ANGLIA RUSKIN UNIVERSITY

FACULTY OF HEALTH, EDUCATION, MEDICINE AND SOCIAL CARE

The nutritional profile of meals and the association between their glycaemic load and the mood of older adults with and without dementia residing in care homes.

BY

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Dedication and Acknowledgement

This thesis is dedicated to all the older adults residing in care homes who may feel abandoned or forgotten. Know that you are loved. Equally, to all the hardworking careers, who are under appreciated for the tremendous work that they do. Know that you are appreciated.

I would like to take this opportunity to acknowledge some important persons who have continually provided their moral and emotional support, advice and encouragement.

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To anyone who has supported me during my PhD- *¡Dios te bendiga!*

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ABSTRACT

FACULTY OF HEALTH, EDUCATION, MEDICINE AND SOCIAL CARE

DOCTOR OF PHILOSOPHY

THE NUTRITIONAL PROFILE OF MEALS AND THE ASSOCIATION BETWEEN THEIR GLYCAEMIC LOAD AND THE MOOD OF OLDER ADULTS WITH AND WITHOUT DEMENTIA RESIDING IN CARE HOMES.

RICH.S.WARNER

MAY 2019

Low glycaemic index/glycaemic load (GI/GL) foods offer several health benefits. They avoid large fluctuations of blood glucose levels resulting in improved cognitive function and mood. Currently, most studies examining the association between GL and mood have focused almost exclusively on children and young adults. Both groups present different physiological and lifestyle characteristics to older adults. This observational study examined the relationship between the glycaemic load (GL) and the mood of older adults in care homes, focusing on those with and without dementia, the nutrient offerings as well as the nutrient density and GL relationship.

The nutrient content of all meals offered in each care home was analysed using Nutritics Software. The Profile of Mood States (POMS-short form) was used to assess mood after meal consumption. Nutrient density was determined using the UK Ofcom Nutrient Profiling Model. Participants included 147 older adults from four care homes. Descriptive statistics, paired t-test, linear regression, Pearson's correlation and Cronbach's alpha, were employed to analyse data.

The POMS Total Mood Disturbance (TMD) for the high glycaemic load (HGL) meals=+4.21 and low glycaemic load (LGL) meals= +0.67. $t(146)= 4.21$ $P<.001$. Dementia group TMD for HGL (+6.71) and LGL (+2.13). $t(74)= 4.79$ $P<.001$. Non-Dementia group TMD for HGL (+1.62) and LGL (-0.9). $t(71)= 1.92$ $P> 0.05$ (0.059).The relationship between nutrient density and GL was statistically significant.

Overall macronutrient offerings were satisfactory. Fibre and micronutrient offerings for vitamin D, iodine and folates were below the recommended targets. The GL of a meal appears to be associated with the mood outcomes of older adults. This association is more pronounced in those with dementia. Nutrient density and GL of meals appear to be positively associated. GL should be considered in the creation of menus and nutritional guidelines for older residents of care homes as it does appear to impact mood outcomes. More definitive interventional evidence required.

Keywords: Glycaemic/glycaemic load, mood, older adults

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LIST OF ACRONYMS

GL- Glycaemic Load

GI-Glycaemic Index

BGL-Blood Glucose Level

WHO- World Health Organisation

FAO- Food and Agriculture Organisation

SACN- Scientific Advisory Committee on Nutrition

GCP- Good Clinical Practice

CQC- Care Quality Commission

POMS- Profile of Mood States

UKNPM- UK Ofcom Nutrient Profiling Model

Na^+- Sodium

K^+-Potassium

Mg^+-Magnesium

SGLT1- Sodium Dependent Glucose Transporter

GLUT1- glucose transporter 1

GLUT2- glucose transporter 2

GLUT5- glucose transporter 5

ATP- Adenosine Triphosphate

ADP-Adenosine Diphosphate

NADPH-Nicotinamide Adenine Dinucleotide Phosphate

PFK1- Phosphofructo-kinase 1

G3P- Glyceraldehyde-3-Phosphate

G2P- Glyceraldehyde-2-Phosphate

PEP-Phosphoenolpyruvate

NICE- National Institute for Clinical Excellence

ICQC- International Carbohydrate Quality Commission

AUC-Area under the Curve

FFA-Free Fatty Acids

Tufts-NEMC EPC-Tufts-New England Medical Centre Evidence-Based Practice Centre

RCT- Randomised Control Trials

LGI- Low Glycaemic Index

CON- Normal Carbohydrate Mixed Meal

FFQ- Food Frequency Questionnaire

RAG- Rapidly Available Glucose

SAG- Slow Available Glucose

ADACL- Activation-Deactivation Adjective Check List

CES-D- Centre for Epidemiological Studies-Depression Scale

DSM-V- Diagnostic and Statistical Manual

BRUMS- Brunel University Mood State

NSAIDs- Non-steroidal anti-inflammatory drugs

NMES- Non-milk extrinsic sugars

NDNS- National Diet and Nutrition Survey

LRNI- Lower Reference Nutrient Intake

BPSD- Behavioural and Psychological Symptoms of Dementia

MMSE- Mini Mood State Examination

AMTS- Abbreviated Mental Test Score

MCA- Montreal Cognitive Assessment

MRI- Magnetic Resonance Imagery

CT scan- Computerised Tomography Scan

VAMS- Visual Analogue Mood Scale

VAS- Visual Analogue Scales

ARU- Anglia Ruskin University

FS- Feeling Scale-Hardy and Rejeski

MCA- Mental Capacity Act

NHS-National Health Service

STROBE-nut- Strengthening the Reporting of Observational studies in Epidemiology-Nutrition

TMS- Total Mood Score

TMD- Total Mood Disturbance

BDA- British Dietetics Association

DRV- Dietary Reference Values

EAR- Estimated Average Requirements

RNI- Reference Nutrient Intake

COMA- Committee on Medical Aspects of Food Policy

SACN- Scientific Advisory Committee on Nutrition

NHMRC- National Health and Medical Research Council

EFSA-European Food Safety Authority Guidelines

r- Pearson's Correlation Coefficient

SD- Standard Deviation

OJ-Orange Juice

DoH- Department of Health

MCA- Mental Capacity Act

NIHR- National Institute for Health Research

DFP- Direct Food Photography

IoM- Institute of Medicine

UVB- Ultraviolet B rays

USDA- United States Department of Agriculture

EU- European Union

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Copyright Declaration

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Chapter 1: Introduction and Study Overview

1. 0: Introduction

This study examined the nutritional profile of meals offered in care homes, and the association between the glycaemic load of these meals and mood outcomes in older adults with and without dementia in care homes. This introduction and study overview chapter presents firstly a concise scientific background section. This section highlights the historical context of behavioural nutrition involving carbohydrates, the importance of carbohydrates as an energy source for the body, and its effects on blood glucose levels when it is absorbed and metabolised by the body. The measures of glycaemic load (GL) and glycaemic index (GI) related to blood glucose levels are then introduced, examining how variations in these measures can potentially influence mood outcomes.

Having informed of the importance of GL of foods on mood outcomes the chapter continues into the rationale of study section. Here, existing evidence is presented, the lack of which is identified in the older adult group, as well as why investigations into people with dementia are particularly important, and the reasons for carrying out the study in care homes. The importance and contribution to knowledge are then stated.

The chapter then presents the research aims and objectives, an overview of methodology, data collection, analysis, and then concludes with an outline of each chapter forming an integral part of the thesis followed by a chapter summary.

1.1: Background Information

The nutrients in the foods we consume have the capacity to affect our mental status on a metabolic level (Lim, et al., 2016). The first randomised controlled trial examining a food-mood relationship occurred in the 1920s and suggested a link between sugary foods and changes in mood in children (Shannon, 1922). This was the first of its kind, but it was not until the 1990s when comprehensive analyses were undertaken to explore the role of sugars on both cognitive and behavioural measures (Wolraich, et al., 1995). Nutrients aid in the creation of various neurotransmitters in the brain, which in turn influence cognition and behaviour (Beseler, 1999). One such group of nutrients are the biological molecules called carbohydrates. Although carbohydrates, more specifically those foods rich in sugars, have been implicated in causing conditions such as Diabetes Mellitus, tooth decay and obesity (WHO, 2014), they play a vital role in maintaining a healthy body through a wide range of physiological effects (FAO,1998). These biological molecules can be divided into three groups: sugars, (such as monosaccharaides like glucose, disaccharides and polyols), oligosaccharides (such as maltodextrins, raffinose and stachyose) and polysaccharides (further subdivided into starch and non-starch polysaccharides) (Scientific Advisory Committee on Nutrition, 2015). The Scientific Advisory Committee on Nutrition (SACN) then later created a more recent revised classification as each carbohydrate group presents overlapping effects on health and physiology. Carbohydrates can therefore be divided into digestible and non-digestible. Digestible carbohydrates are absorbed and digested in our small intestines while non-digestible carbohydrates are not digested in the small intestines. Of interest to this study is the importance of digestible carbohydrates as a principal substrate for energy metabolism and their role in the control of blood glucose and insulin metabolism.

Glucose is the brain's main energy source and therefore essential to its function (Mergenthaler, et al., 2013). A severe decline of this simple sugar has been shown to influence psychological processes such as decision-making and self-control (Gailliot, et al., 2007).An important aspect of the digestion of carbohydrates in the human body, is the degradation process must occur where they are broken down into glucose or other monosaccharaides such as galactose or fructose. The process commences with starches in the mouth being broken down via salivary alpha-amylase. The monosaccharides are then transported into the intestinal mucosal cells, into the liver and then the blood stream. Once in the blood stream two things will occur: The blood glucose concentration will rise. This rise or elevation is dependent upon how quickly absorption occurs in the body, the rate of gastric emptying, as well as baseline insulin and insulin sensitivity. Secondly, this elevation will prompt the secretion of the hormone insulin, which is necessary for the metabolism of carbohydrates and lipids to occur optimally as well as necessitating the use of glucose by the various cells in the body (Scientific Advisory Committee on Nutrition, 2015).Foods consumed will prompt various blood glucose and insulin responses. These differences in response have possible implications for health and well-being (Blaak, et al., 2012).

The two measures used to assess the glycaemic characteristics of foods are the Glycaemic index (GI) and the Glycaemic load (GL). The term GI was first introduced as a tool for those with diabetes to select foods (Jenkins, et al., 1981). A comprehensive International GI Food Table was later introduced as a means of standardisation and making the search for GI values easier (Foster-Powell, et al., 1995). GI is defined as "a relative measure of the capillary blood glucose response to a specific ingredient, food or portion of a meal, as compared with the response to a reference food having the same amount of available carbohydrate (usually 50g)" (Brouns, et al., 2005). This glycaemic response is dependent on the amount of food consumed (more food, larger glycaemic response).

As a method of predicting this response the glycaemic load measure was introduced (Salmerón, et al., 1997). The GL of a food, according to the same source, is referred to as a product of GI and its available carbohydrate content (representing both the quality and quantity of carbohydrate and the relation between the two) (Brouns, et al., 2005). The variations of GI and GL of foods have the capacity to affect the rates of carbohydrates absorbed by the body and the amount of glucose that is produced and circulated (Eelderink, et al., 2012). Food processing and cooking, the nature of monosaccharide components as well as other food components such as fats, proteins, organic acids and dietary fibres can influence the body's glycaemic responses (FAO, 1998).

In addition to these variations, a prolonged glucose response after a meal can improve the glucose tolerance of the individual at the second meal (Ardvidsson-Lenner, 2004). Research pioneered by Jenkins, et al. (1987) noted that this second meal effect occurred even after fasting overnight. The consumption of a low GI/GL evening meal improved glucose tolerance and reduced the insulin response to a standard high GI/GL breakfast, compared to when a high GI/GL evening meal was consumed. High GI/GL meals are rapidly digested and tend to cause spikes in blood glucose levels that will tend to fluctuate to hypoglycaemic levels. High GL foods include pasta, white rice, chips and sweetened fruit juices, while examples of low GL foods include some whole grain breads, legumes, milk and eggs (Foster-Powell, et al., 2002). When blood glucose levels drop to these low values the brain is deprived of glucose (neuroglycopenia) resulting in cognitive dysfunction and poorer moods (McCrimmon, 2012). On the other hand, low GI/GL meals are considered more desirable as they aid in improving blood glucose control by offering the body a slow, steady absorption of glucose and avoiding rapid drops to hypoglycaemic levels and excessive secretion of insulin (Bjork, 2000).

Mood is defined as, "the prevailing psychological state (habitual or relatively temporary), a feeling, state or prolonged emotion that influences the whole of one's psychic life." (Clark, 2005).Evidence does suggest a relationship between food consumption and mood outcome (Gibson, 2006). One's mood may express happiness, anger, tension, or anxiety. One commonly cited theory as to how foods consumed may influence mood outcomes involves a chemical messenger in the brain called serotonin. It is made from dietary protein, i.e. the amino acid tryptophan. The more tryptophan that enters the brain when carbohydrate rich foods are consumed, the more serotonin is secreted and it is theorised that this increase in serotonin may cause a positive mood change (Jenkins, et al., 2016).

1.2: Study Rationale

Existing Evidence and Relevance of GI/GL

Over the years, research into the importance of the GL and GI of meals has ranged from using these measures to reduce weight in subjects, to benefits in reducing the risk of Type 2 Diabetes (Das, et al., 2007; Villegas et al., 2007). Benefits of low glycaemic load meals on cognition and to a lesser extent mood have also been investigated. Most of these studies, which sought to make a correlation between the glycaemic load of meals and cognitive function, used either children or young adults as the main subjects. Nabbs and Benton (2006) studied the positive cognitive influence of low GL foods on young adults whilst Cooper, et al. (2012) also provided positive evidence for the consumption of low GL foods in children. The evidence supporting a relationship between the GL and mood is, however limited. The gap in knowledge is further compounded by the shortage and conflicting evidence available regarding the impact of the GL on mood in adults. The systematic review carried out by the author (refer to Chapter 3) found only two of eleven studies examining GL's effect on mood in older adults. This further evidence can be examined in chapter three.

The focus of the study

Older adults do not metabolise glucose as optimally as younger adults do or children, hence controlling the levels of postprandial blood glucose in older adults will differ to that of their younger counterparts and result in differing consequences (Chee, et al., 2018).

