 I am too tired to do anything.

18.

0 My appetite is no worse than usual.

1 My appetite is not as good as it used to be.

2 My appetite is much worse now.

3 I have no appetite at all anymore.

19.

0 I haven't lost much weight, if any, lately.

1 I have lost more than five pounds.

2 I have lost more than ten pounds.

3 I have lost more than fifteen pounds.

20.

0 I am no more worried about my health than usual.

1 I am worried about physical problems like aches, pains, upset stomach, or constipation.

2 I am very worried about physical problems and it's hard to think of much else.

3 I am so worried about my physical problems that I cannot think of anything else.

21.

0 I have not noticed any recent change in my interest in sex.

1 I am less interested in sex than I used to be.

2 I have almost no interest in sex.

3 I have lost interest in sex completely.

Page 6

Socioeconomic questions *(Please see part of page 6 in the Appendix)*

What is your Age?

What is your legal marital or same-sex civil partnership status?

Never married and never registered a same-sex civil partnership

Married

Separated, but still legally married

Divorced

Widowed

In a registered same-sex civil partnership

Separated, but still legally in a same-sex civil partnership

Formerly in a same-sex civil partnership which is now legally dissolved

Surviving partner from a same-sex civil partnership

How many times have you given birth (regardless of whether the child was born alive or was stillborn)?

Never

Once

Two times or more

What is your Father's educational level?

No qualifications

Certificate of Secondary education (CSE) taken at 14-16 years at a lower level than GCSE

O-level or GCSE examinations taken at 16 years

A-level school examinations taken at 18 years

Higher education

What is your Mother's educational level?

No qualifications

Certificate of Secondary education (CSE) taken at 14-16 years at a lower level than GCSE

O-level or GCSE examinations taken at 16 years

A-level school examinations taken at 18 years

Higher education

What is your Father's Occupation?

working as an employee?

on a government sponsored training scheme?

self-employed or freelance?

working paid or unpaid for your own or your family's business?

doing any other kind of paid work?

retired (whether receiving a pension or not)?

a student?

looking after home or family?

long-term sick or disabled?

What is your Mother's Occupation?

working as an employee?

on a government sponsored training scheme?

self-employed or freelance?

working paid or unpaid for your own or your family's business?

doing any other kind of paid work?

retired (whether receiving a pension or not)?

a student?

looking after home or family?

long-term sick or disabled?

What is your ethnicity?

Mixed / multiple ethnic groups

White

Asian / Asian British

Black / African / Caribbean / Black British

Other ethnic group

If other, please specify:

What is you smoking status?

Current smoker

Never smoked

Ex-smoker

What is your parents' household income per year?

<£13,000

£13,000 to £23,400

>£23,400 to £33,800

>£33,800 to £52,000

>£52,000

What is your income per year?

<£13,000

£13,000 to £23,400

>£23,400 to £33,800

>£33,800 to £52,000

>£52,000

What is your religion?

No religion

Christian (including Church of England, Catholic, Protestant and all

Other Christian denominations)

Buddhist

Hindu

Jewish

Muslim

Sikh

Any other religion? Please specify:

Page 7

Physical Characteristics *(Please see page 7 in the Appendix)*

What is your current weight (Kg)?

What is your Height (cm)?

What is your waist circumference (cm)?

(2 images that guide participants on how to measure their waist circumference correctly will be attached here)

Page 8

Phase 2 of the study *(Please see page 8 in Appendix)*

Phase Two is a study that requires a one-to-one interview.

What will phase 2 include?

Participants in phase 2 will:

- Provide their dietary intake through a food frequency questionnaire (paper format).

-Answer some socioeconomic questions (paper format).

-Have their body composition measured using Tanita.

-Provide saliva samples (non-invasive and safe).

-Wear accelerometer to measure their physical activity.

If you are interested in participating in Phase 2 of the project, please copy and paste the link below in a new web page where you can provide you email address in order to be contacted before launching phase 2. (*See Appendix 10 for the link*)

https://bournemouth.onlinesurveys.ac.uk/interested-in-participating-in-phase-2-of-the-project

Please note that providing your email address in the link above ensures that all your data, which have been filled in the survey, are anonymous and you cannot be identified.

Page 9

Prize Draw

To thank you for your participation, a prize draw of a £100 Amazon Voucher will be done by randomly selecting one participant who has completed the survey.

In order to enter the prize draw, please copy and paste the link below in a new web page where you can provide your email address. If you *win* the prize, you will be contacted through the email address that you provide in the link below (*See Appendix 11*).
https://bournemouth.onlinesurveys.ac.uk/prize-draw

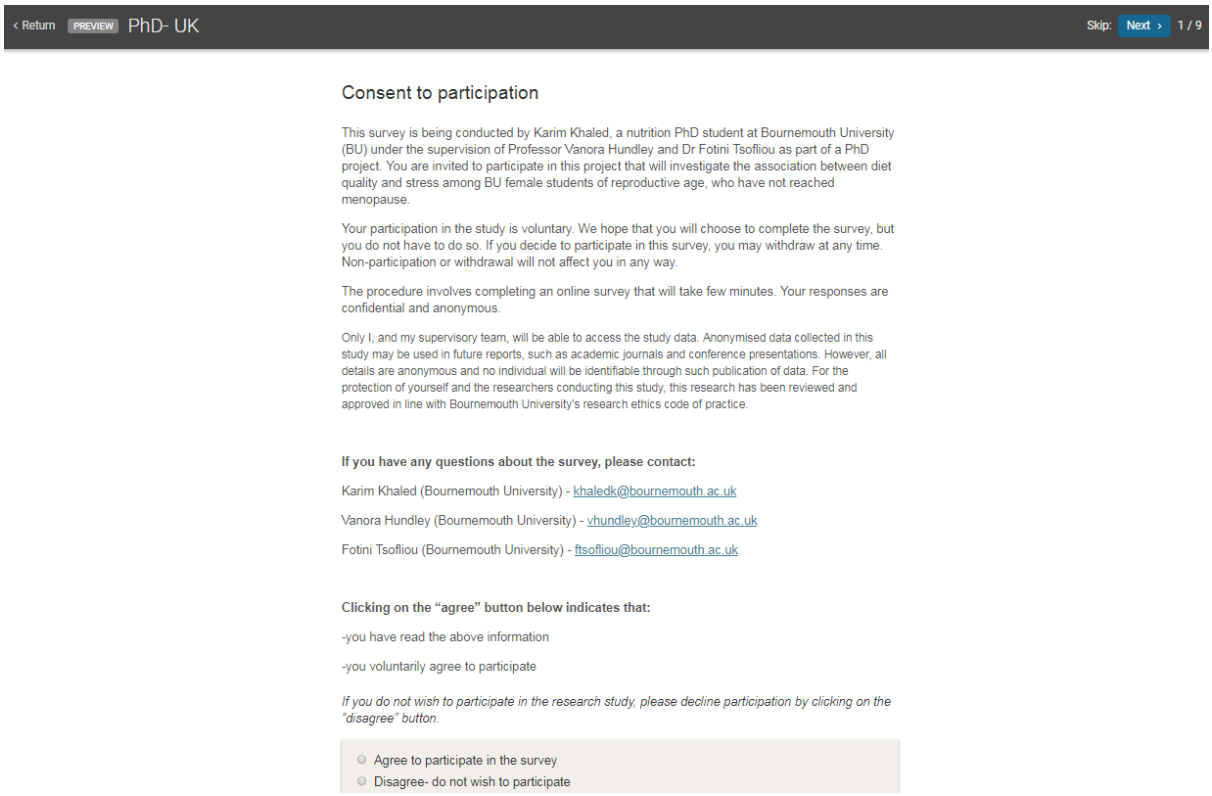
Please note that providing your email address in the link above ensures that all your data, which have been filled in the survey, are anonymous and you cannot be identified.

Page 10

Thank you for your interest and time.

Appendix 8 – Preview of Survey

Page 1-a of the survey (Consent form)



Page 1-b of the survey (Inclusion/Exclusion Criteria)

- Agree to participate in the survey
- Disagree- do not wish to participate

Please select "agree" or "disagree" on the following statements in order to see if you meet the inclusion criteria ofthis study.

This part of the survey uses a table of questions, view as separate questions instead?

	Agree	Disagree
You are a Female at birth.	○	○
You are 18-49 years old.	○	○
You are a student or staff	○	○
You do not suffer from any chronic illness or disease such as: Cancer, Crohns Disease, Diabetes, Heart Disease, HIV/AIDS/ Multiple sclerosis, Asthma, COPD, Cystic fibrosis, or mental health disorder.	○	○
You do not have any kind of food intolerance or food allergy.	○	○
You are not pregnant or breastfeeding.	○	○
You are not on any medication known to affect appetite or body weight.	○	○
You have not undergone any bariatric surgery.	○	○

If you have ticked "agree" on **ALL** of the above statements, then you are eligible to participate in this survey.

If you have ticked "disagree" on one or more of the boxes above, then you are **NOT** eligible to participate in this survey.

Next ›

Part of page 2 (Food Frequency Questionnaire)

‹ Return PREVIEW PhD- UK Skip: ‹ Previous Next › 2 / 8

Diet

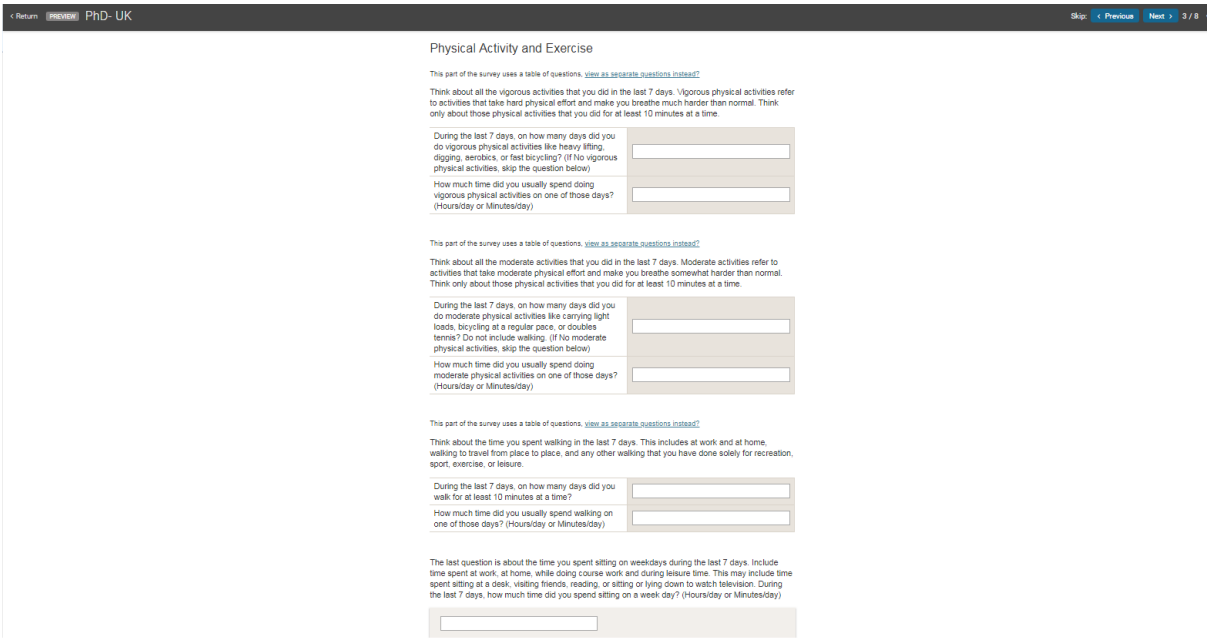
Please report your intake over the last year of all food items included below by ticking on the frequency of consumption to the right side of each food item.

This part of the survey uses a table of questions, view as separate questions instead?

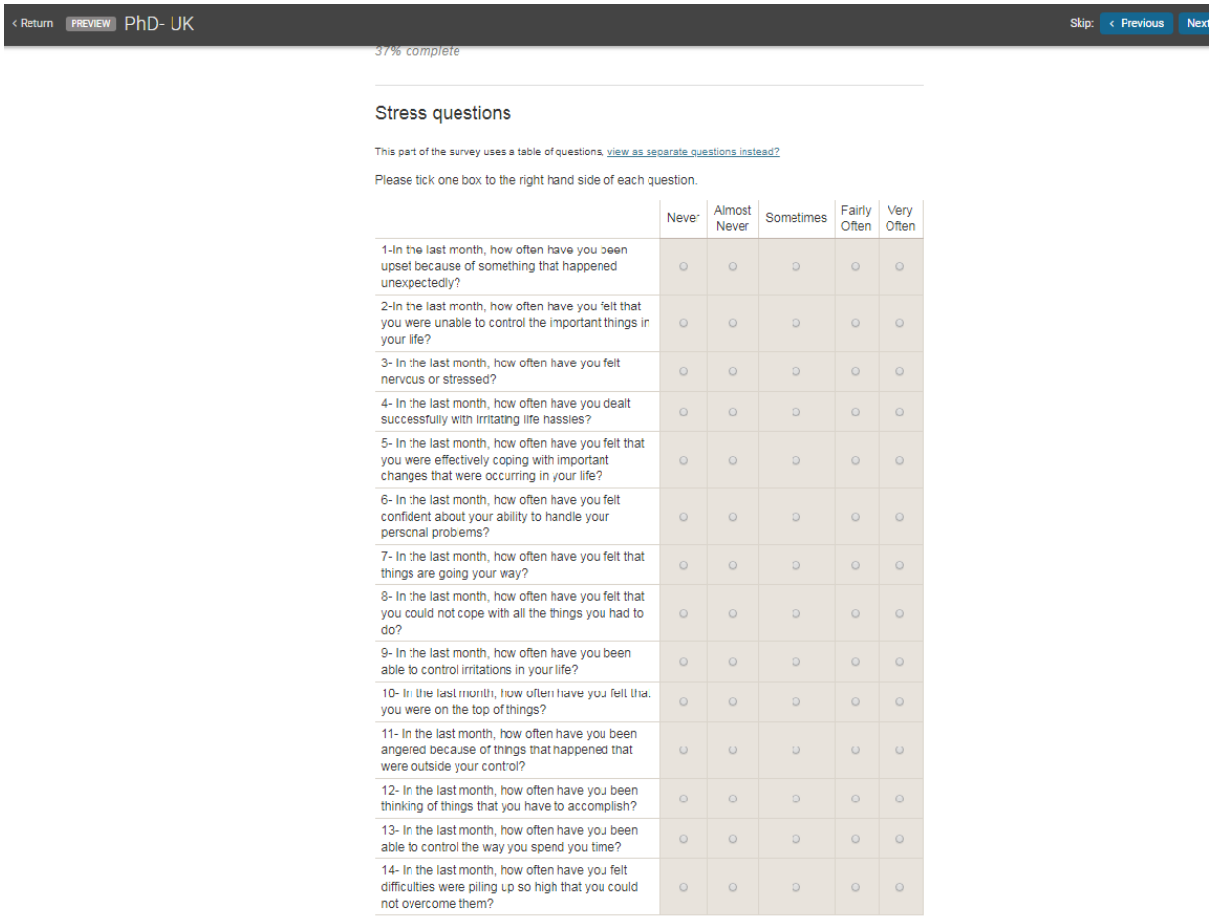
Meat, Poultry, and Fish

	Frequency of consumption of each food item								
	Never or less than once/month	1-3 per month	Once a week	2-4 per week	5-6 per week	Once a day	2-3 per day	4-5 per day	6+ per day
Beef: roast, steak, mince, stew or casserole	○	○	○	○	○	○	○	○	○
Beef burgers	○	○	○	○	○	○	○	○	○
Pork: roast, chops, stew or slices	○	○	○	○	○	○	○	○	○
Lamb: roast, chops or stew	○	○	○	○	○	○	○	○	○
Chicken or other poultry eg. turkey	○	○	○	○	○	○	○	○	○
Bacon	○	○	○	○	○	○	○	○	○
Ham	○	○	○	○	○	○	○	○	○
Corned beef, spam, luncheon meats	○	○	○	○	○	○	○	○	○
Sausages	○	○	○	○	○	○	○	○	○
Savoury pies, eg. meat pie, pork pie, pasties, steak & kidney pie, sausage rolls	○	○	○	○	○	○	○	○	○
Liver, liver pate, liver sausage	○	○	○	○	○	○	○	○	○
Fried fish in batter, as in fish and chips	○	○	○	○	○	○	○	○	○
Fish fingers, fish cakes	○	○	○	○	○	○	○	○	○
Other white fish, fresh or frozen, eg. cod, haddock, plaice, sole	○	○	○	○	○	○	○	○	○