The brain of a child is relatively bigger and, per unit of weight, more active than that of adults, children may be particularly responsive to provision of glucose, the major fuel of the brain (Chugani, 1998). The same source further notes that, with age, cerebral metabolic rate decreases as well as the control of postprandial blood glucose levels. This decline in the ability to control the levels of postprandial blood glucose has been previously linked to poorer cognitive performance and mood (Taylor and Rachman, 1988). The poorer glucose tolerance present in older adult populations may be remedied by the consumption of low rather than high GI/GL meals, which could then improve cognition and mood (Maekawa, et al., 2014).

Apart from a decreased ability to metabolise glucose, older adults are more at risk of malnutrition and other nutrition related diseases (Clegg and Williams, 2018). The most frequent of these geriatric syndromes is frailty, with malnutrition being a major contributing factor to it (Guyonnet and Rolland, 2015). It is estimated that the number of persons aged 60 or over in the UK is expected to surpass the 20 million mark by 2030 (Office of National Statistics, 2015). It will therefore become increasingly more important to conduct research such as this study to increase the scope of scientific literature on an ever-growing old adult population and to provide more evidence for the use of nutrition in improving quality of life.

Persons living with dementia form part of the older adult population and present changes in mood as a common symptom of their disease (McKeith and Cummings, 2005). These changes range from depression to aggression and can be linked to known environmental factors/stimuli (light, sound, smell) as well as patient related ones (Cerejeira, et al., 2012). This study may provide evidence that GL of meals may act as a nutritive stimulus. A link between the GL of meals consumed and mood in these persons has never (to the knowledge of this researcher) been investigated. It is unfair (prejudice even) and goes against good clinical practice (GCP) guidelines to exclude participants solely because of an underlining cognitive impairment. Those suffering from dementia require a high intake of energy but current recommendations for them suggest an increase in energy intake through the consumption of high sugar as well as high fat products (Crawley and Hocking, 2011). Some evidence exists which suggests that persons with cognitive impairments are more susceptible to low blood sugar that in turn influences their mood (Feil, et al., 2011; de Galan, et al., 2009). It is therefore important to the field of behavioural nutrition to observe whether low GL meals aid in improving mood outcomes in persons with dementia and if the impact of these meals on mood, (when compared to high GL meals) is the same in older persons with and without dementia.

Research Site Rationale

Care homes are an optimal location as they offer a greater possibility for recruiting potential participants and more standardised eating environments when compared to the individual homes of free-living older adults. This aids in reducing confounders as well as easier research logistics (e.g. less time consuming and travel to various sites). The meals offered can be easily assessed as they are cooked and prepared on site in one location. The homes also offer the specific population group for carrying out such types of research. Carrying out research in these institutions further ensures ethical guidelines can be properly followed and maintained, as different approvals were required.

Importance and contribution to knowledge

The scientific literature

The current gap in scientific knowledge will benefit tremendously from this thesis. Firstly, the systematic review conducted provides evidence of existing literature regarding the relationship between GL and mood outcome whilst highlighting the inconsistencies on the subject matter. The study then provides the evidence of the impact of the GL on the mood outcomes in older adults. The physiological differences of older adults as well as the social characteristics of care homes, aid to improving existing literature that focuses almost exclusively on children. Another characteristic of the study, which also adds to literature, is the involvement of those with dementia. This evidence will be new to the field of behavioural nutrition as to the knowledge of the researcher, no studies exist which: 1) seek to examine the association between the GL and mood outcomes in dementia sufferers or 2) compares mood outcome findings between those with dementia and those without with respect of the GL of meals. Further, as this study examines the array of transient mood outcomes, it provides further evidence of the mood spectrum because of HGL or LGL meal consumption and does not just focus on one or two moods as is observed in the majority of research in the field.

Practical Contributions and Benefits

The study will be able a comprehensive examination of meal GL, covering fifteen weeks of 4 different menus offering hundreds of meal combinations. These results could also allow care homes to better plan their menus and source food products that would assess the proper use of the GL measure with the objective of maintaining good mood outcomes. Related to this knowledge of the GL of several meals is the nutritional findings of this study. The study will be able to highlight existing deficient intakes in macro and micronutrient offerings as well as whether care homes are meeting existing nutritional targets.

These findings will contribute to identify which care homes are affording better nutritional offerings. The practices of these homes could be used in homes lacking in specific areas.

Having this knowledge of nutritional findings and the relation between nutrient density and GL could further assist with proper menu planning, but also with food procurement (type of catering) as well as improving food preparation to maintain nutritional value as well as GL of foods. The benefits to the residents' health outcomes cannot be overlooked as these measures bode well for the types of foods residents will consume, which influences the prevention of certain conditions such as malnutrition. These factors, such as the type of catering, menu planning, as well as others, which will be identified from the study, could potentially provide a framework that will allow a better understanding of the GL- mood outcome relationship. Participating care homes will be able to use the results for marketing purposes as well as during visits from the Care Quality Commission (CQC) to highlight efforts made in improving the nutritional outcomes of residents.

Policy Contribution

Currently the United Kingdom as well as many countries around the world do not have existing nutritional guidelines for older adults, or more broadly residents in care homes. The results of this study could provide some insight into the creation of specific guidelines and recommendations, given the different nutritional requirements of older adults and the lifestyle of care home residents.

A more in depth review of contribution to knowledge as well as implications for practice guided by the study findings, can be gleaned from the discussion chapter towards the end of the thesis.

1.3: Research Aims and Objectives

Research Question: Is there an association between the glycaemic load of meals and the mood outcomes of older adults residing in a care home?

Hypothesis: It is hypothesised that within the study population, after the consumption of the low GL meal, residents will present better moods when compared to the high GL meal consumption. The researcher further hypothesises that those subjects with dementia should also present better mood outcomes similar to residents without dementia after consuming the low GL meal.

Research Objectives:

Primary Objective

    a) To assess the association between high glycaemic load meals and low glycaemic load meals and the mood of older adults within a care home setting.

Secondary Objectives

b) To examine the glycaemic load of meals offered within care homes.

c) To analyse the nutritional profile of food offered within care homes.

d) To examine the possible relationship between the glycaemic load and nutrient density within care homes.

e) To examine the differential relationship of mood and the glycaemic load of meals in older adults with and without dementia within a care home setting.

1.4: Overview of Methodology, Data Collection and Analysis

The research is observational in nature and uses a quantitative approach. It is a non-clinical trial, that does not alter the meals consumed by participants and was designed to be as non-invasive as possible given the vulnerable group under study and to reflect real life practice in care homes. The primary outcome measure is regarded as the matched–pairs difference between the first and second results i.e. mood state scores (Total Mood Scores) after high GL meal and after low GL meal consumption. This difference in TMS is the Total Mood Disturbance (TMD). The primary analysis is the test that the true mean difference is zero, using the matched-pairs t-test. It is hypothesised that mood (Total Mood Scores from the Profile of Moods States- short form survey) will be more positive (i.e. mood sub- factors presenting a lower total mood score) after the low glycaemic load meal is eaten. This lower TMS will correspond to a lower total mood disturbance score indicating that low glycaemic load meals are associated with better mood outcomes. This would therefore answer the research question regarding the association between glycaemic load of meals mood outcomes in this group of persons as well as which type of GL meals offer more negative mood outcomes i.e. greater mood disturbances.

The secondary outcomes of the study are the difference in mood results of persons with and without dementia with respect to the consumption of the high GL meal vs low GL meal, whether the nutrients within the meals offered meet current requirements and the relationship between the GL and nutrient density of the meals offered.

The primary endpoint of the study is the difference in the Total Mood Disturbance between after consumption of the low GL meal and high GL. The primary analysis is to test the null hypothesis, which is that the true mean difference is zero between high and low GL meals. This was tested statistically using the paired t-test. A statistically significant P-value of 0.05 was used in the study.

Power analysis was used to determine appropriate sample size with the study considered presenting an 80% power and 5% significance. A final 147 participants formed part of the study from four different research sites (care homes). Data collected from the monthly menus were used to conduct the nutrient analysis and glycaemic load of all meals offered at the respective research sites using Nutritics software. The software allows the user to conduct complete analysis of total nutrients both macro and micronutrients of a wide range of foods. Nutrient density was determined using the UK Ofcom Nutrient Profiling Model (UKNPM). This model allows the user to determine how nutrient dense foods are. The UKNPM assesses the nutrient content of 100 grams of a product or meal. It allocates points in the first step for the less healthy components and in the second step for the healthy components. The final score (step three) is obtained by a simple algorithm that depends on the points obtained in the previous steps (Food Standards Agency, 2009).

The Profile of Mood States (POMS) survey was used to determine whether low or high GL meals are more positively associated with better mood states. Total Mood Scores (as well as the corresponding total mood disturbance) of the population were used to make this correlation. Statistical tests such as mean, standard deviation, paired t- test, Pearson's correlation formed part of analyses. Cronbach's alpha reliability estimates were incorporated to measure internal consistency/reliability. The differential relationship of mood and the glycaemic load on those with and without dementia was also be determined. Paired t-test was used to analyse the aforementioned associations. Linear regression was employed to analyse the possible relationship between the GL of meals and nutrient density. Given the nature of the data collected in this observational study, and the statistical test required to achieve the primary and secondary outcomes, Microsoft Excel was deemed most appropriate. Excel presented all the statistical functions required as well as seamless data transfer from Nutritics Software. As an added measure, statistical test results were verified using SPSS Stats Software 24v2.

1.5 Outline of Thesis

The thesis is divided into six chapters.

Chapter one: Introduces the research by providing a brief background on the subject under review. It gives the scientific justification and rationale for a study of this nature and presents themes that are expounded upon within the thesis. The research question, aims and objectives as well as hypothesis are established within this chapter.

Chapter two: Presents the literature review necessary for a more in depth comprehension of the area of focus. It highlights key concepts and terms and provides a detailed look into the biochemistry and physiology involved in the metabolism of carbohydrates (specifically glucose) and the theory surrounding how foods consumed affect mood. How GI and GL are determined and their beneficial uses are established. Conversely, the other side of the debate is critically examined regarding the perceived deficiencies when GI and GL are used. The chapter proceeds with the different factors that influence food consumption, the importance of appropriate portion sizes and nutrition in the elderly. Dementia and its symptomatology are examined as well as the concept of mood.

Chapter three: Presents evidence explored from the systematic review. It assesses the strengths and weaknesses of the evidence, comparing and contrasting the study designs employed, dietary interventions, composition of meals, participants used, and types of mood surveys, timing of mood examinations and the incorporation of overnight fasting.

Chapter four: The methodology chapter details the processes involved in completing the research. Beginning with the research process highlighting and illustrating the various stages of the research. The research design employed, and why it was most appropriate, are outlined here. The sample size used, and how it was calculated will be expressed, as well as the different statistical test that were used to determine results.

This chapter explains what the Profile of Mood States is and how it is determined, the use of Nutritics Software and how nutrient analysis is carried out and how the Ofcom UK Nutrient Profiling Model determines nutrient density. Additionally, the calculation of meal GL is expressed. All data collection, analyses, and storage procedures are outlined by the researcher as well as the ethical considerations of the study. Finally, the strengths and limitations of the methods are mentioned.

Chapter five: Presents and interprets the results of the study in written and graphic forms. The results of each care home are presented separately. Findings of the nutrient analysis are first presented highlighting both macro and micronutrients. Deficiencies discovered such as Vitamin D, calcium and fibre as well as excesses of free sugars are presented. These results were garnered from Nutritics software. The GL of the target meals on the menu within the care home are then presented. These meals all presented similar glycaemic loads due to similarities in food make as was discovered. These are then followed by the findings of a linear relationship between GL of meals and the nutrient profile. The chapter then continues with the presentation of findings in relation to the mood survey. These results from the profile of Mood States (POMS) first offer general study findings, followed by results per care home. Mood results are then expressed in relation to participants with dementia and those without, and then juxtaposed to both the high glycaemic load meal and low glycaemic load meal targeted. The mood survey results offered the reader with the evidence that the GL of meals does have an impact on mood outcomes in older adults, more so in those with dementia.

Chapter six: This chapter explains and discusses the results found in the previous chapter. Results are not restated, but rather important findings are briefly highlighted, contextualised and their implications examined. Using the study objectives as a guide, it provides the reader with evidence supporting findings as well as offering rationale and critique for these findings. The glycaemic load and mood outcome results are discussed as well as the differences presented between the dementia and non-dementia groupings.

Differences in internal consistency between these groupings are addressed. Results of each nutrient of the nutritional analysis are then discussed, along with health implications for deficiencies discovered. The GL and nutrient density relationship is later discussed. A conceptual framework is also developed in the chapter that guides the reader in examining several factors that should be considered to better contextualise findings. Each of these factors are addressed individually.

Chapter seven: This chapter ends the thesis with contributions and implications for the field of Behavioural Nutrition, strengths and limitations of the study, potential nutritional recommendations and a conclusion that succinctly summarises study results in relation to the previously mentioned objectives.

1.6: Summary

This chapter has introduced the thesis to allow the reader to have some knowledge of the subject under review and the rationale for the study. The chapter presented existing evidence regarding GL and mood impact research as well as detailed aims and objectives of the study. An outline of the entire thesis is given to orient the reader of the thesis. General information on methodology, data collection and analysis are also given. Filling a gap in knowledge was established as an important contribution of this work as well as other meaningful contributions.

The next chapter expands on the existing literary information that is required to understand this important aspect of behavioural nutrition.

Chapter 2: Literature Review

2.1: Introduction

This chapter offers an overview of literature relating to the glycaemic load, mood and other key components of the study. This review was compiled to cover an appropriate scope of relevant information which seek to address important aspects of the study.

The chapter begins with the biochemistry, physiology of carbohydrates and how this energy substrate impacts blood glucose levels. The concepts of Glycaemic index and load are consequently introduced detailing how they are calculated, their relevance and opposing views as well as critical defence of said measures. Secondary factors that influence food consumption and consequently the GL- mood dynamic are then examined. The chapter then flows into information of older adult nutrition and the condition of dementia and its behavioural signs and symptoms. Here the section then enters the aspect of mood in nutritional research and its measurement. The chapter then concludes with a summary. A complimentary list of important concepts and terminologies regarding the main themes of the study is afforded in Appendix 5.

2.2 Carbohydrate Metabolism: Biochemistry and Physiology

2.2.0: Introduction

This sub-section delves into the accepted knowledge of carbohydrates. How they are digested, absorbed and metabolised form part of this sub-section. Once converted into energy, the glycolytic pathway stands as an important component of how the body uses this energy. This pathway is thus presented also. The sub-section then ends with the metabolism of glucose in the brain and a possible theory explaining how carbohydrates may affect mood.

2.2.1 Classification of Carbohydrates

Carbohydrates are important macronutrients containing carbon, hydrogen and oxygen. They are commonly classified by their chemical characteristics based upon the Food and Agriculture Organization/World Health Organization Expert Consultation in 1997 (FAO/WHO, 1998). From these characteristics, carbohydrates can be divided into three groups: monosaccharides and disaccharides (sugars), oligosaccharides and polysaccharides (expressed in table one).

This classification however, provides some challenges, particularly in nutritional research as many of the chemically different carbohydrates present similarities in both physiology and health effects, thus rendering a chemical classification unsuitable at times (Mann, et al., 2007). Carbohydrates can therefore be classified in other ways. One such classification is distinguishing between digestible and non-digestible carbohydrates.

The Scientific Advisory Committee on Nutrition (2015), defines digestible carbohydrates as those that can be absorbed and digested in the small intestines whilst non-digestible carbohydrates are not digested in the small intestines (due to their resistant to hydrolysis) and make their way to the large intestines where their partial fermentation by bacteria occurs.

Table 1: Chemical classification of carbohydrates

Class	Sub-group	Components
Sugars	Monosaccharides	Glucose, Fructose, Galactose
	Disaccharides	Sucrose, Lactose, Maltose
Oligosaccharides	Malto-oligosaccharides	Maltodextrins
	Non-digestibles	Raffinose, Stachyose, Verbascose, Fructo-oligosaccharides
Polysaccharides	Starch	Amylose, Amylopectin, Modified starches.
	Non-starch Polysaccharides	Cellulose, Hemicellulose Pectin, Hydrocolloids (gum)

Source: SACN (2015)

2.2.2: The Digestive System

2.2.2.1: Digestion

Globally, cereals such as corn, rice, wheat, starchy roots and legumes, supply the body with the large amounts of carbohydrates it requires (Brand-Miller, et al., 2008). Data from the National Diet and Nutrition Survey shows that in the United Kingdom, adults over the age of 65 receive most of their carbohydrates from bread (of note white bread), breakfast cereals, potato-based foods (chips, roasted, mashed) and fruit juices (Bates, et al., 2014).

In order for the human body to convert glucose to energy, carbohydrates must be broken down first through the process of digestion. Human digestion starts in the mouth. Complex carbohydrates such as starch and glycogen are broken down via the secretion of salivary a-amylase that targets internal a-1-4 glycosidic bonds within these nutrients specifically (Devlin, 2006). This process occurs during the chewing of the food and the movements of the tongue, rolling the hydrolysed food into a ball (bolus) which makes its way down the oesophagus to the stomach. In the stomach, salivary a-amylase is deactivated due to the stomach's acidic nature. The enzyme can continue to function inside the bolus as long as it is not in contact with stomach acids (Binder and Rueben, 2009).

Complex carbohydrates (oligo, di, and polysaccharides) must be broken down into simple monosaccharides in order to be absorbed into the blood stream. This absorption occurs in the small intestines and only the monosaccharaides glucose and galactose can be actively absorbed via the sodium(Na+) dependent glucose transporter (SGLT1) during this process (Thoerens and Mueckler, 2010).

Pancreatic juices are secreted once the food reaches the lumen. These juices neutralise the gastric acid and contain pancreatic a-amylase. Whilst the digestion of starch polysaccharides begins via the secretion of salivary a-amylase, pancreatic a-amylase also targets a-1-4 glycosidic bonds and plays a more significant role in the digestive process breaking down complex carbohydrates even further, into simple carbohydrates (Binder and Rueben, 2009). The resulting products of the actions of pancreatic a-amylase are further acted upon by enzymes located on the plasma membranes of the brush borders of the intestinal epithelial cells. Where complex carbohydrates present resistant glycosidic bonds which cannot be broken down into monosaccharides by either pancreatic a-amylase or the brush border enzymes they are passed on to the large intestines where they are acted upon my specialised bacteria (Flint, et al., 2012).

2.2.2.2: Absorption

The carbohydrates which are broke down into monosaccharaides are then taken up by intestinal absorptive cells (enterocytes) via specialised protein transporters. SGLT1 aids in the active absorption of glucose as well as galactose. The glucose substrate , for example will bind itself to the transporter and take advantage of the high Na+ gradient outside the cell (this occurs due to the presence of Na+ K+ ATPases), allowing it to move from an area of high concentration of Na+ into the intracellular environment (lower Na+ concentration) (Binder and Reuben, 2009). Conversely, when the intracellular concentration of glucose is high, the glucose substrate can diffuse to lower concentrations outside the cell via diffusion transporters (GLUT2). These transporters are specific to different monosaccharaide substrates (glucose, galactose and fructose) they transport. Unlike glucose and galactose, which are aided by SGLT1 in active absorption, the diffusion transporter GLUT5 takes up fructose (Manolescu, et al., 2007).

The substrates of sugar (glucose, galactose and any remaining fructose) can now easily leave the cells pass across the concentration gradient into the adjacent blood supply of the intestinal epithelial cells with the aid of their diffusion transporters. Energy conversion can now occur. The processes of digestion and absorption are highlighted in the diagram below (Figure 1).

Figure 1: Diagram of the digestion and absorption of carbohydrates
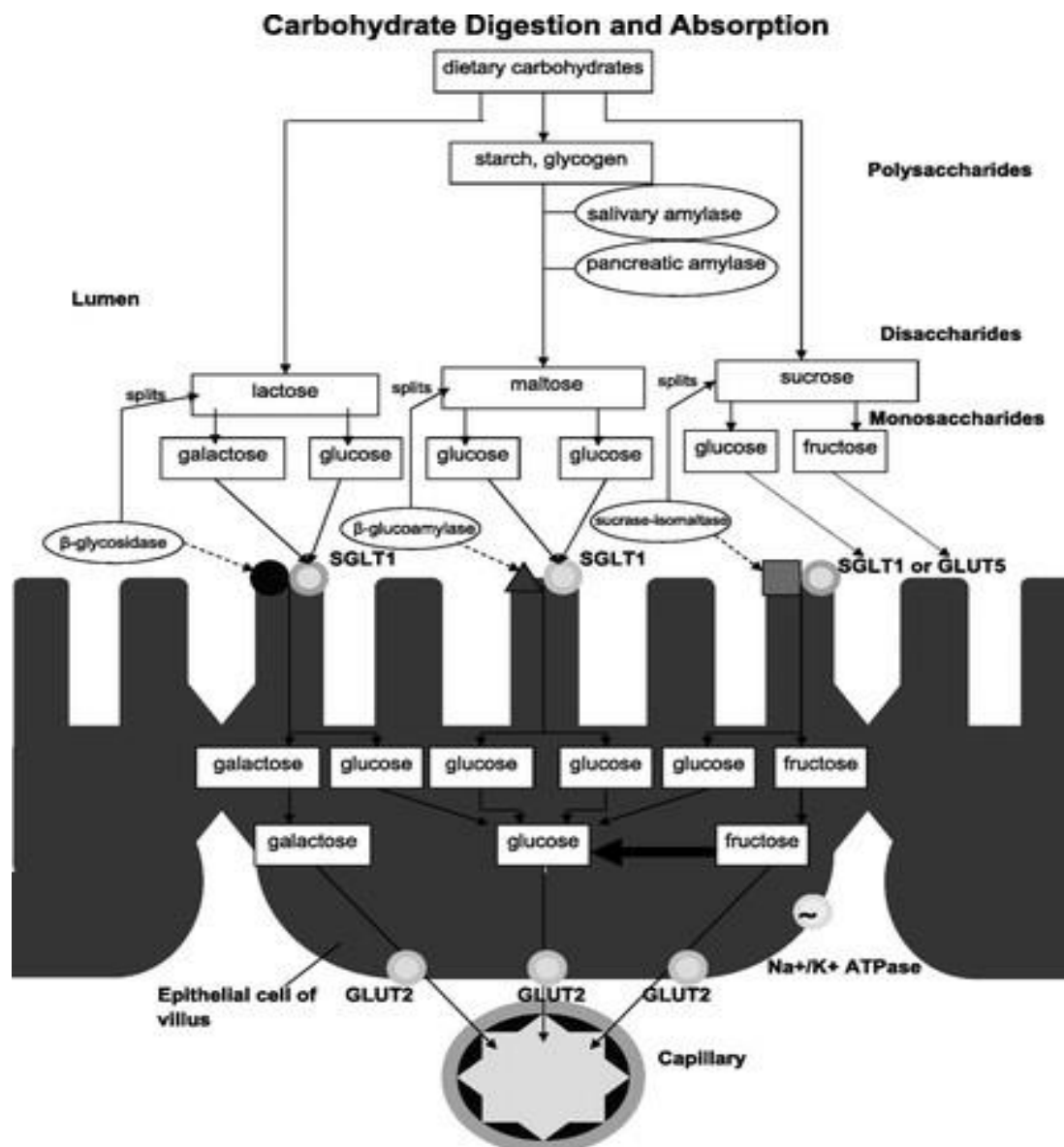
Source: (Sherwood, 2010)

2.2.3: Metabolism of Glucose

The metabolism of glucose involves different pathways. These pathways all have the common objective of producing energy for the body. The glycolytic pathway involves the breakdown of a glucose molecule into two pyruvate molecules and storing the energy released as ATP and NADPH (Nelson, et al., 2013). In instances where blood glucose levels are high, glycogen is synthesised to store glucose via the glycogenesis pathway and stored primarily in the liver. On the other hand, when glucose levels are low this glycogen is broken down into glucose via the process of glycogenolysis to reduce the glucose deficit (McKee and McKee, 2012). Non-carbohydrate molecules such as pyruvate, lactate, glycerol etc. can also be converted to glucose when the body's glucose levels are diminished. This pathway is referred to as gluconeogenesis and is the inverse/ opposite of the glycolytic pathway (Maughan, 2008). The pentose phosphate pathway is another form of glucose metabolism that produces glucose through an alternative pathway (Nelson, et al., 2013).

2.2.3.1: The Glycolytic Pathway

Once glucose enters the blood stream it can be broken down to create energy. The glycolytic pathway is considered anaerobic as it does not require oxygen molecules to create energy and is the only method of energy production in some tissues (Nelson, et al., 2013). Glycolysis involves two stages. In stage one four steps occur causing glucose to form two molecules of glyceraldehyde-3-phosphate using up two ATP molecules in the process.

Firstly, glucose must be undergo phosphorylation to prevent its transport outside of the cell. ATP, hexokinase and Mg^{2+} are all necessary for this reaction. Once glucose has been phosphorylated and becomes glucose-6-phosphate, it is then converted to fructose-6-phosphate in a reaction which involves the enzyme phosphor-glucose isomerase.

Fructose-6-phosphate is then phosphorylated to become fructose-1, 6-bisphosphate. This reaction requires the presence of ATP, Mg2+ and PFK1 (phosphofructo-kinase1). Stage 1 then ends with the cleavage of fructose-1, 6-bisphosphate aided by the aldolase enzyme to create dihydroxyacetone phosphate and glyceralydehyde-3-phosphate.

Stage two of the glycolytic pathway is focused on the conversion of glyceralydehyde-3-phosphate into pyruvate producing four ATP and two NADPH molecules. In order to avoid the loss of glyceraldehyde-3-phosphate a reversible reaction occurs via the triose phosphate isomerase enzyme creating another glyceraldehyde-3-phosphate (G3P) from dihydroxyacetone phosphate. The original glucose molecule from stage one, is now converted to two molecules of G3P. G3P is then oxidised and phosphorylated creating glycerate-1, 3-biphosphate. The phosphoryl group of this product is then transferred to form glycerate-3-phosphate in the presence ADP, Mg2+ and phosphoglycerate kinase. This process also produces two ATP molecules. G3P is then interconverted to G2P, which is then dehydrated via the enzyme enolase to become phosphoenolpyruvate (PEP). Finally, to create pyruvate, the phosphoryl group of PEP is transferred via pyruvate kinase to ADP. Two molecules of ATP are thus formed from each glucose molecule. The entire glycolytic pathway is expressed in the illustration below in Figure 2.
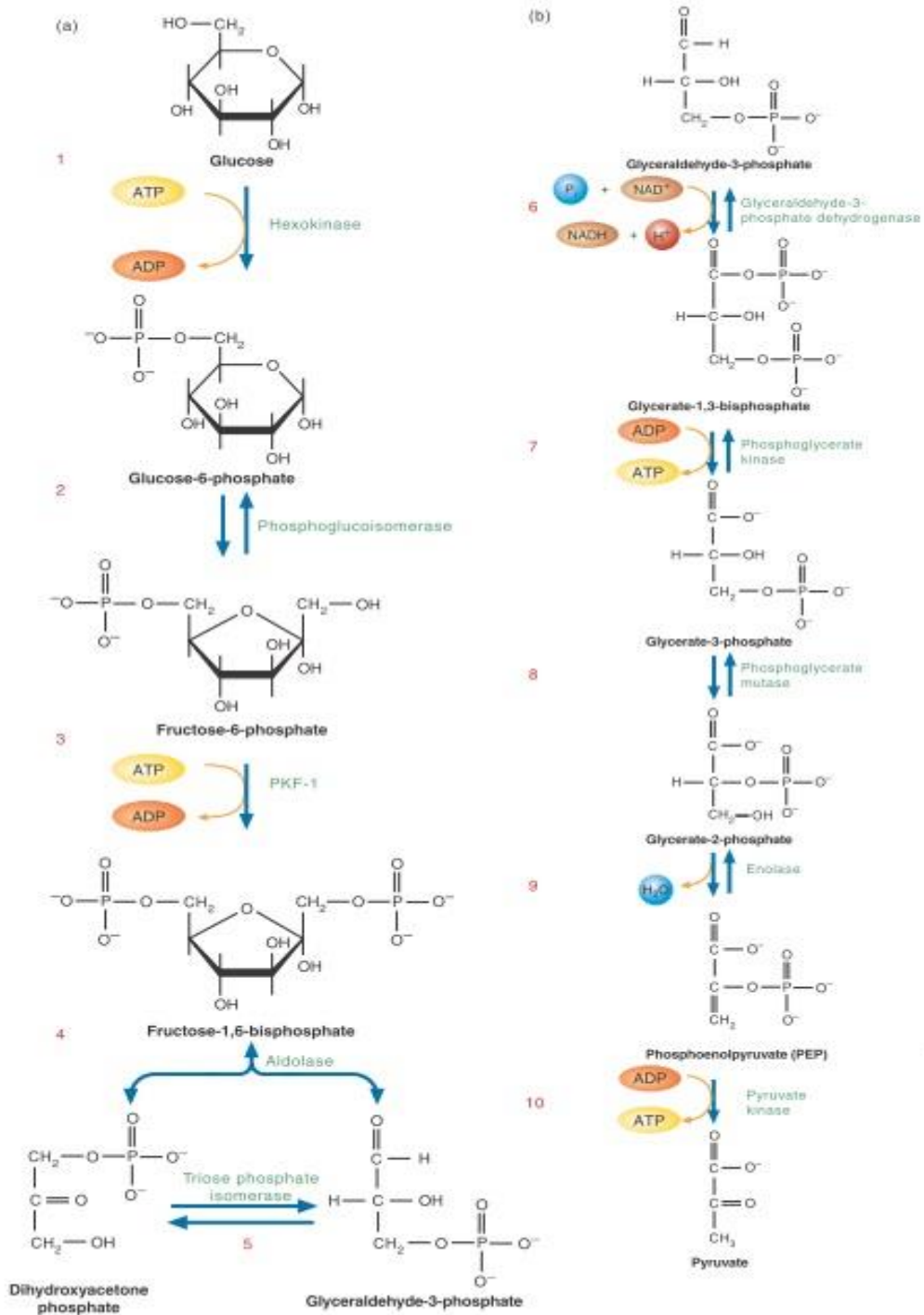
Figure 2: Stage 1 (a) and stage 2(b) of the 10-step process of the Glycolytic Pathway.