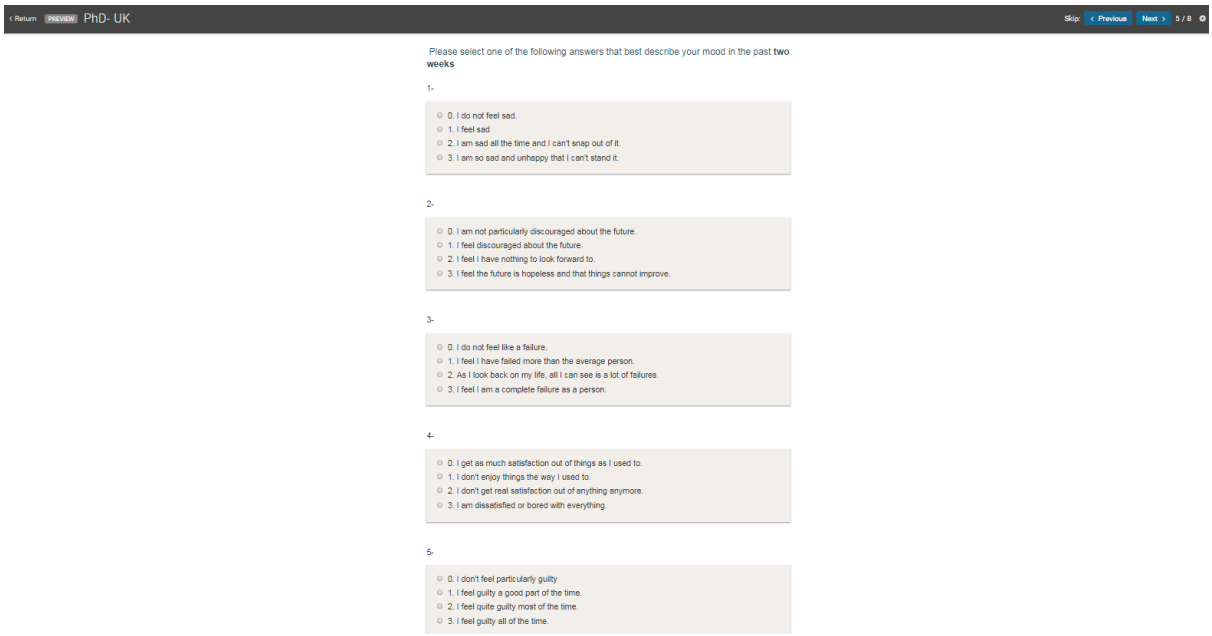
Page 3 (Physical Activity Questionnaire)



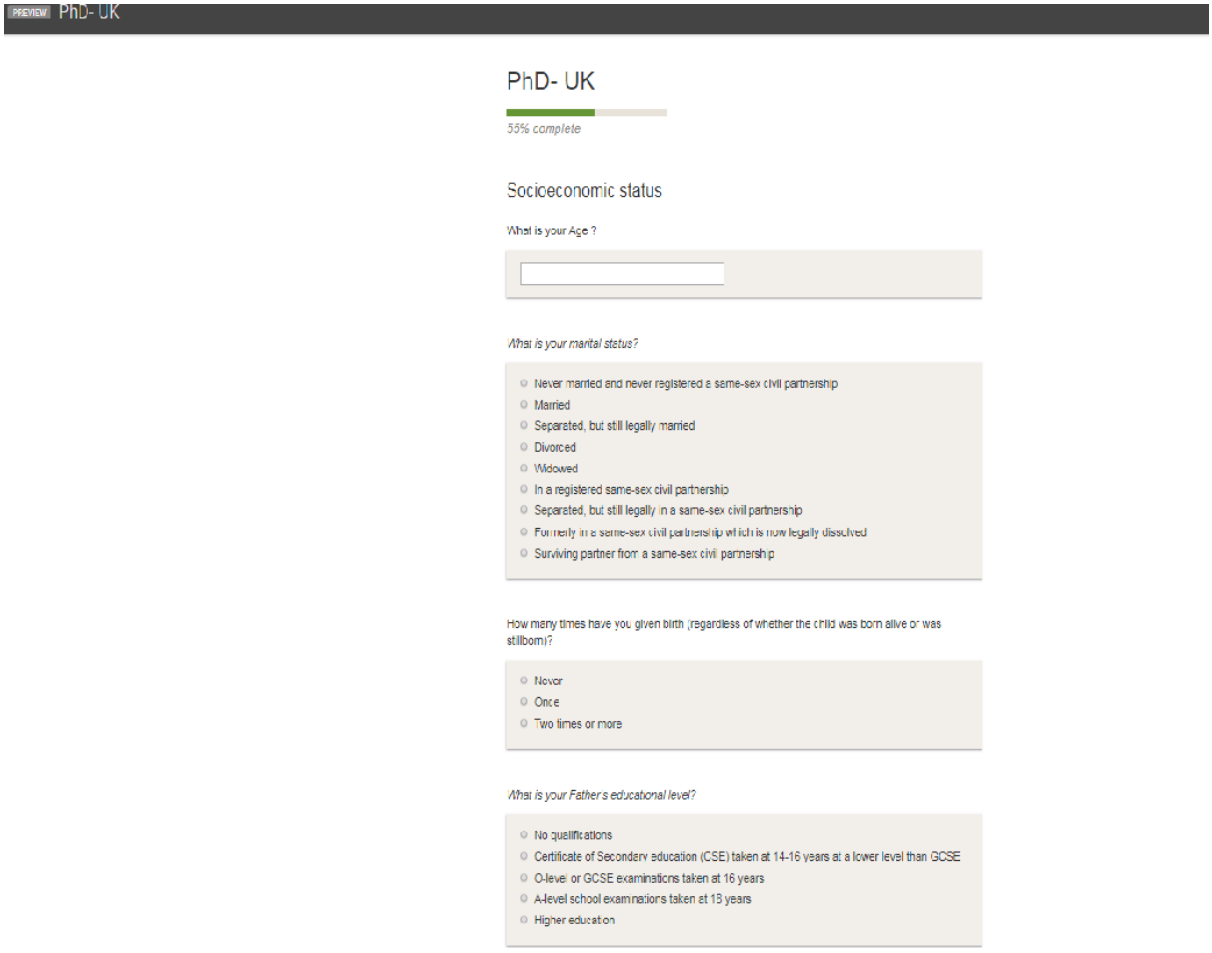
Page 4 (Perceived Stress Scale)

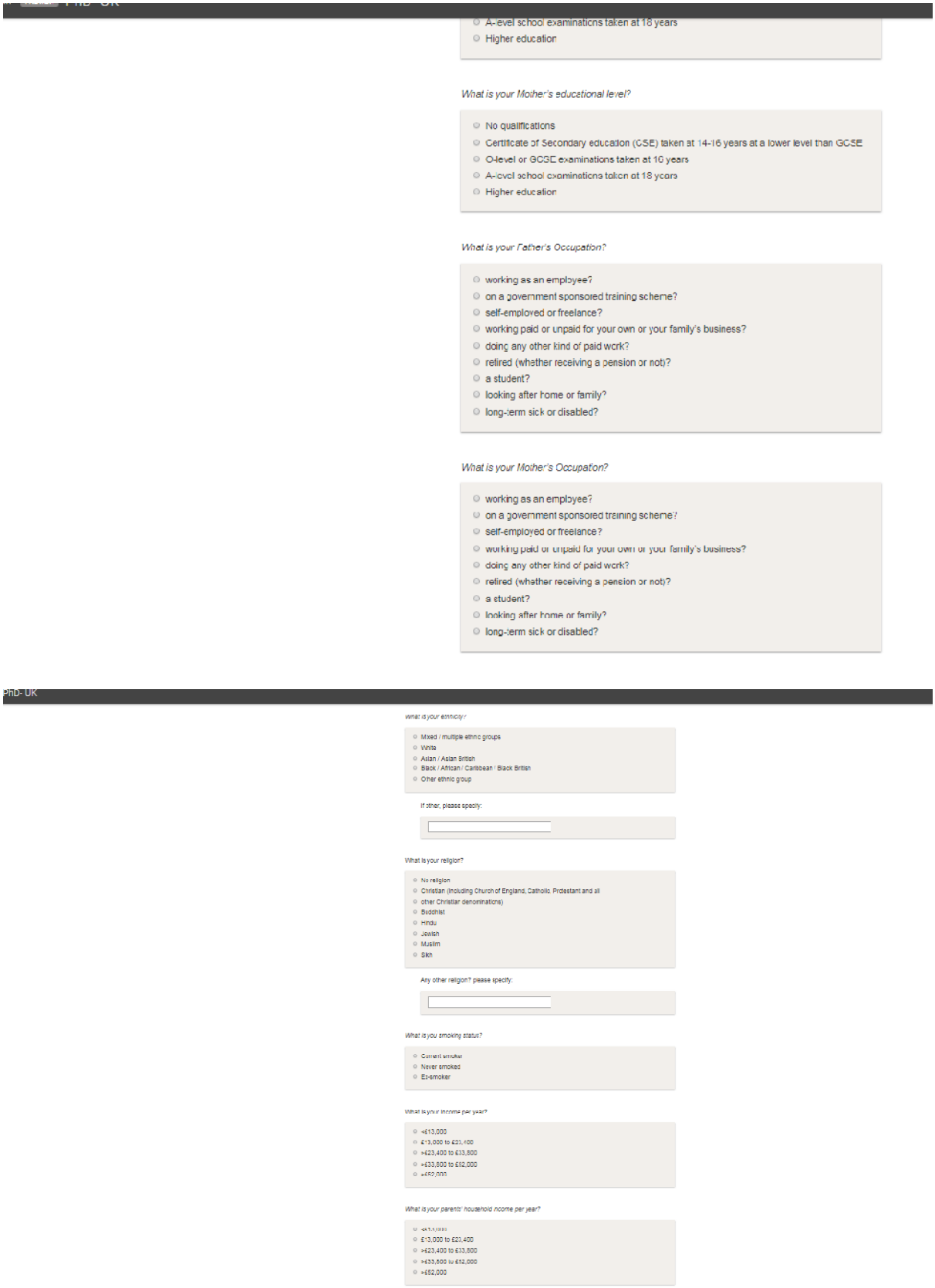


Part of page 5 (21- item Beck Depression Inventory II)

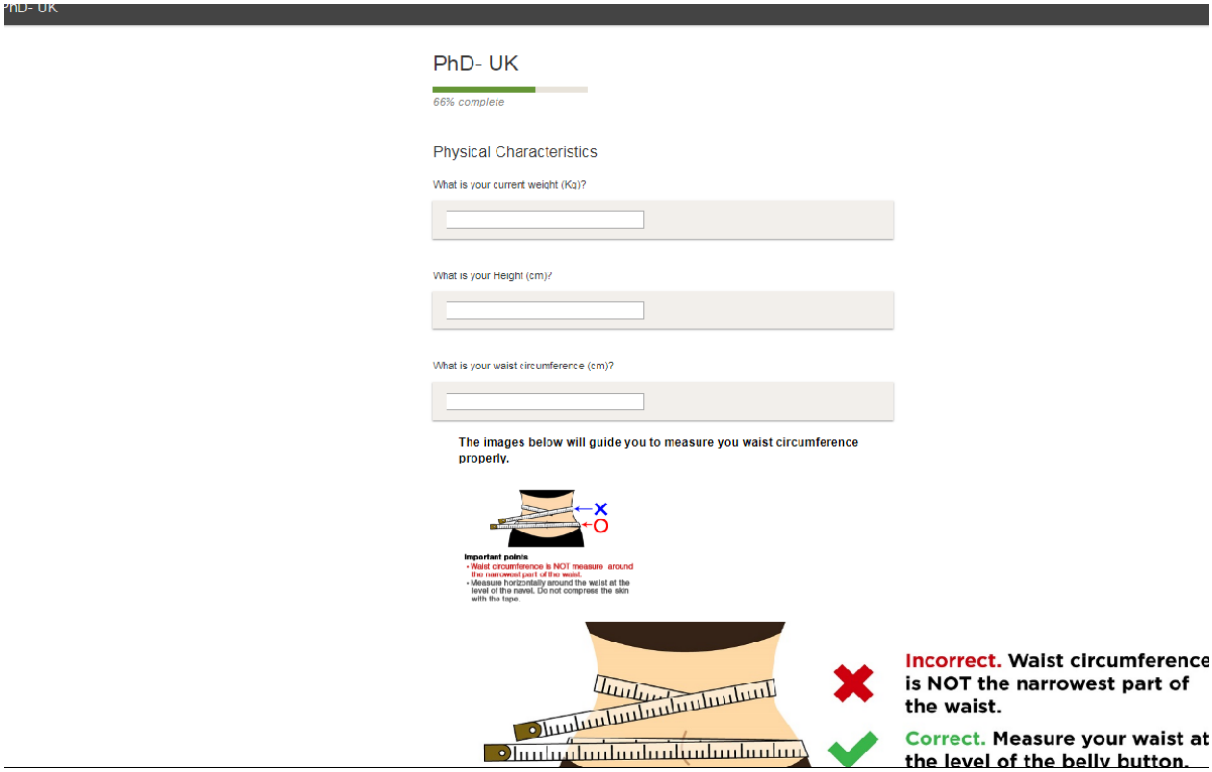


Part of page 6 (socioeconomic questions)