(McKee and McKee, 2012)

Two important peptide hormones control the glycolytic process: glucagon and insulin. Both hormones are secreted by the pancreas and are responsible in ensuring that blood glucose levels remain stable. Healthy adult individuals present normal blood sugar levels between 4.0 to 5.4 mmol/L (72 to 99 mg/dL) when fasting (National Institute for Clinical Evidence, 2012). A detailed explanation of normal blood sugar levels in those with and without diabetes is given in table 2 below. Glucagon is released by the alpha cells of the pancreas when blood glucose levels (BGL) decrease while insulin, secreted by the beta cells of the same organ is released when blood glucose levels rise (McKee and McKee, 2012). In effect, increased secretion of glucagon inhibits all enzymes participating in glycogenesis while activating those in glycogenolysis. The opposite occurs in the presence of increased insulin secretion (Hall, 2015). A rise in blood glucose concentration levels however, is dependent on the rate of absorption, the rate of gastric emptying and, of interest to the author, the characteristics of the foods consumed (Scientific Advisory Committee on Nutrition, 2015).

Table 2: National Institute for Clinical Excellence (NICE) recommended target BGL

Target Levels by Type	Upon waking	Before meals (pre-prandial)	At least 90 minutes after meals (post prandial)
Non-diabetic*		4.0 to 5.4 mmol/L	under 7.8 mmol/L
Type 2 diabetes		4 to 7 mmol/L	under 8.5 mmol/L
Type 1 diabetes	5 to 7 mmol/L	4 to 7 mmol/L	5 to 9 mmol/L
Children w/ type 1 diabetes	4 to 7 mmol/L	4 to 7 mmol/L	5 to 9 mmol/L

Provided for information but do not form part of NICE guidelines.

Source: (Diabetes UK, 2019)

2.2.4: Metabolism of Glucose in the Brain

The nervous system of the brain requires a lot of energy and oxygen to function at its optimum as some of these functions can be considered energetically expensive (Harris, et al., 2012). Some authors suggest that most of the glucose entering the brain from the blood supply does so through glucose transporter 1 (GLUT1) and cells called astrocytes and then used by the different cerebral cells for energy. The glucose substrate in the brain is used for the synthesis of amino acids and proteins, in reactions to produce important neurotransmitters and homeostasis maintenance. The remaining glucose is also converted to lactate, and transferred for neuronal metabolism (Benarroch, 2010; Hyder, et al., 2006).

Changes in blood glucose levels can have a significant impact on brain health. Increase of BGL as is the case in diabetes mellitus can lead to damage to nerves (diabetic neuropathy) and affect the different stages of glucose metabolism (Albers and Pop-Busui, 2014).On the other hand, in cases of hypoglycaemia (<70 mg/dL) symptoms can range from a simple irritation, confusion, brain injury, coma or even death. These symptoms depending on the severity of the hypoglycaemia, the physical health of the individual as well as age (Mahmoudi, et al., 2013). It must be noted that the BGL in humans constantly change and are dependent upon the types of food consumed, physical activity and metabolism of an individual (American Diabetes Association, 2018).

2.3: Glycaemic Measurements

Defined previously, one approach used internationally to evaluate the quality of carbohydrates is to classify foods and dietary patterns based on their glycaemic index (GI) or glycaemic load (GL). The glycaemic index of a food is first determined in healthy persons. Volunteers, in a laboratory are given a food containing 50g of carbohydrate and blood samples taken from them every 15 minutes over a 2-3 hour duration. The blood samples are taken to determine blood glucose levels. Once these levels are known, a graph of the blood glucose results over time is plotted and compared with a reference sample that is usually a slice of white bread or pure glucose. Each food is then given a GI rank/number (Dyson, 2008). Based on the GI number assigned, foods can be classified as having a high GI when this number is equal or more than 70, medium between 56-69 and low GI between 0-55 (Foster-Powell, et al., 2002). Various international databases have been created compiling the GI of many commercial foods specifically in the Australian, Canadian, and American and to a lesser extent the British market allowing for easier identification of the GI of foods (Foster-Powell, et al., 2002).

2.3.1: The Glycaemic Load

Whilst the quality of a carbohydrate (measured by its GI) plays an important role in determining the speed at which a food raises blood glucose levels, the quantity of carbohydrate consumed cannot be overlooked. In an effort to consider both aspects of carbohydrates (quality and quantity) an associate term, the glycaemic load was developed (Salmerón, et al., 1997). Once the GI of a food is known, its GL is determined using the following formula:

GL= grams of carbohydrate (i.e. total carbohydrates- dietary fibre) X GI/100

Based on the GL calculation, foods can therefore be classified as high GL when their GL value is equal to or more than 20, medium when the GL value is between 11-19 and low GL with a number value below or equal to 10 (Brand-Miller, et al., 2003).

Both the GI and GL can be used on a dietary scale. The dietary GL is the estimated sum of the GLs of all the carbohydrate foods consumed by an individual during a meal, day, week or month. Meanwhile the dietary GI gives a weighted average of the GI of all carbohydrate foods consumed over a determined period giving an indication of the carbohydrate quality in the overall diet (Neuhouser, et al., 2006).

2.3.2: Factors influencing the glycaemic characteristics of food

One of the fundamental factors affecting the glycaemic characteristics of a food is its own physical and chemical properties. A food's cellular structure and ripeness (with respect to fruits/vegetables) will affect its GI. The riper a food is the higher its GI will be (Bjorck, et al., 2000). The same source notes that starches presenting unbranched amylose present lower GI when compared to those with those with branched amylopectin. The more sugar content present in a food the higher the GI will be. Large amounts of fat and protein in a food (30g of fat and 50g of protein per 50g of CHO) can increase the GI through their influence on gastric emptying and insulin secretion (Wolever, et al., 1994). However, the addition of smaller quantities of fat and proteins to foods can also reduce its GI (Bornet, et al., 1987). In addition to fats and proteins, a foods sugar content (the more sugar present the higher the GI) and acidity, (acid slows gastric emptying and thus slows down starch digestion) have important implications to/on GI (Radulian, et al., 2009). The presence of fibre in food or in the stomach slows down the digestive process by protecting starchy carbohydrates from the action of different enzymes (Lattimer and Haub, 2010). How foods are prepared also impact glycaemic characteristics (FAO, 1998).

Foods that are highly processed go through less digestive processes in the body and thus tend to have higher GI values than their non-processed counterparts do as they raise BGL faster (Schulte, et al., 2015). Studies in cooking have found that foods that are roasted or baked tend to have higher GI values than the same foods that are boiled or fried (Bahado-Singh, et al., 2006). Similarly, addition of cheese, nuts and vinegar to other foods have been found to lower a food's GI value (Jenkins, et al., 2006; Henry, et al., 2006; Ostman, et al., 2005; Johnston and Buller, 2005).

2.3.3: Criticisms associated with using the Glycaemic Measurements.

Opponents of the use of the glycaemic index and glycaemic load, often cite inconsistencies in the measurement procedure (Arvidsson-Lenner, et al., 2004), difficulties in determining GI in mixed meals (Flint, et al., 2004), insulin responses not taken into account (Coulston and Reaven, 1997), and intra-subject variations with the glucose response to a food (Pi-Sunyer, 2002) as the main issues with using these two measurements. The International Carbohydrate Quality Consortium notes that most criticisms levied at the GI and GL are not valid but reflect a failure in knowledge translation of the proper use of these measurements and interpretation (Grant and Wolever, 2011).

The differences in how the GI of foods is calculated are varied. These important methodological concerns include the number of subjects used to determine the glycaemic response of a food, whether pure glucose or white bread is employed as the reference product, use of blood samples of a venous nature instead of preferable capillary blood which offers less variation and when blood samples are taken (Arvidsson-Lenner, et al., 2004). A study, which examined how GI determination differed among laboratories, found that among the seven laboratories under review, the GI of the different foods, did not differ significantly although variations in individual determinations of the same foods varied by 17 to 34 GI units (Wolever, et al., 2003).

Whilst the main methods behind GI determination have not changed since 1981, in an effort to improve method standardisation and result accuracy, the International Carbohydrate Quality Consortium (ICQC) established a standard method that is precisely defined by the International Organisation for Standardisation (IOS, 2010).

Wolever (2013) notes that if the GI measurement is used correctly, it can differentiate between high and low GI foods with a certainty of 95%.

The difficulties in determining GI in mixed meals is another criticism of the validity of GI. RCTs carried out over the years have shown that though foods all have different GI values, when they are added together to create a meal, the meal's unique postprandial glycaemic index has a tendency to be similar to the single main carbohydrate food source (Flint, et al., 2004; Wolever and Jenkins, 1986). As previously mentioned, the manner in which a meal is prepared as well as the amount of protein, carbohydrates and fat rich foods used will have a significant impact on its glycaemic characteristics. In this regard, calculating the GI of the meal based on the individual GIs of each component food will not reliably predict the overall GI (Venn and Green, 2007). Further, given that GI is a product of carbohydrate rich foods, the GI of a mixed meal should be calculated from the carbohydrate rich foods or ingredients present (Augustin, et al., 2015). Whilst those opposing use of GI note that different methods of cooking and processing foods are important variables for discrediting the use of GI, the author takes the opposite stance. A food that is boiled versus fried will indeed present two different GIs due to the *cooking variable*. It is precisely why the measurement of GI is important. Knowing that the food in question when boiled versus fried has a different GI quantifies the impact of the cooking variable and improves the reliability and usefulness of the GI ranking.

Intra-subject (within subject) and inter-subject (external variables such as cooking and food processing) variations with the glucose response to a food and the differences in insulin response are put forward by the opponents of GI/GL usage.

Intra- subject variations would refer to those physiological factors uniquely expressed by the subject. The subject's rate of digestion and absorption are factors that may influence postprandial glycaemia. Suzuki, et al. (2005) and Read, et al. (1986) both mention the extent to which food is chewed as an example of an intra-subject variation influencing glycaemic response. Random intra-subject variations account for the majority of the differences observed among laboratories testing GI (Wolever, et al., 2003). One method of overcoming this challenge is to increase the number times a reference food is tested to two or three times in each subject (Brouns, et al., 2005). Further, Brouns, et al., (2005) notes that intra-subject variations present for test foods could be reduced by increasing the amount of subjects tested. Whilst both these recommendations would improve the precision of GI measurements, the cost of measuring GI would increase (Venn and Green, 2007).

Differences in insulin response is another opposing critique to examine. Persons suffering from diabetes and glucose tolerance impairments will present an increase in glycaemic response measured as blood glucose area under the curve (AUC) (see Figure 3) when compared to those with normo-glycaemic individuals (Foster-Powell, et al., 2002).

 The same source posits however, that giving the very nature of GI as the AUC in response to a test food relative to a reference food and the fact that each person acts as their own control, a food's GI should not differ in normo-glycaemic subjects and those with glycaemic impairments. Although GI ranking tables exists for those with glucose tolerance impairments, (Foster-Powell, et al., 2002) the use of normo-glycaemic subjects in GI testing is recommended given the increased probability of glycaemic responses in those with diabetes and glucose tolerance impairments (Brouns, et al., 2005).

The factors previously mentioned can affect the glycaemic characteristics of food, within a physiological range different foods will cause different glycaemic responses.

High GI/GL foods will increase blood glucose levels causing spikes and fluctuating to lower levels whilst low GI/GL foods provide more sustained blood glucose levels providing the individual with different health benefits (refer to Figure 3).

Figure 3: The glycaemic response in healthy adults.
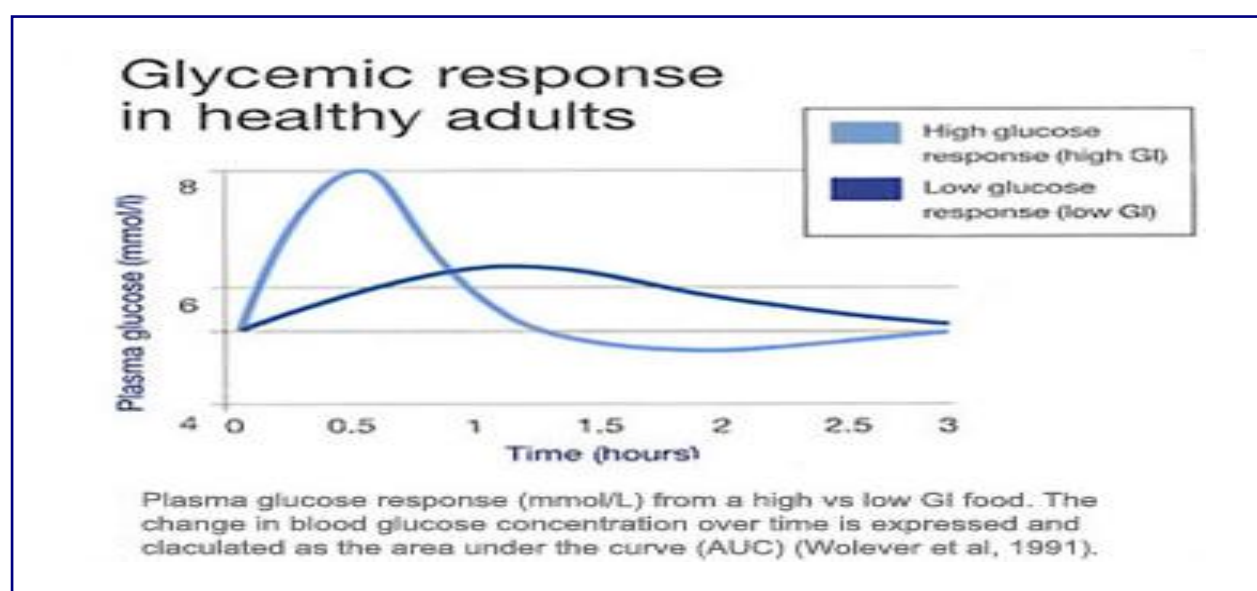
Source: Wolever et al (1991)

2.4: The Second Meal Effect

The ability of a previous meal to decrease ones blood glucose level after a subsequent meal was first examined in RCTS in the early 1920s (Tragaut, 1922; Staub, 1921) and then later confirmed and named by Wolever, et al.,1988 in their RCT. It is simply a phenomenon where the GI of a previously consumed meal has an impact on another due to the previous meal's prolonged glycaemic response (Brighenti, et al., 2006).

Wolever, et al. (1988) carried out 3 RCTs involving feeding interventions and blood glucose monitoring of 5-10 young adult participants(age averages of 24, 28 and 33 years respectively) and found that a low GI evening meal significantly lowered the postprandial glycaemic response to a meal the following morning when compared to a high GI evening meal. How this phenomenon occurs is not fully understood but its possible mechanisms can be divided into two groups, breakfast to lunch and overnight effects (Arvidsson-Lenner, et al., 2004). An overnight meal with a low GI but rich in dietary fibre is a widely suggested mechanism (Bjorck and Elmstahl, 2003). The presence of dietary fibre slows down the rate of digestion and can reduce the level of glucose absorption in the small intestines (Jenkins, et al., 1980). More recently in a study examining the effects of three evening meals with differing amounts of non-digestible carbohydrates on the same breakfast meal, it was observed that the evening meal with the highest amount of non-digestible carbohydrates significantly reduced the postprandial glucose response to the breakfast meal when offered to the other evening meals (Grandfelt, et al., 2006). A prolonged insulin response, coupled with an overnight suppression of free fatty acids (FFA), (Jovanoic, et al., 2009), the fact that some low GI-foods provoke longer insulin responses, and thus maintain elevated insulin levels during the next meal, (breakfast to lunch) (Liljerberg, et al., 1999) as well as the presence of lactic acid in a meal (such as barley bread) or produced by the process of fermentation of carbohydrates not digested in the small intestines, (Ostman, et al., 2002) are all probable mechanisms explaining the second meal effect. Although the actual mechanism is not fully understood, it is important that studies investigating glycaemic response and persons using the GI of foods for health related reason take into account the second meal effect.

2.5: Uses and benefits of GI/GL

Proponents of the use of GI and GL highlight the measurements' ability to identify foods with potential health benefits against certain diseases as well as the management of different ailments their main importance. The benefits of low GI/GL foods have been noted in the reduction of coronary disease risk (Barclay, et al., 2008), weight reduction and maintenance (Thomas, Elliot, and Bauer, 2005), the reduction of blood cholesterol levels (Thomas, Elliot, and Bauer, 2005), control of diabetes (Goldstein, et al., 2004; Brand-Miller, et al., 2003) as well as other diseases.

2.5.1: Coronary Disease

Several studies have found a reduced risk of coronary disease in persons who follow a low GI/GL diet. A longitudinal population study assessing the risk of acute myocardial infarction in Finnish men (average age 52 years) found that diets of high GI and GL were associated with increased risk of acute myocardial infarction (Mursu, et al., 2011). The EPIC study, a systematic review and meta-analysis, examining the GL and its relation to coronary disease in a Mediterranean population found that high dietary GL increases the risk of coronary heart disease while adherence to a low/moderate GL Mediterranean was associated with a reduced risk of 40% and the risk of death from coronary heart disease by 60% (Turati, et al., 2015). Similarly, an ongoing large scale prospective study, after a 17-year follow up in persons without diabetes, found a significant increase in the risk of coronary heart disease in white and African Americans with high GI/GL diets Hardy, et al., 2010). The most comprehensive evidence however was presented in a meta-analysis of 37 studies with follow-ups ranging from 4-20 years across studies which concluded that low GI and/or low GL diets were independently associated with a reduced risk of certain heart diseases (Barclay, et al., 2008).

2.5.2: Weight Reduction and Maintenance

Various mechanisms exist highlighting the possible advantages of consuming low GI foods for the purposes of weight reduction or maintenance. One such mechanism posits the presence of a generally higher fibre content in low GI foods as the reason for these advantages. This high fibre content produces a more satiating effect upon consumption (Arvidsson-Lenner, et al., 2004). A review examining the effects of low GI or GL foods on weight loss in overweight and obese patients, ranging from five week to 6 month intervention studies, found significant decreases in body mass, total fat mass, and body mass index in subjects on a low GI diet when compared to subjects on higher GI/GL diets (Thomas, Elliot, and Baur, 2005). Similarly, evidence exists showing low GL diets are beneficial in treating obesity in younger subjects (Fajcsak, et al, 2008; Ebbeling, et al., 2003).

2.5.3: Blood Cholesterol Levels

Though not extensively studied, decreasing the GL of foods consumed has been found to improve lipid profiles and lowering both total cholesterol and LDL-cholesterol (Thomas, Elliot, and Baur, 2005). This area requires more studies with longer durations and follow-up to ascertain whether these results are maintained over time.

2.5.4: Diabetes Mellitus

One disease studied extensively in glycaemic research is Diabetes Mellitus. The use of low GI foods in the treatment of diabetes is a controversial one. Some authors suggest that currently enough information does not exist supporting the use of low GI foods to help manage diabetes (Sheard, et al., 2004) while others opine that it should be one of the first lines of treating the diseases (Brand-Miller, et al., 2003). Another point of view is not to use low-GI foods as a form of treatment but rather to properly manage the disease (Connor, et al., 2003).

While there is some evidence showing a diet rich in carbohydrates over time can contribute to persons presenting with diabetes, a recent meta-analysis sort to find a definitive causal relationship between GI/GL of foods and the incidents of type 2 diabetes (Livesey, et al., 2016). Using Bradford-Hills criteria, it found a high confidence in causal associations for type 2 diabetes incidents and opined that because of this the GI and GL of foods should be considered when nutritional recommendations for diabetic patients are made. Reviews conducted by Brand-Miller, et al. (2003) as well as Thomas and Elliot (2009) (published in the Cochrane Collaboration Library) both concluded that low-GI foods significantly improved glycaemic control in diabetics. The reviews noted that these low-GI foods improved glycaemic control while at the same time producing a reduction in hypoglycaemia. The studies and reviews mentioned above are not advocating one approach to treating or managing diabetes. They are however stating that from a dietary perspective the glycaemic effect of different carbohydrates should be taken into consideration.

Some evidence from various RCTS also suggests that low GI foods can also reduce the risk of different types of cancers (Don and Qin, 2011; Shikany, et al., 2011), stroke (Oh, et al., 2005), the management of polycystic ovary syndrome (Marsh and Brand-Miller, 2005) and chronic kidney disease (Gopinath, et al., 2011) among others.

2.6: Factors influencing food consumption among care home residents

The determinants of food choice play a fundamental role in what foods one will consume. Though these determinants are related to food intake factors, they are not one in the same, specifically in the case of older adults in care homes. These determinants can be divided into the following:

- Biological determinants (hunger, appetite, taste),
- Person related determinants (intrapersonal-perceptions, attitudes, beliefs, knowledge and skills; interpersonal-family and social networks).
- Social and Environmental determinants (food availability, cultural practices, policies, cost, advertising etc.) (Shepherd, 1999).

Whilst these determinants will directly affect what foods are selected for consumption other, factors play an even more pivotal role in whether and how much of these foods are actually eaten. This part of the thesis looks at these factors in the unique context of older adults in care facilities.

Malnutrition is a common condition observed in residents of care facilities which if not treated can lead to fragility and falls, poor immune systems, depression and an overall reduced quality of life (Verbrugghe et al., 2013; Wendland, et al., 2003). Overcoming malnutrition requires an improved understanding on the factors that will influence the food intake of residents (Khan, et al., 2013; Worsley, 2002). These factors can be divided into the three Ms as well as policies and regulations. The three Ms include Meal Access, Meal Quality and the Mealtime Experience (Keller, et al., 2014).

2.6.1: Meal Access

This refers to those factors intrinsically linked to a resident's access to food. Meal access factors include characteristics unique to residents such as oral and dental health, difficulty to swallow food, as well as the ability to smell and taste food. Meal access can also include the ability of a resident to feed him or herself, whether they require feeding assistance and the duration of time as well as expertise required by staff to assist them with feeding. These factors are more frequently seen in residents with mental incapacity issues such as dementia (Schiffman, et al., 2007).

Previous evidence has shown that poor oral health prevented as much as 20% of older adults from consuming their preferred meals (Locker, 1992). The presence of oral cavities and dentition issues (loose teeth, dentures not properly fitted) also cause decreased food intake, as they affect the ability to properly chew food, which will then lead to malnutrition (Tamura, et al., 2013). The risk of malnutrition is further exacerbated when residents present difficulty swallowing due to the textures of the foods offered. The difficulty to swallow a meal is closely linked to its sensory appeal. This sensory appeal can be attributed to the appearance of the meal, smell and lack of taste (Keller and Duizer, 2012).

Residents with dementia present even more barriers to meal access. These residents may present difficulty with opening packaging, using a straw and using cutlery efficiently. This inability to carry out these tasks may cause frustration and agitation and could reduce consumption (Greenwood, et al., 2005). Consequently, care facilities must deploy staff to assist with feeding. Whilst this aids in overcoming one barrier, it could also potentially create new barriers to food consumption. An insufficient staff compliment within the facility can in effect decrease food intake (Simmons and Schnelle, 2004).

2.6.2: Meal Quality

Meal quality is another important factor influencing food intake in older care home adults. This factor focuses specifically on the meal offerings and includes aspects such as the appearance of served meals, whether meals afford residents the required nutrients, whether food is freshly prepared as well as the temperature of the food when served.

Foods that appeal to the senses affect both food choice and intake (Small and Prescott, 2005). As previously expressed (example of pureed meals), foods which look appealing and taste well are more likely to be consumed in larger quantities (Lumbers and Raats,2006). Food preference is largely determined by "taste" and this taste or palatability encompasses the texture of food, smell and flavour (Small and Prescott, 2005). Jones, et al. (2005) note that older adults present and increased appetite and motivation to eat when food can be smelled during the cooking/preparation process. The temperature of the meal offered will also determine how much of it is eaten as serving temperature has been found to affect taste (Drake, et al., 2005). Meals with the appropriate temperature are chewed and swallowed easily. Offering an extremely hot meal requires time for it to cool and this may frustrate the person eating (Caroline Walker Trust, 2004). Further, evidence from two non-randomised control trials of participants over 16 have shown that meals that are neatly presented on a plate or is easier to eat (for example finger foods) significantly increases intake (Velasco, et al., 2016; Zellner, et al., 2011).

2.6.3: Mealtime Experience

This factor refers to the social and environmental aspects which impact food intake at the time of actual consumption. The environment or surroundings either will positively or negatively influence food consumption (Wansink, 2004). A dining area that is clean, where tables and chairs are properly organised to promote persons sitting together, instead of apart will have an impact on food consumption (Gibson and Henry, 2005).

Smartly set tables, visually appealing menus, music, decorations using an inviting and relaxed colour seem also favour improved food intake (Nijs, et al., 2006).

Socially, residents who are allowed to interact with other residents, being involved in conversations around food, as well as developing relationships with tablemates, are more likely to eat more food (Curle and Keller, 2010; Jones, et al., 2005). When residents are left alone to eat, they are more likely to be depressed and apathetic and eat less (Volicer, et al., 2013). It is therefore important to foster an environment where residents can socialise at meal times. This socialisation is not limited to residents as interaction and the formation of relationships between residents and staff will promote food intake and improve the residents' quality of life (Chang, et al., 2013). These factors are supported by the Life Nourishment Theory, which notes the importance of social and environmental characteristics in food consumption (Keller, et al., 2014).

2.6.4: Other factors to consider

Policies within the care facilities with regards to food sourcing, the creation and planning of menus without the input of residents regarding their preferences, how often menus are reused (short menu cycles increase malnutrition), the variety of meals offered to residents, food storage, and safety requirements are all factors with the potential to impact food intake of residents. Additionally, broader governmental regulations and laws could also have an indirect impact on consumption (Keller, et al., 2014; Carrier, et al., 2007).

2.7: Portion Sizes

2.7.1: Introduction

Over the last thirty years food portion sizes have seen an increase (Piernas and Popkin, 2011; Steenhuis, et al., 2010; Young and Nestle, 2002). One source notes that the average dinner size plate used in the 1980s of 25 cm, increased in area by 44% (to 30cm) in the 2000s (Klara, 2004). An increase in plate size has been found to impact food consumption more than an increase in serving size (Wansink, et al., 2006). Portion size, however, is not solely dependent on the size of the plate, but can be impacted by the server, the serving utensils in use as well as the type of food being served (Benton, 2015; Wansink and Cheney, 2005). Knowledge and guidance regarding standard portion or serving sizes for different foods, particularly older adults in day centres or care homes are important to achieve and maintain nutritional guidelines and thus reduce malnutrition (Caroline Walker Trust, 2004).