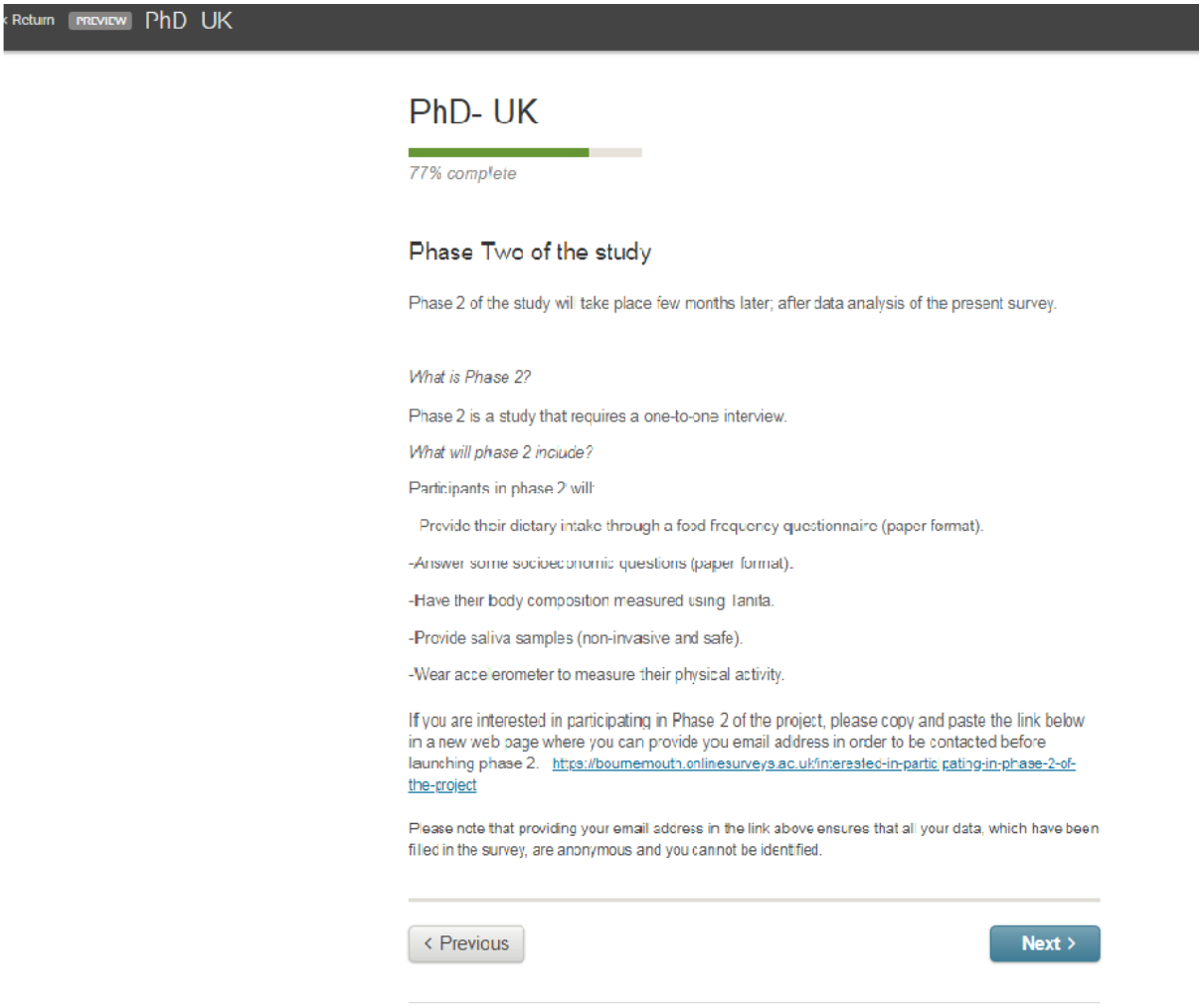




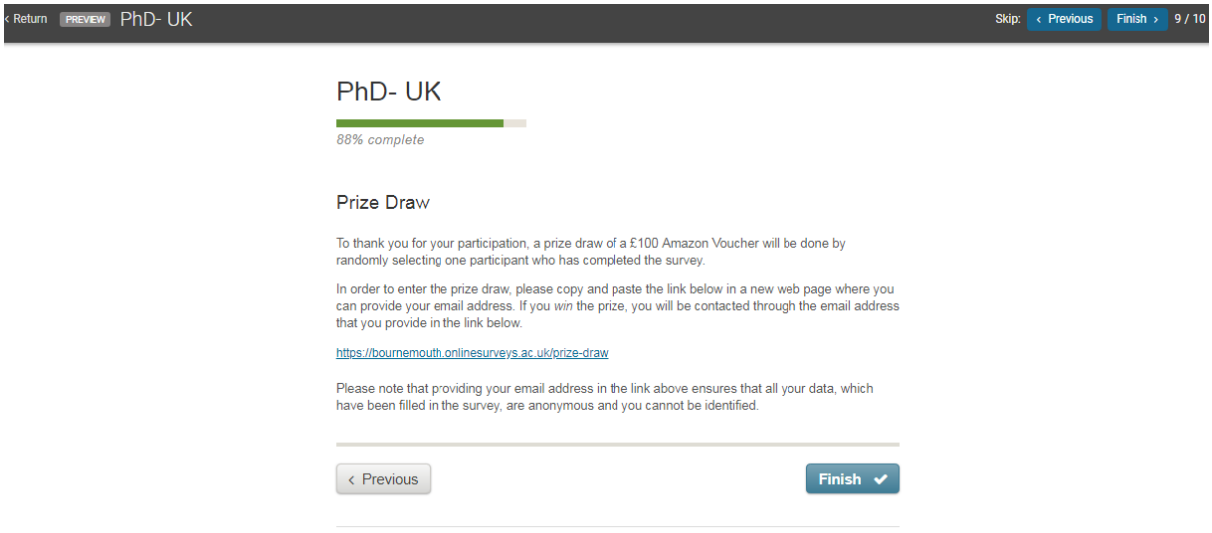
Page 7 (Physical Characteristics)



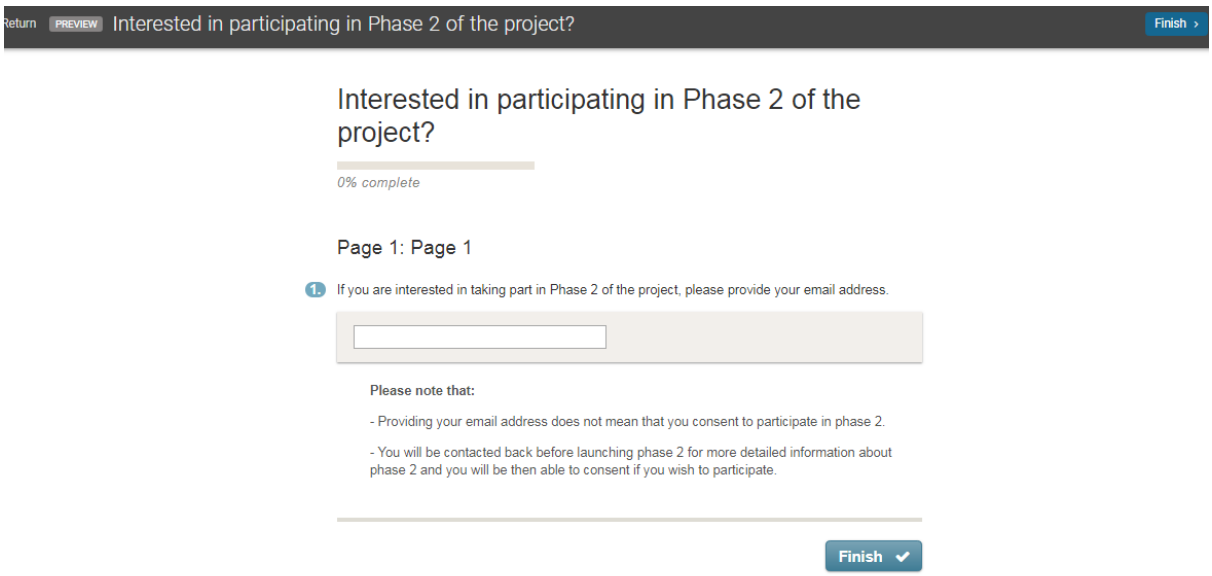
Page 8 (introducing phase two)



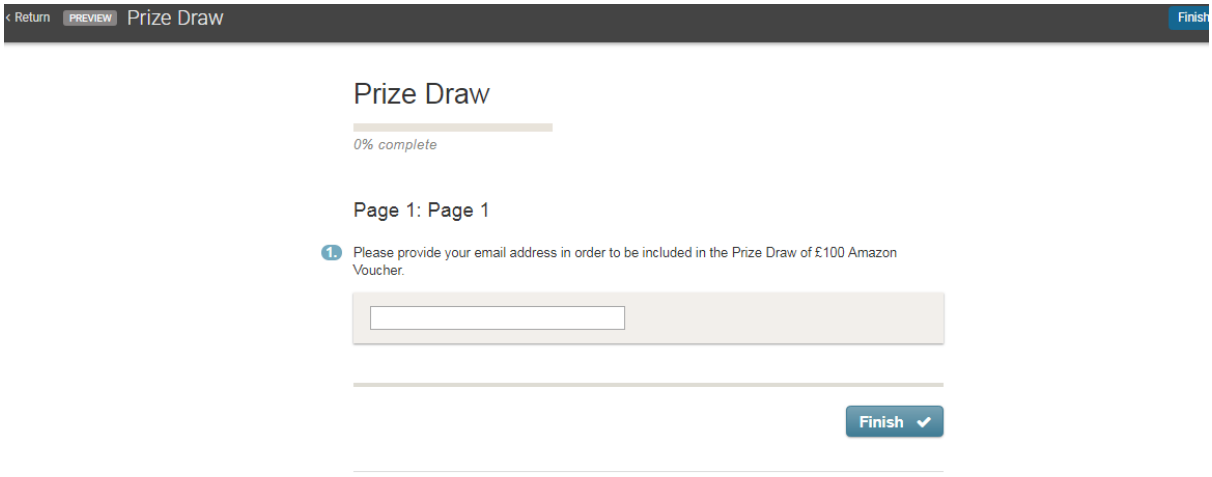
Page 9 (Prize Draw)