2.7.2: Portion Size and Influential Factors

A portion size refers to the quantity of a food or drink served (serving size) (Brunstrom, 2014). Standardised portion sizes often differ by country (Benton, 2015). In the United Kingdom, the British Nutrition Foundation gives general guidelines with information obtained from the Scientific Advisory Committee on Nutrition (SACN) (BNF, 2019). Other sources such as the Food Standards Agency and the Caroline Walker Trust offer recommendations for older adults and care facilities (Food Standards Agency, 2018; Caroline Walker Trust, 2004).

The use of correct portion or serving sizes can significantly influence glucose and insulin concentrations in older adults and consequently impact health outcomes (Barton, et al., 2000). Factors that can potentially influence portion size are varied and can be examined from a communal/community and or individual perspective.

Factors within a community that could influence portion size:

- Utensils, serving containers, plate size (Wansink and Cheney, 2005)
- Inaccuracy in correct portion size estimation (Blake, et al., 1989)
- Societal, personal, and cultural norms (Lewis, et al., 2015;Berelander, et al., 2012)
- Existing portion size knowledge (Benton, 2015)

From the individual perspective, influences include palatability and preference, visual and olfactory cues, the environment and physiological characteristics (McCann, et al., 2013). These factors can either cause an increase or decrease in portion size resulting in health outcomes such as obesity and undernutrition (Zamboni, et al., 2005). One school of thought opines that an increase of portion sizes for older adults could lead to a reduction in appetite and thus reducing the portions of these adults would have the opposite effect and as a result increase food consumption (Barton, et al., 2000 and Cluskey and Dunton, 1999). In contrast, some sources opine that reducing portion sizes would result in a decrease in consumption (Cluskey and Dunton, 1999). Whilst these schools of thought differ, one aspect that continues to determine the health outcomes from portion sizes that should be considered in nutritional research (specifically in consumption research) is the energy density (Steenhuis and Poelman, 2017). Energy density refers to the amount of calories present in a food (per gram) (British Nutritional Foundation, 2019). A reduced portion size with a high energy density can increase food consumption in older adults more than what has been hypothesised by the aforementioned schools of thought (Leidy, et al., 2009).

2.7.3: Methods of portion size estimation: The Direct Food Photography Method

 The most frequently used methods in nutrition research to determine portion size include the direct observation of eating, weighing of foods, FFQ (Food Frequency Questionnaire), dietary recall as well as direct digital photography (Williamson, 2003).

The weighing of foods, in nutritional research has remained the most accurate method for measuring portion sizes and intake (BNF, 2019a). Whilst this method is frequently used, its disadvantages can hinder its use (Wolper, et al., 1995). Weighing foods can be viewed as extremely time consuming, particularly in large data studies, it is disruptive (this can be due to the time required for it to be complete or the participants involved) and it can be financially burdensome (specifically the equipment and environment required for measurement) (Williamson, 2003). Food frequency questionnaires (FFQ) are the most common dietary assessment tools used in large epidemiological nutritional studies (Shim, et al., 2014). It is an advanced version of the checklist in the dietary history method asking the respondent how often they ate and the amount of found eaten in a specified period (Steinemann, et al., 2017). It is not time consuming, can be designed for a specific group and is cost-effective (Shim, et al., 2014). However, self-reported methods such as FFQ, dietary recall and food diaries are limited by false information reported by study participants (Subar, et al., 2015; Rumpler, et al., 2008; Scagliusi, et al., 2003). In contrast, three-dimensional and visual methods such as direct observation and digital photography present more report accuracy (Williamson, 2003).

Direct observation or visual estimation requires a trained individual to observe food trays or plates before and after ingestion and estimate portion sizes in reference to standard portions (McClung, et al., 2017). This method is non-intrusive and considered ideal for studies in communal settings (school cafeteria, lunchroom etc.) (Williamson, et al., 2004).

However, one must consider the research in question as direct visual estimation, though accurate, is a slow time-consuming method and very labour intensive (characteristics not ideal for larger studies) (Dhingra, et al., 2007). Direct food photography perhaps can be considered a modified version of direct visual estimation providing a solution to those disadvantages.

In contrast to the other methods examined, direct food photography (DFP) is a fast and reliable method allowing more data to be collected in a shorter period (McClung, et al., 2017). The same source also notes that information collected is also permanent i.e. the researcher can review the images on multiple occasion during the analysis process and the stored photographic data can be compared with standard portions presented in computer software for better accuracy. Interference by the researcher is reduced and the method is less-labour intensive. Validity studies of the different methods have found that although weighing food presents the strongest reliability and accuracy, both the direct visual estimation and DFP methods were both valid methods with a tendency to present small over and underestimates of portion sizes when compared to the weighing of foods (Williamson, et al., 2004). More recent observational studies of both older and younger adults in the DFP method, suggest it to be a method that improves overall efficiency and feasibility in dietary intake and portion size research particularly in larger population studies in collective eating settings (Timon, et al., 2018; Martin, et al., 2010).

2.8: Older Adult Nutrition

2.8.1: Introduction

Adequate nutrition is regarded as the foundation of human health and wellbeing (FAO, 2013). In the UK, as the life expectancy of the population increases so does the number of adults over 65 (Office of National Statistics, 2015). Malnutrition is an all too common condition observed in older adults. As much as 14% of the older adult free-living population and 21% of those living in institutions are considered to be at risk of under nutrition (Margetts, et al., 2003). This condition has serious implications on health outcomes of these individuals. The British Nutrition Foundation (2016) notes that presently malnutrition is more prevalent in older people living in care facilities than free-living adults. Why this is the case and the recommendations not being met by these older adults are mentioned in this section.

2.8.2: Characteristics of older adults

As previously mentioned, there are various reasons affecting food intake in older adults that can lead to malnutrition. However, there are unique characteristics of the older adult to consider which can be attributed to natural bodily changes as well as disorders (Copemann, 1999).With ageing muscle mass decreases while fat tissue increases (St-Onge and Gallagher, 2010). A decrease in muscle mass leads to a decrease in the basal metabolic rate that affects energy requirement i.e. it is also reduced (Kalyani, et al., 2014). A lack or reduction in physical activity in old age further reduces energy requirements (Hoos, et al., 2004).

Another important change in older adults is the synthesis of vitamin D. The synthesis of the vital micronutrient vitamin D, is severely reduced by the skin with old age (British Nutrition Foundation, 2019b). This can lead to increased fragility, falls and fractures and favours osteoporosis (Boucher, 2012).

The changes in the body also affect internal bodily systems from the nervous to alimentary systems that no longer function as optimally as before (Chapman, 2011; Howell, 2000).

As the ageing process ensues, the body becomes prone to certain diseases which themselves can lead to malnutrition such as arthritis, depression, Parkinson's, diabetes, dementia and certain forms of cancer (Neel, 2001; Davidhizar and Dunn, 1996; Booth,1993). Additionally, care home elderly as a group are major users of drug such as non-steroidal anti-inflammatory drugs (NSAIDs), antidepressants, diuretics, opioids and the like (Neel, 2001). The metabolism of some of these drugs can create deficiencies in nutrients (by affecting their absorption or distribution), specifically micronutrients and thus lead to further nutritional deficiencies.

2.8.3: Nutritional Recommendations

Currently there are no specific general nutritional guidelines for older persons (i.e. over 65) nor those residing in care. With the exception of the recommended daily supplement of 10 micrograms (mcg) of vitamin D daily and consume foods rich in this micronutrient, the recommendations in the UK for older adults are generally the same for the overall adult population (BNF, 2019c).

Public Health England and the Food Standards Agency's National Diet and Nutrition Survey (NDNS)-Rolling Programme (NDNS, 2016) highlights current consumption patterns in relation to dietary targets of the United Kingdom population. For fruits and vegetables, it recommends that older adults consume at least five portions daily, which is equivalent to 400 grams. Fruits and vegetables that contribute to the total carbohydrate intake that should meet the target of ≥ 50% of nutrient food energy with sugars (including free sugars) targeted at ≤ 5%. Red and processed meats that contribute to protein intake should not exceed 70 grams per day.

This amount should also be the target for those who consume more than 90 grams of meat daily. Oily fish, due to the presence of long chain omega-3 fatty acids are important in protecting against various cardiovascular diseases, improve cognition and the immune system (Gutiérrez, et al., 2019; Kris-Etherton, et al., 2002). It is recommended that adults consume 140 grams of oily fish or one portion per week. Regarding the macronutrient fat, it is advised that total fat should contribute ≤ 35% with saturated fats targeted at ≤ 11% and trans fats at ≤ 2% (NDNS, 2016).

The Diet and Nutrition Survey identifies the current nutrient recommendations not being met in the older adult group. Fruit and vegetable targets are only met by 35% of older adults. Oily fish consumption is also below the recommended amounts in the majority of this group. On the other hand, the mean consumption of red and processed meats met the targets suggested with older males exceeding the recommended amount. These food intakes compared to current recommendations are given below in table three in addition to table four that summarises percentage of nutrient food energy targets in comparison to current diet in the older adult UK population.

Table 3: The UK diet compared to recommendations

Food	Target	Old Adult Diet (65+)
Fruit and Vegetables (per day)	At least 5 portions	4.3 portions
Oily Fish (grams/week)	140 grams (1 portion adults)	87 grams
Red/processed meat (grams/day)	No more than 70 grams	69 grams

Source: NDNS years 5 & 6 -2012/13 - 2013/14 **(2016)**

Table 4: The UK diet compared to recommendations

Nutrient (% food energy)	Target	Older Adult Diet (65+)
Total Fat	≤35%	34.7
Saturated Fat	≤11%	13.4
Trans Fat	≤2%	0.6
Total Carbohydrate	≥50%	45.8
Sugars (free sugars)	≤5%	11.1 (NMES)*
Salt (grams/day)	≤3-5 grams/ ≤6 grams	7.6 grams

*NMES refers to non-milk extrinsic sugars including added sugars and sugars released from cell structures e.g. fruit juices.

Source: NDNS years 5 & 6- 2012/13-2013/14 (2016)

Another aspect of nutritional requirements to consider are micronutrients. Presently there is also a lack of micronutrient recommendations for those over the age of 65. (The reference micronutrient intakes in the UK (British Nutrition Foundation, 2019c) and by the European Food Safety Authority are given in Appendix 13). As a result, this poses some challenges. Due to the ageing process, older adults will digest, absorb, metabolise and excrete micronutrients differently from their younger counterparts (British Nutrition Foundation, 2016). It therefore requires specific micronutrient recommendations for this group.

The National Survey identified deficiencies in vitamin B12, C, D, Riboflavin, Thiamine, Folate and Iron in those in the old age category. These deficiencies were below the lower reference nutrient intake (LRNI) and were more pronounced in older adults in care homes when compared to their free-living counterparts (see figure 4).

Figure 4 : The proportion of older British adults with a low micronutrient status (percentage below LRNI).
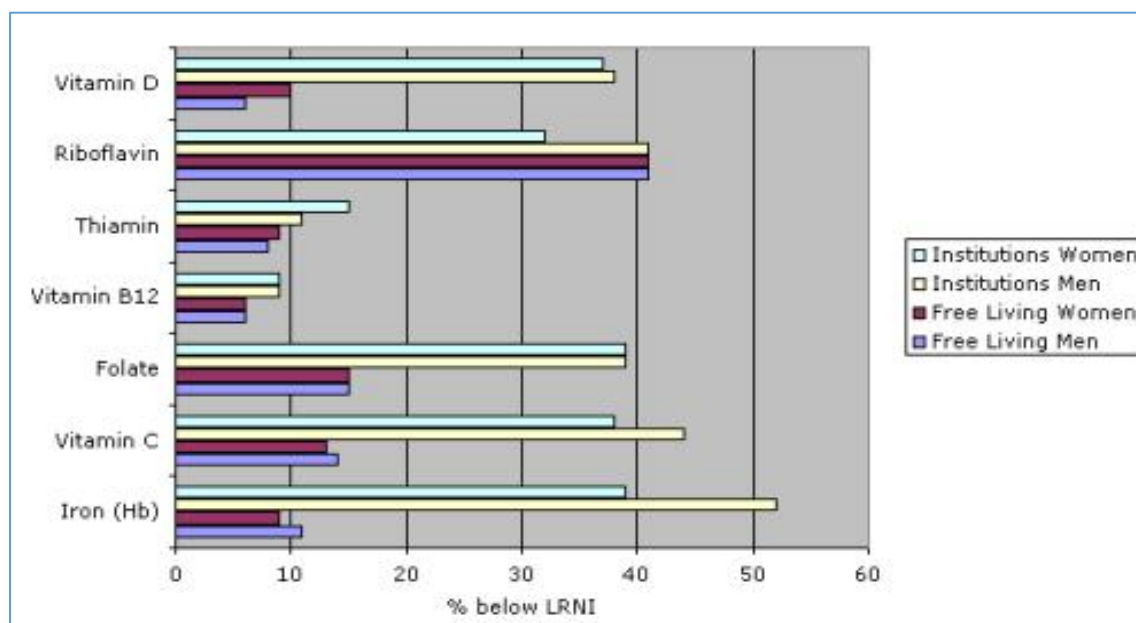
Source: British Nutrition Foundation (2016)

2.9: Dementia

2.9.1: Definition and Public Health Perspective

Dementia is not a single disease but rather an umbrella term that encompasses all brain diseases that cause a gradual decrease in cognitive function which affect ones' memory, ability to think, language/communication ability and emotions (Public Health England, 2018).

The four main causes of dementia are Alzheimer's disease (two-thirds of all cases), Vascular Dementia (20%), Levy Bodies Disease (15%) and Front-temporal Dementia (5%). These cases can appear simultaneously resulting in "mixed dementias". Whilst dementia is a condition related to ageing, 4% of all Alzheimer's cases in the UK occur in persons under the age of 65. This type of dementia is referred to as early-onset dementia (Alzheimer's Society, 2019).