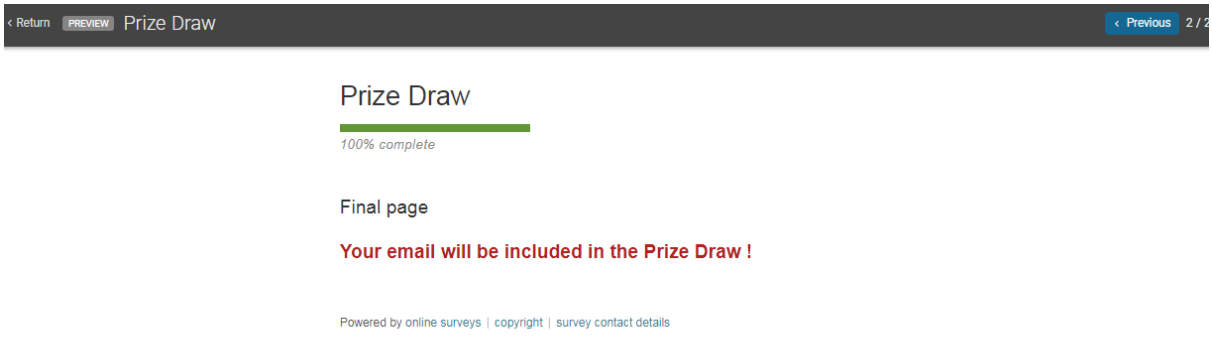


Appendix 10 (page of the link to provide email address if interested in phase 2)



Appendix 11 (page of the link to provide email address to be included in the prize draw)


‹ Return
PREVIEW
Prize Draw
Finish
Prize Draw
0% complete
Page 1: Page 1
1.
Please provide your email address in order to be included in the Prize Draw of £100 Amazon Voucher.
Finish


‹ Return
PREVIEW
Prize Draw
‹ Previous
2 / 2
Prize Draw
100% complete
Final page
Your email will be included in the Prize Draw !
Powered by online surveys | copyright | survey contact details

Appendix 9 - STH REP Approval Letter amendment

University Research Ethics Committee
Science, Technology & Health Research Ethics Panel
Bournemouth University
Melbury House 402
1-3 Oxford Rd
Bournemouth
BH8 8ES
Telephone: 01202 961073

20th November 2019

Karim Khaled

Bournemouth University

Royal London House

Christchurch Road

Bournemouth, Dorset

BH1 3LT

Dear Karim:

Project Title:	Association between Diet Quality and Stress in Women of Reproductive Age from a University population in Three Countries: UK, USA, and Lebanon
Ethics Reference ID:	22344

Thank you for applying for Bournemouth University ethics approval.

This letter is to confirm that your ethics checklist for the above research project was reviewed by the Science, Technology & Health Research Ethics Panel, and was approved on 3rd December 2018.

This letter also confirms that approval was granted on 20th November 2019 for your amendment to conduct a study to validate the questionnaire at your sites in Lebanon and the USA.

This approval relates to the ethical context of the work. Specific aspects of the implementation of the research project remain your professional responsibility.

It is your responsibility to ensure that where the scope of the research project changes, such changes are evaluated to ensure that the ethics approval you have been granted remains appropriate. You must re-submit for ethics approval if changes to the research project mean that your previous approval is no longer valid.

Yours sincerely,

pp. 

Professor Sam Porter

Chair, Science, Technology & Health Research Ethics Panel

Appendix 10 – CITI ethics completion report

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE

COMPLETION REPORT - COURSEWORK

* NOTE: Scores on this Requirements report reflect quiz completions at the time all requirements for the course were met. See separate Transcript Report for more recent quiz scores, including those on optional

- **Nam** Karim Khaled (ID:
- **Institution** Lebanese American University (LAU)
- **Institution** khaledk@bournemout
- **Institution** LAU School of Arts &
- **Phon** 0044746011

- **Curriculum** Social-Behavioral-Educational
- **Course Learner** Same as Curriculum
- **Stag** Stage 1 - Basic

- **Record** 301112
- **Completion** 22 Ja-
- **Expiration** 21 Ja-
- **Minimum** 7
- **Reported** 8

REQUIRED AND ELECTIVE	DATE	SCO
History and Ethical Principles -	22 Ja-	4/5
Defining Research with Human Subjects -	22 Ja-	5/5
The Federal Regulations - SBE	22 Ja-	4/5
Assessing Risk - SBE	22 Ja-	3/5
Informed Consent - SBE	22 Ja-	3/5
Privacy and Confidentiality - SBE	22 Ja-	4/5
Unanticipated Problems and Reporting Requirements in Social and Behavioral	22 Ja-	4/5
Conflicts of Interest in Human Subjects	22 Ja-	5/5

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI identified above or have been a paid

Verify www.citiprogram.org/verify/?k4a16dc52-15d9-45ec-b666-

Collaborative Institutional Training Initiative
Email: support@citiprogra
Phone: 888-529-
Web: https://www.citiprogr

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI

COMPLETION REPORT - PART 2 OF COURSEWORK TRANSCRIPT**

** NOTE: Scores on this Transcript reflect the most current quiz completions, including quizzes on optional (supplemental) elements of course. See list below for details. See separate Requirements Report for the reported scores at the time all requirements for the course were

- **Name** Karim Khaled (ID:
- **Institution** Lebanese American University (LAU) (ID:
- **Institution** khaledk@bournemouth.ac.u
- **Institution** LAU School of Arts &
- **Phone** 0044746011159

- **Curriculum** Social-Behavioral-Educational
- **Course Learner** Same as Curriculum
- **Stage** Stage 1 - Basic

- **Record** 3011129
- **Report** 22Ja -
- **Current** 8

REQUIRED, ELECTIVE, AND SUPPLEMENTAL	MOST	SCOR
Defining Research with Human Subjects - SBE (ID:	22Jan-2019	5/5 (100%)
The Federal Regulations - SBE (ID:	22Jan-2019	4/5 (80%)
Assessing Risk - SBE (ID:	22Jan-2019	3/5 (60%)
Informed Consent - SBE (ID:	22Jan-2019	3/5 (60%)
Privacy and Confidentiality - SBE (ID:	22Jan-2019	4/5 (80%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID:	22Jan-2019	4/5 (80%)
History and Ethical Principles - SBE (ID:	22Jan-2019	4/5 (80%)
Conflicts of Interest in Human Subjects Research (ID:	22Jan-2019	5/5 (100%)

identified above or have been a paid Independent

Verify :www.citiprogram.org/verify/?k4a16dc52-15d9-45ec-b666-e124118aa7a6e-

Collaborative Institutional Training Initiative (CITI
Email:support@citiprogram.or
Phone: 888-529-
Web:https://www.citiprogram.o

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing

Appendix 11 – CITI completion certificate

CITI PROGRAM

Completion Date 22-Jan-2019
Expiration Date 21-Jan-2022
Record ID 30111291

This is to certify that:

Karim Khaled

Has completed the following CITI Program course:

Social-Behavioral-Educational Researcher (Curriculum Group)
Social-Behavioral-Educational Researcher (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

Lebanese American University (LAU)

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wf43ec1e3-693f-4513-912f-213a2766f013-30111291

Appendix 12 – Participant information sheet for validation study in Lebanon

Participant Information Sheet

The title of the research project

Validation of the European Prospective Investigation into Cancer (EPIC) Food Frequency Questionnaire for use with Adults in Lebanon

Invitation to take part

You are being invited to take part in a survey being conducted by Karim Khaled, a PhD student at Bournemouth University (UK) assessing the validation of a food frequency questionnaire among adults in Lebanon. Before you decide 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 others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the project?