Public Health Perspective

With the improvements to healthcare and accessibility, the world's population is now living longer (Prince, et al., 2015). This increase in ageing is associated with an increase in the risk of developing dementia (Alzheimer's Society, 2019). In both developed and developing countries, increased dementia risk brings with it an increased number of challenges. (Kalaria, et al., 2008). Dementia will challenge the family affected by significantly changing its dynamic, as the member with dementia requires additional support and care (WHO, 2019). This extra care is accompanied by additional financial burdens on the family and in some instances the community. As a result, the mental health of members of the family are also affected and the dementia sufferer may experience some level of social exclusion (Alzheimer's Society, 2019).

More broadly, there is an economic challenge that governments have to address. Both healthcare systems and social services are impacted by dementia (Prince, et al., 2015). Worldwide, over 50 million people have dementia with as many as 10 million new cases each year (WHO, 2019). The Global Burden of Diseases, Injuries and Risk Factor Study of 2016, places Alzheimer's and other dementias as the fifth leading cause of death globally accounting for 2.5 million deaths (GBD 2016 Dementia Collaborators, 2018). This amount presented an estimated global burden of £804 billion ($1 trillion dollars) for 2018, with a projected doubling by 2030 (Prince, et al., 2015). Presently, there are more than 850,000 dementia sufferers in the United Kingdom with this number likely to surpass the one million mark by the year 2025 (Public Health England, 2018). Of these dementia sufferers, the current crude prevalence rate in England in 2018 was 4.3 per 100 of the general practice population over the age of 65 (Public Health England 2018). This rate according to the same source is over 10,000 persons more than that of 2017. Further, the rate of emergency admissions to hospital for people with dementia in 2017 to 2018 was 3,609 per 100,000 population aged 65 years and over, an increase on 2016 to 2017 (3,482).

Data compiled by the London School of Economics, in their *Modelling Outcomes and Cost Impacts of Interventions for Dementia Study*, highlighted a total cost of care for people with dementia in the UK at £34.7billion for 2019. 45% of this cost was associated with social care such as care and residential homes, while the remainder was made up of healthcare cost (NHS) and unpaid care of family members (Alzheimer's Society, 2019). In 20 years, the same source projects the economic cost of dementia at £94.1 billion pounds. It is therefore no surprise that the WHO regards dementia as a public health priority (WHO, 2019).

2.9.2: Signs and Symptoms

Based on the symptoms exhibited dementia can be divided into three stages: early stage, middle stage and late stage (WHO, 2019).

Early stage dementia occurs gradually and may be difficult to diagnosis. The most common signs and symptoms include losing track of time, difficult concentrating, continued forgetfulness and diminished spatial orientation (lost in familiar places).

In the middle stage, signs and symptoms become more pronounced and include difficulty communicating, forgetting the names of friends and family, getting lost at home, requiring more assistance with personal care and tasks and experiencing noticeable changes in behaviour (Public Health England, 2018). Whilst the signs and symptoms of the first two stages of dementia are concerning, these persons still possess the capacity to make decisions (Buchanan and Brock, 1990).

The final stage is the late stage were dependence is almost total and activity severely diminished. Sufferers have difficulty recognising family and friends, lose orientation of time and place increased need with care, difficulty walking and behaviour changes which become more drastic (WHO, 2019).

2.9.3: Behavioural and Psychological Symptoms of Dementia (BPSD)

While changes in behaviour have been viewed as secondary to symptoms of cognitive decline these symptoms are the ones most frequently identified by relatives and carers (McKeith and Cummings, 2005). BPSDs are important in offering differential diagnosis and establishing a treatment plan (particularly in the prescription of psychotropic drugs). Table five details the behavioural and psychological symptoms most frequently seen in the four most common causes of dementia.

Table 5: Behavioural signs and symptoms most frequently observed in cases of dementia.

Cause of Dementia	Signs and Symptoms
Alzheimer's Disease	Apathy, agitation, depression, anxiety, irritability and less common; delusions and hallucinations.
Vascular Dementia	Apathy, depression, delusion
Levy Bodies Dementia	Visual hallucinations, delusions, depression
Frontotemporal Dementia	Apathy, disinhibition, elation, repetitive behaviours.

Source: (McKeith and Cummings, 2005)

2.9.4: Diagnosis and Treatment

Diagnosing a specific type/cause of dementia can be challenging due to the similarity in the symptomatology. However, a dementia diagnosis can be broken down into three aspects, namely the clinical aspect, logical search for a cause and the identification of any comorbid or underlining conditions contributing to cerebrovascular decline (Feldman, et al., 2008). A standard diagnostic process is first carried out involving patient and family medical history, interview of family members and physical examination (Alzheimer's Society, 2019). Various tests are also ordered to establish a differential or confirmed diagnosis.

These tests will normally include a cognitive test such as the Mini Mood State Examination (MMSE), Abbreviated Mental Test Score (AMTS), Trail-making test or the Montreal Cognitive Assessment (MCA) (Sager, et al., 2006). These screening tests are often carried out during the examination of the patient to determine the degree of functional cognitive decline (Alzheimer's Society, 2019). Routine laboratory tests are done to identify any underlining conditions, which may be attributing or causing the symptoms of cognitive decline. The laboratory tests could range from full blood panel to examining levels of thyroid stimulating hormones (Robinson, et al., 2015). The same source notes that an MRI or CT scan can also be ordered as part of the diagnostic process with the objective of getting a detailed view of the patient's brain structure.

Currently there is no cure for any dementias. The WHO (2019) identifies five principle goals for dementia care:

- Early diagnosis in order to promote early and optimal management.

- Optimising physical health, cognition, activity and wellbeing.

- Identifying and treating comorbidities and underling illnesses.

- Detecting and treating challenging behavioural and psychological symptoms.

- Providing information and long-term support to carers.

2.10: Mood in Nutritional Research

2.10.1: Introduction:

The ingestion of foods can have an impact on mood outcomes. Various studies in nutritional research have examined and found different neuropsychological effects because of food consumption (Gibson, 2006). Early research into this relationship has included studies on carbohydrates, lunch, breakfast, among others (Smith, et al., 1999; Lloyd, et al., 1996; Spring, et al., 1986) among others. All of which have found both positive and negative outcomes.

Similarly, more recent studies have produced mixed results (Breymeyer, et al., 2016; Benton and Young, 2015; Png, et al., 2014; Soh, et al., 2009).

Studies in this area tend to examine how the ingestion of a food tends to impact transient or protracted mood, emotion or affect, as well as the other side/aspect of the relationship i.e. such as, how the changes in mood can influence ingestion choices and consequently one's health (Hammersley, et al., 2014). Examining mood has been an area of interest in nutritional research for over 30 years; however, a consensus has not been reached where measurement and interpretation are concerned (Ekkekakis, 2013). The examination of mood in nutritional research usually involves a rating scale. Due to the consistent challenges of assessing mood, this section will examine how mood is defined, how it is differentiated from other neuropsychological states (emotion, affect), the challenges with mood assessment specifically in relation to nutritional research and ways in which mood assessment can be improved.

2.10.2: Types of mood and definitions

In behavioural science mood is classified based on its duration. Mood therefore can be transient or protracted (Parkinson, et al., 1996). Protracted mood occurs over a period of hours or days and is more consistent whilst transient mood as the name suggests, occurs for a relatively shorter timeframe (few hours or less) and can vary during this period (Hammersley and Reid, 2009). As a result, most nutrition research into mood examine protracted mood due to participants being more conscious of their "mood state" or behaviour. Factors or determinants affecting this state tend to be known and most instruments to assess moods were initially designed to study protracted mood (Ekkekakis, 2013).

On the other hand, transient moods due to their more brief nature are not as strong as to affect ones consciousness and those determinants or factors of transient mood are often of an unconscious nature and if conscious tend to be extremely brief resulting in a person forgetting the factor/determinant in question (Ericsson and Simon,1984).

In this regard, one may be unaware of their own transient mood unless questioned about it (Hammersley and Reid, 2009). For the author's research, given the population under study, transient mood was examined. It would be considered onerous for participants both with and without dementia to participate in a mood survey lasting hours or days (as would be the case if protracted mood was studied). Further, the POMS-short form was created for the use in specific groups such as older adults and was designed solely to assess transient mood. Using the survey instrument to assess protracted mood outcomes would affect the validity of the findings. Transient mood is known to be caused by both cognitive and physiological processes (Hammersley and Reid, 2009). In effect, the author posits that these processes are influenced by the glycaemic characteristics (GI/GL) of foods ingested.

2.10.3: Differentiation between Mood and Emotion

Several schools of thought within behavioural sciences offer different definitions for mood and emotion. Despite the importance of both terms in behavioural sciences, distinguishing between mood and emotion still remains a challenge within the field (Beedie, et al., 2003). Oatley (1992) opines that mood is often defined in contrast to the term emotion. Emotions are defined as immediate responses to a specific stimulus that are of strong intensity and short duration (Hamersley and Reid, 2009; Ekkekakis and Petruzello, 2002). This strong intensity is normally reflected in ones' facial expression (visible behavioural effects) (Greimel, et al., 2006). Moods, defined previously, are less intense but last for a longer duration when contrasted with emotions (Ekkekakis, 2013). Emotions usually influence behavior whilst moods, because of weaker intensity, do not always result in behavioural changes (Parkinson, et al., 1996).

2.10.4: Difficulties with assessing mood measurement.

Mood is generally more difficult to assess because it is generally a weak phenomenological experience. In assessing transient mood, one must consider the instrument being used and the various factors that could potential influence the mood rating outcomes (Hammersley, et al., 2014). The instrument used should be easy to understand and carried out in a brief period in order to capture true transient moods. Potential influential factors should also be controlled and minimised to reduce bias and error. This is even more important where the instrument is administered repeatedly thus potentially causing similar future responses (Postman, 1975). Hammersley, et al. (2014) note further, potential biases such as granularity of the scale (will affect how much of the scale is used by participants), labelling of the scale, the dimensions of the scale (two dimensional scales measuring a phenomenological state in nutrition research tend to be less accurate and less sensitive to changes over a 24 hour period), among other aspects to consider when selecting an appropriate instrument.

Table six (reproduced form Hammersley et al (2014) highlights five mood-rating systems most commonly used in ingestion research and their respective characteristics. The rationale/justification for the researcher selecting the POMS can be seen in section 4.4.1.

Please note that the POMS- short form (37 item) was used to eliminate the disadvantage expressed below in the table.

Table 6: The commonly used mood-rating systems in ingestion research.

	Visual Analogue Mood Scale	Profile of Mood States (POMS)	Visual Analogue Scales	Activation-Deactivation Adjective Check-List
Advantages	Simple	**Popular**	Validated	Theoretically Derived
Disadvantages	Too simple	**Too long**	Factors may not be appropriate	Not popular
Dimensions	One item: best to worst	**Six items (the six sub-factors)**	Two or three: arousal; affect; calmness	Two: arousal; affect
Number of items	1	**72/65/37**	18	50/20
Type of rating	Bipolar analogue	**Unipolar 0-4 rating**	Bipolar analogue	Unipolar 0-4 rating
Construct validity	Not applicable	**Yes**	Yes	Yes
Sensitive to normal mood changes over <24 hours	Maybe	**Not established**	Yes	Not established

Source: Hammersley (2014)

2.10.5: Summary of Mood in Nutritional Research

Mood continues to be difficult to measure with no definitive "gold standard" for assessing it. In assessing transient mood, one must consider the requirements of the research when considering an assessment scale. The appropriate scale should be brief, easy to administer good construct validity and favour repetitive administration. Further, factors that could potential influence the scales accuracy should be identified and controlled where possible (Hammersley, et al., 2014). Currently, to the knowledge of the researcher, there are no mood assessment tools designed specifically for older adults in care homes or those suffering with dementia.

2.11: Chapter Summary

This chapter has discussed the existing literature in relation to the Glycaemic load and mood. The fundamental principles of carbohydrate biochemistry and physiology as well as the metabolism glucose were expressed. Both glycaemic measures of carbohydrates are adequately defined with both schools of thought regarding the use of these measures are presented. The second meal effect, portion sizes, and other factors, which influence both food consumption and the glycaemic load-mood outcome dynamic were also addressed. The chapter further dealt with important aspects of nutrition in older adults and the current nutritional guidelines used. Dementia, a common condition in this stage of life was then outlined and its most common behavioural signs and symptoms. The final section of the chapter then followed in this behavioural vain by examining mood in nutritional research and how it is assessed.

Evidentiary support for the topic of the research is given in the following Systematic Review chapter. The following chapter will expose the reader to the gap in knowledge as well as the inconsistencies in research regarding the glycaemic load and its effect on mood.

Chapter 3: The Glycaemic Load of Meals and its effect on mood: Systematic Review of the Existing Evidence.

Research Question: What is the effect of the glycaemic load of meals on mood?

3.1: Introduction

The foods we consume have the capacity to influence our mental status and the development of behavioural disorders (Lim, et al., 2016). Studying the relationship between nutrients and mood outcomes is difficult to discover and not easily observable (Hammersley, et al., 2014). This is perhaps due to a lack of consensus on measurement and interpretation of findings (Ekkekakis, 2013). From a behavioural perspective, the nutrients in our food affect the creation of neurotransmitters in the brain influencing brain function and mood (Beseler, 1999). The human brain requires a steady energy supply to function optimally and this exclusive energy source is glucose. A lack of this simple sugar has been shown to influence psychologically processes such as decision-making and self-control (Gailliot, et al., 2008). In the 1920s, a RCT in children suggested a possible link between sugary foods and their effect on one's mood (Shannon, 1922). This was the first of its kind, but it was not until the 1990s when comprehensive meta-analysis of 16 different interventions was undertaken to explore the role of sugars on both cognitive and behavioural measures (Wolraich, et al., 1995). Over the years, existing studies have differed significantly. The scientific evidence investigating the relationship between food and mood is still limited. Werbach (1995) opined that the lack of incorporating nutritional factors in the study of behavioural change is due to the perceived notion that nutritional deficiencies have no impact on behaviour even though growing evidence does not support this perception. For over 30 years mood assessment in nutritional science has occurred however, little progress has been made in this field (Ekkekakis, 2013).

The objective of this chapter is to systematically review existing evidence of the effect of the glycaemic load of meals on mood, as well as to determine the quality of the evidence available. This systematic review of the evidence forms an integral part of this PhD thesis.