The purpose of the survey is to validate an existing tool, the EPIC food frequency questionnaire, in a new country context, Lebanon.

Why have I been chosen?

You have been chosen since this survey will be conducted among LAU students and staff.

The inclusion criteria of this study are adults who are:

- >18 years old.
- Students and staff.

The Exclusion criteria of this study include adults who are:

- Suffering from a chronic disease such as: Cancer, Crohn's Disease, Diabetes, Heart Disease, HIV/AIDS/ Multiple sclerosis, Asthma, COPD, Cystic fibrosis, or mental health disorder.
- Having food intolerance or allergy.
- Pregnant/breastfeeding.
- On any medication known to affects appetite or have undergone bariatric surgery.

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 given this information sheet to keep and be asked to sign a participant agreement form in the online survey. You can withdraw from participation while filling out the survey at any time and without giving a reason. If you decide to withdraw we will usually remove any data collected about you from the study. Once the online survey has been filled out and finished, you may not be able to withdraw since your data will be anonymous, so your identity cannot be determined, and it may not be possible to identify your data within the anonymous dataset. Therefore, if you wish to withdraw from the study, you can simply stop answering the questions of the survey and exit the web page. We hope that you will choose to participate in the survey, but you do not have to do so. Non-participation will not affect you in any way.

What would taking part involve?

The procedure involves filling an online survey on four different days. You will be followed and reminded by the researcher on each day to fill out different sections of the surveys. To participate in this survey simply click the link below to take you to the online survey:

Link to be developed later

The landing page explains the survey further and you will be given the opportunity to consent to participation at that point.

What are the advantages and possible disadvantages or risks of taking part?

Whilst there are no immediate benefits for those people participating in the project, it is hoped that this work will shed the light on a gold standard dietary assessment tool; the EPIC food frequency questionnaire. According to the results, the EPIC FFQ can be used in Lebanon to enhance the dietary assessment among adults.

What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

In the survey, you will be asked to fill out three 24-hour recalls that ask you what you have eaten in the previous 24 hours (the previous day). Please note that the three 24-hour recalls should be completed on three different days (2 weekdays and weekend day). Additionally, you will be asked to fill in the EPIC food frequency questionnaire. Please note that once the survey has been completed and submitted, it will be impossible to communicate the scores calculated from your response because data will be anonymised.

Filling out this survey will achieve the objective of the research since the research aims to investigate the validity of the EPIC food frequency questionnaire among adults in Lebanon.

How will my information be kept?

All the information we collect about you during the course of the research will be kept strictly in accordance with current data protection legislation. Research is a task that we perform in the public interest, as part of our core function as a university. Bournemouth University (BU) is a Data Controller of your information which means that we are responsible for looking after your information and using it appropriately. BU's Research Participant Privacy Notice sets out more information about how we fulfil our responsibilities as a data controller and about your rights as an individual under the data protection legislation. We ask you to read this Notice so that you can fully understand the basis on which we will process your information.

Publication

You will not be able to be identified in any external reports or publications about the research without your specific consent. Otherwise your information will only be included in these materials in an anonymous form, i.e. you will not be identifiable.

Research results will be published in an academic journal, but no individual will be identified.

Security and access controls

BU will hold the information we collect about you in hard copy in a secure location and on a BU password protected secure network where held electronically.

Except where it has been anonymised your personal information will be accessed and used only by appropriate, authorised individuals and when this is necessary for the purposes of the research or another purpose identified in the Privacy Notice. This may include giving access to BU staff or others responsible for monitoring and/or audit of the study who need to ensure that the research is complying with applicable regulations.

The information collected about you may be used in an anonymous form to support other research projects in the future and access to it in this form will not be restricted. It will not be possible for you to be identified from this data. Anonymised data will be added to BU's Data Repository (a central location where data is stored) and which will be publicly available.

Has the research been approved?

This research has been reviewed and approved in line with LAU Institutional Review Board (IRB).

Contact for further information

If you have any questions or would like further information, please contact:

Karim Khaled (Bournemouth University) - khaledk@bournemouth.ac.uk

Maya Bassil (Lebanese American University) - mbassil@lau.edu.lb

Vanora Hundley (Bournemouth University) - vhundley@bournemouth.ac.uk

Fotini Tsofliou (Bournemouth University) - ftsofliou@bournemouth.ac.uk

In case of complaints

Any concerns about the study should be directed to Karim Khaled (khaledk@bournemouth.ac.uk). If you concerns have not been answered by Karim Khaled, you should contact Professor Stephen Tee, the Executive Dean of the Faculty of Health and

Social Sciences at Bournemouth University by email to researchgovernance@bournemouth.ac.uk.

Finally

We hope that you will take the opportunity to participate in the survey.

The survey will stay open until September 2019.

Thank you for considering taking part in this research project.

Appendix 13 – Consent form for validation study in Lebanon

Consent to participation

This survey is being conducted by Karim Khaled, a nutrition PhD student at Bournemouth University, United Kingdom, in collaboration with the Lebanese American University (LAU) as part of a PhD project. You are invited to participate in this project that will investigate the validity of a Food Frequency Questionnaire among LAU students and staff through an online survey.

Your participation in the study is voluntary. We hope that you will choose to complete the survey, but you do not have to do so. If you decide to participate in this survey, you may withdraw at any time. Please note that it will not be possible to withdraw once the survey has been submitted. Non-participation or withdrawal will not affect you in any way.

Only I, and my supervisory team, will be able to access the study data. Anonymised data collected in this study may be used in future reports, such as academic journals and conference presentations. However, all details are anonymous and no individual will be identifiable through such publication of data. For the protection of yourself and the researchers conducting this study, this research has been reviewed and approved in line with Lebanese American University Institutional Review Board (IRB).

If you have any questions about the survey, please contact:

Karim Khaled (Bournemouth University) - khaledk@bournemouth.ac.uk

Maya Bassil (Lebanese American University) - mbassil@lau.edu.lb

Vanora Hundley (Bournemouth University) - vhundley@bournemouth.ac.uk

Fotini Tsofliou (Bournemouth University) - ftsofliou@bournemouth.ac.uk

Clicking on the "agree" button below indicates that:

-you have read the above information

-you voluntarily agree to participate

If you do not wish to participate in the research study, please decline participation by clicking on the "disagree" button.

- Agree to participate in the survey
- Disagree- do not wish to participate

Appendix 14 – Ethical approval of amendment of recruitment strategy for UK study

University Research Ethics Committee
Science, Technology & Health Research Ethics Panel
Bournemouth University
Melbury House M402
1-3 Oxford Rd
Bournemouth
BH8 8ES

14 April 2020

Karim Khaled
Bournemouth University
Royal London House
Christchurch Road
Bournemouth, Dorset
BH1 3LT

Dear Karim:

Project Title: Association between Diet Quality and Stress in Women of Reproductive Age from a University population in Three Countries: UK, USA, and Lebanon
Ethics Reference ID: 22344

Notification of Amendment:

Change of Recruitment Strategy is Approved subject to prior permission from the appropriate 'owner' is obtained before placing your recruitment posters via following platforms:

- The placement of study poster on Bright space under the "announcement" section in some courses.
- The placement of poster on staff blogs, such as the Faculty of Health & Social Sciences (HSS) Blog.

Yours sincerely,

pp.

Professor Sam Porter
Chair, Science, Technology & Health Research Ethics Panel

Appendix 15- Systematic review additional files:

Additional file 1- Search strategy

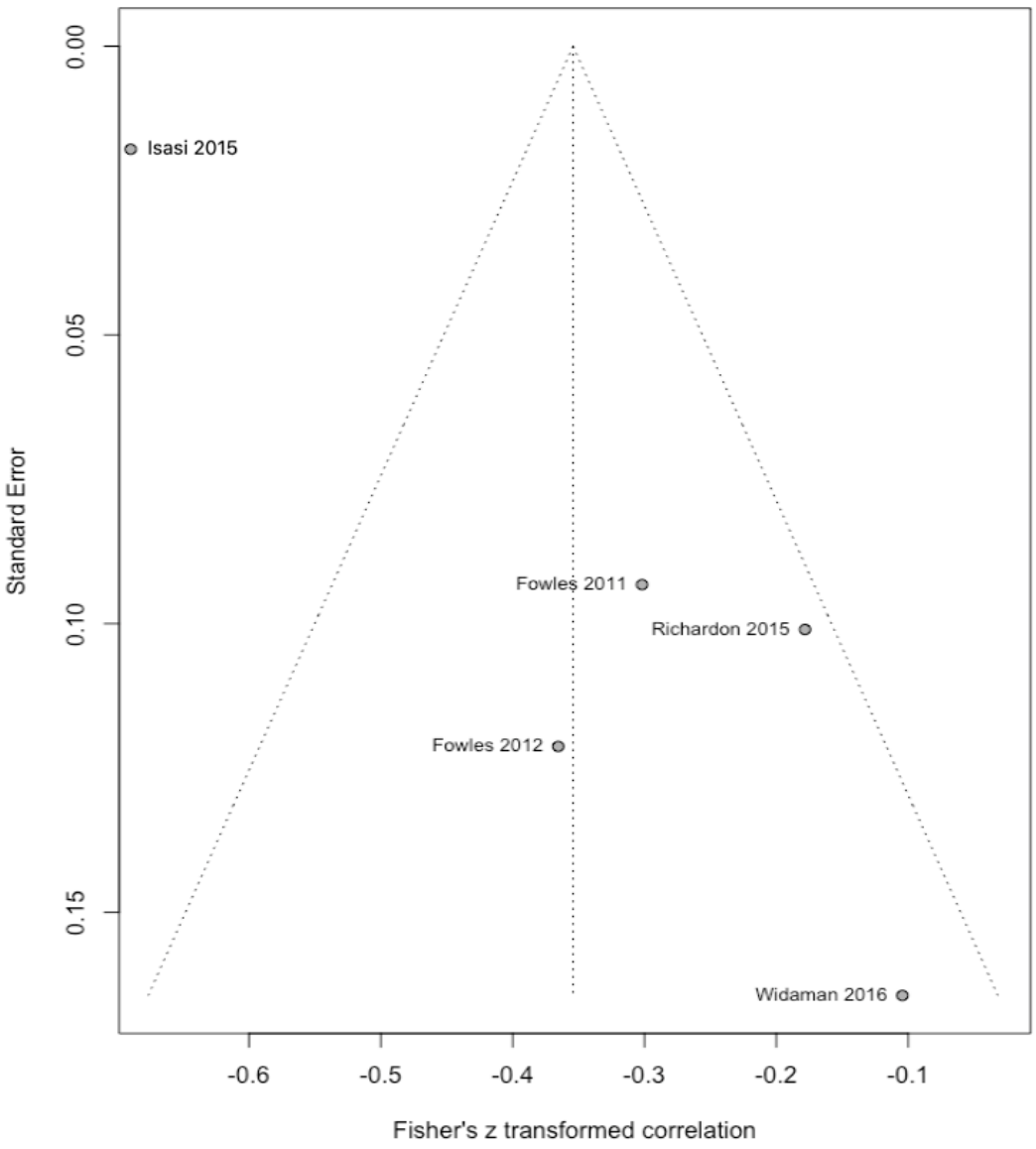
Diet	"diet* qualit*" or "diet* pattern*" or diet* or nutrition* or food intake* or food N5 consumption* or eating N5 habit* or eating behaviour* or " Mediterranean diet*" or "MDS" or "aMED" or priori or posteriori or Food or "Health* behaviour*" or energy N5 intake* or "nutrition* status" or "health* status" or eat* or appetite or "feeding behaviour*"
Stress	Stress* or anxiet* or anxious* or depress* or Psycholog* or distress* or emotion*
Women of reproductive age	wom#n or "childbearing age*" or "reproductive age*" or female* or premenopausal or "before pregnanc*" or "prior to conception" or "prior to pregnancy" or preconception

Table 1. Search strategy

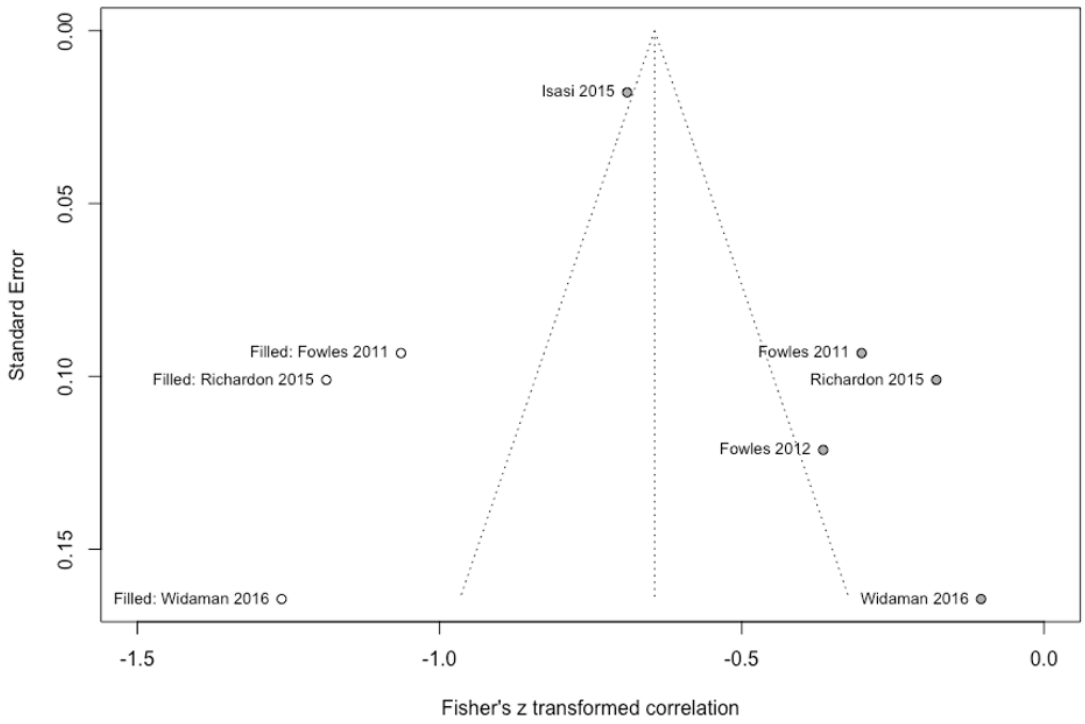
Additional file 2- MOOSE checklist

Reporting Criteria	Reported (Yes/No)	Reported on Page No.
Reporting of Background		
Problem definition	Yes	2,3
Hypothesis statement	Yes	4
Description of Study Outcome(s)	Yes	4
Type of exposure or intervention used	Yes	4
Type of study design used	Yes	5
Study population	Yes	5
Reporting of Search Strategy		
Qualifications of searchers (eg, librarians and investigators)	Yes	5
Search strategy, including time period included in the synthesis and keywords	Yes	4
Effort to include all available studies, including contact	Yes	5

Additional file 6- Funnel Plot



Additional file 7- Trim-and-fill procedure


Standard Error
0.00
0.05
0.10
0.15
Isasi 2015
Filled: Fowles 2011
Filled: Richardon 2015
Fowles 2011
Richardon 2015
Fowles 2012
Filled: Widaman 2016
Widaman 2016
-1.5
-1.0
-0.5
0.0
Fisher's z transformed correlation