3.2: Methods

3.2.1: Literature Search

The review process began with a search of three electronic databases during a 3-month period. The databases included CINAHL Plus, PubMed/Medline and Embase. Additionally, general searches were also conducted using the university online library and Google Scholar. The terminology used for each database was customised but specific to the subject matter. The terms used for the search included glycaemic (glycemic) index or glycaemic load with a combination of either behaviour, behavior or mood. The conjunction 'AND' was used in each search (refer to Table 7 below for search terms used).

Table 7: Various search terms used.

Glycaemic term	Conjunction	Mood/Behaviour term
Glycaemic index	AND	Mood
Glycaemic load	AND	Mood
Glycaemic index	AND	Behaviour
Glycaemic load	AND	Behaviour

*Both spellings of behaviour/behaviour and glycaemic/glycemic were used.

3.2.2: Inclusion-Exclusion Criteria and Data Extraction

Studies without the search terms in the title or abstract were excluded. The searches spanned a period from the year 1981 to present and incorporated articles written in English, the language intelligible to the researcher. The year 1981 was selected because the term glycaemic index was first introduced into the scientific literature in that year (Jenkins, et al., 1981). The associated term glycaemic load was used years later (Wolever, et al., 1986). Studies prior to the aforementioned year would not be identified in the search. Based on the inclusion and exclusion criteria established (please refer to Table 8), the appropriate articles were selected for analysis. The reference lists of the selected articles were also reviewed in an effort to source other possible papers relevant to the systematic review. Full articles were only downloaded and analysed for those studies that met the established criteria.

Data from these studies were then extracted using a data extraction sheet. The data extraction sheet included a summary of the most pertinent information from each selected study. This data included: the name of the author(s), population, sample size, design, mood assessment tool, and timing of assessment tool, diet related intervention and sources of funding. This data can be seen in Table 9. An independent reviewer also assisted in reviewing the selected papers to prevent the natural biases of the researcher. The criteria used are given in Table 8.

Table 8: The inclusion and exclusion criteria.

Criteria	Inclusion	Exclusion
Languages	English	Any other language.
Year of publication	Between 1981-2017	Before 1981 or after 2017
Population and Subjects of interest.	Humans of any age.	Studies which focused on animal subjects (rats, monkeys, ants etc.)
Type of Publications	Articles that are peer-reviewed.	• Newspaper articles • Magazines • Chapters of books • Conference Presentations • Student dissertations • Articles not peer reviewed. • Abstract only
Exposure	The study design must examine high and or low GL effect on mood outcomes. All mood outcomes must be measured.	• Papers focusing primarily on protocols and methods. • Papers lacking them measurement of mood outcomes.
Characteristics of Papers	Papers that examine the association between the glycaemic load of foods and mood (i.e. studies identifying associations between low GL foods and high GL foods in relation to mood).	Papers that do not examine an association between glycaemic load of foods and mood.

3.2.3: Quality Appraisal.

In appraising the validity of the selected studies, the researcher relied upon the appraisal tool used by the Cochrane Collaboration Handbook as this checklist is appropriate when systematically reviewing the effectiveness of intervention studies (Cochrane Collaboration, 2011).The existence of any bias or confounding factors were reviewed to determine methodological quality using the appraisal tool. The appraisal tool selected was compatible with the study design of the studies being reviewed. It covered several domains of bias such as selection bias, detection bias, performance bias, attribution bias, reporting bias and others (Higgins and Altman, 2008). These domains were considered important by the researcher during the quality appraisal phase. Methodological quality of each study was further graded using a grading system applicable to various study designs attributed to the Tufts-New England Medical Centre Evidence-based Practice Centre (Tufts-NEMC EPC) (Balk, et al., 2005) as reproduced below in Figure 5. The Tufts-NEMC EPC, though not a frequently used checklist to establish methodological quality based on degree of bias, there is no uniformed universally accepted approach to assess study quality. The methodological quality assessment was conducted towards the end of the review where the researcher had more knowledge of the included studies. Two independent reviewers (Dr Ha and Professor Schofield) also examined the quality assessment of the studies offered by the researcher. Consensus was reached on the final grades where disagreements existed. The grading of studies can be seen in table 9.

Figure 5: Assessment of methodological quality.

A—Least bias; results are valid; a study that mostly adheres to the commonly held concepts of high quality.

B—Susceptible to some bias, but not sufficient to invalidate the results, study that does not meet all the criteria in category A, above

C—Significant bias that may invalidate the results; a study with serious errors in design, analysis, or reporting.
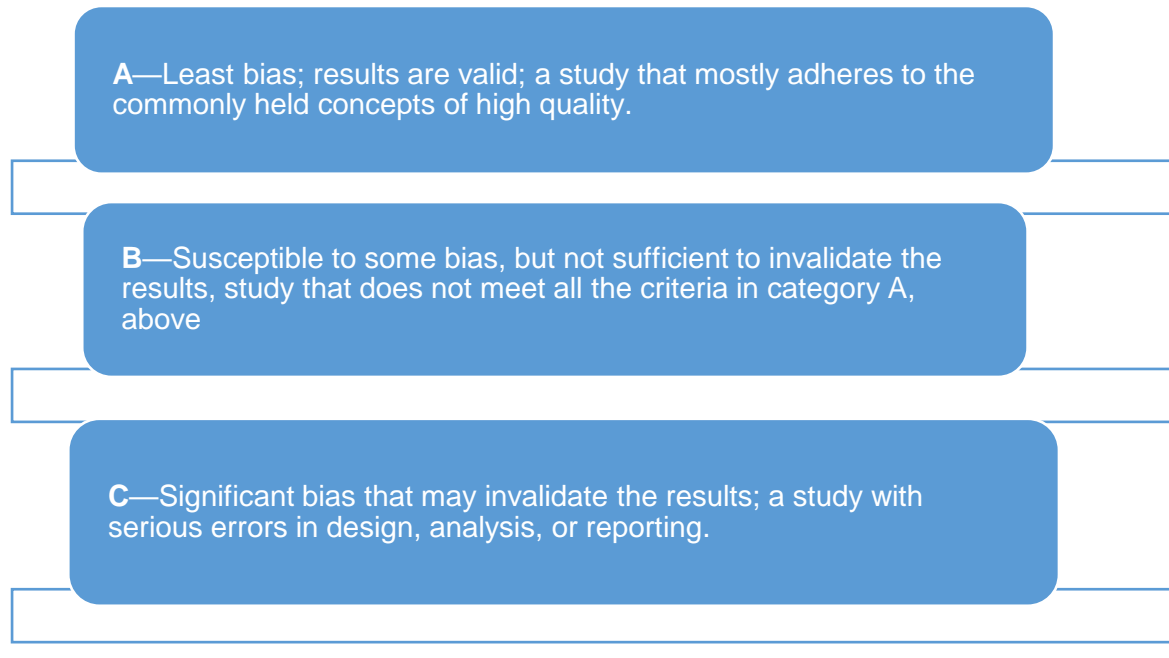
Figure 6: Systematic Review Flow Chart

Step One: Research Question.

What is the effect of the glycaemic load of meals on mood?

Step Two: Literature Search.

Pubmed/ Medline: 656 Articles

CINAHL PLUS: 206 Articles

Embase: 177 Articles

University Online Library: 11 Articles

Google Scholar: 10 Articles

65 articles met criteria of having search terms in title and/or abstract: PubMed/Medline:26, CINAHL Plus: 13, Embase: 15, Google Scholar: 6, University Online Library: 2 and Reference Lists:2

Step Three: Article elimination based on inclusion/ exclusion criteria.

34 of the 65 articles met inclusion and exclusion criteria.

Removal of duplicates left 10 eligible articles.

Step Four: Final 10 articles quality appraised.

Step Five: Findings and conclusions reported.

Table 9: Grade given to each paper based on methodological quality.

Study	Grade of Methodological Quality
Chetham, et al. (2009)	**C**
Mwamburi, et al. (2011)	**A**
Breymeyer, et al. (2016)	**C**
Png, et al. (2014)	**B**
Benton and Young (2015)	**B**
Benton and Nabb (2004)	**B**
Brown (2014)	**C**
Micha, et al. (2011)	**B**
Benton, et al. (2007)	**B**
Benton and Young (2014)	**A**

3.3: Results

3.3.1: Selection Process

The review yielded 1060 articles from the different databases with a range from 10 articles obtained from Google Scholar to 656 from PubMed/Medline. A more specific break down can be seen in the Research Flow Chart (Figure 6). A total of 65 studies presented the search terms in their title and/or abstract. Of these articles, 34 met the inclusion and exclusion criteria for the review. Removing duplicates left ten eligible studies that were then assessed using the quality appraisal method expressed in Figure 5. Of major interest to this systematic review were the mood outcome findings. These findings are summarised in the following table ten.

Table 10: Mood outcomes of each study reviewed.

Study	Mood Findings
Cheatham, et al. (2009)	Participants randomised to LG diet had no change in the depression subscale of POMS during weight loss, whereas those on the HG diet experienced a negative change (p=0.0009 after including covariate-hunger).
Mwamburi, et al. (2011)	Subjects with depression had a slightly higher average GI (using either glucose or white bread as the reference) [Mean+/-SD: 55.8+/-3.8 vs. 55.1+/-3.7, P=0.003) and a tendency to higher GL than those without depression. Depressed subjects with Antidepressant- Lower levels of GI and GL than those not receiving antidepressant. Link between late life depression with high glycaemic intake.
Breymeyer, et al. (2016)	Consumption of the HG diet resulted in a 38% higher score for depressive symptoms (P=0.002), 55% higher score for total mood disturbance (P=0.05) and 26% higher score for fatigue when compared to the LG diet (especially in overweight/obese participants when compared to otherwise healthy adults.
Png, et al. (2014)	No significant differences between LGI and CON meal trial for any of the mood descriptions in the BRUMS. Lack of significant difference for the daytime sleepiness in participants between their LGI and CON meal trials as reflected by the Karolinska Scale.

Study	Mood Findings
Benton and Young (2015)	Eating a glucose rather than isomaltulose sweetened meal, resulted in poorer mood and performance after three hours, although mood did not differ after one hour.
Benton and Nabb (2004)	After Breakfast- In the morning the type of breakfast did not influence ratings of the various POMS subscales (clearheaded-confused,agreeable-hostile,confident-unsure,composed-anxious or elated-depressed).Ratings of energetic-tired showed significance from 20 to 230 min SAG meal group were more energetic compared to fasting counterparts. The nature of breakfast did not influence mood after lunch. Alcohol x Breakfast x time interaction reached significance on ratings of clearheaded-confusion in the RAG breakfast meal group only.
Brown (2014)	Overall mood ratings were higher in dancers who consumed the energy bar. At baseline, those that ate the energy bar within 20 minutes of dancing felt neither pleasure nor displeasure, while those fasting felt displeasure. For both groups pleasure ratings became more positive during the second time point (30 min) followed by a decline in pleasure for both toward the final end point (60 min).
Micha, et al. (2011)	After consuming low-GI meals participants reported feeling less nervous (p=0.04), more happy (p=0.004), more alert (p=0.05) and less thirsty (p=0.05) compared with after consuming the high-GI meals. After consuming the high-GL meals, participants reported feeling more confident, less sluggish

Study	Mood Findings
	(p=0.01), less hungry and less thirsty compared with after consuming the low GL meals.
Benton, et al. (2007)	After low GL breakfast (2-3 hours), fewer signs of frustration were displayed and initially more time spent on task when working individually in class. Ability to maintain attention was also better.
Benton and Young (2014)	Mood related- A lower rather than a higher GL meal improved cognition and mood in study subjects with better glucose tolerance. Effects were strongest during the late postprandial period (105-195 min post-meal). Those in the isomaltulose group were more agreeable than those who consumed glucose.

3.3.2: Characteristics of Studies

The 10 studies presented sample sizes from 10 to as many as 976 participants. Four papers had less than 50 participants, four others with 50 to 200 participants and two which included more than 200 participants. Most studies used samples involving adults (7), while only three studies used children. Of the studies involving adults, it was noted that only two studied older adults (participants over the age of 60). All the studies meeting the criteria for this review involved only physically healthy participants. Studies such as Brown (2015) and Benton and Nabb (2004) only selected female participants whilst Png, et al. (2014) conducted investigations specifically on Muslim young men.

It is also noteworthy that from the 10 studies selected four mentioned Benton from the University of Wales as first author or co-author suggesting an area of interest for the named author.

The most common study type were Randomised Control Trials (RCT) represented by five studies. Among these RCTs 4 were blinded, representing the studies with the strongest methodological quality in the review. Almost all studies (9) used an intervention where subjects were fed a meal and afterwards mood was examined to assess correlations.

Some studies, such as Cheatham, et al. (2009), examined other factors outside of the GI/GL of a meal and mood dynamic. Cheatham, et al. (2009) sought to investigate weight loss whilst Png, et al. (2014) examined physical activity as an additional factor. The study conducted by Mwamburi, et al. (2011) focused specifically on one mood state i.e. depression, whilst all other studies examined a range of moods.

3.3.3: Diet Interventions

An examination of all studies involved in the review found that the nine studies, which were characterised as "feeding studies", all offered the participants, prepared meals or snacks. Five of these studies targeted the breakfast meal for the intervention. None gave a reason for selecting breakfast as the target meal. Benton and Nabb (2004), in addition to targeting breakfast also offered participants lunch as part of their intervention. Differing in approach, both Breymeyer, et al. (2016) and Cheatham, et al. (2009) offered all meals for the duration of their respective studies whilst Png, et al. (2014) was unique with its intervention by offering a meal early in the morning that would not be considered a common breakfast meal. Brown (2014) did not focus on targeting breakfast, and offered an energy bar (snack) before participants carried out physical activity in the form of dance. Png, et al. (2014) like Brown (2014) featured a physical activity component within the intervention after subjects were offered something to eat. In the former's case, participants carried out endurance running 12 hours after meal consumption whilst in the latter case, the participants consumed the energy bars within 15 to 20 minutes of self-chosen warm up.

All investigations conducted by Benton D, sought to target the breakfast for the diet intervention with testing of mood occurring at set periods. Excluded from the group of feeding studies was Mwamburi, et al. (2011) which incorporated a Food Frequency Questionnaires (FFQ) in its study design.

The meals offered within the feeding interventions offered noteworthy similarities and differences. Most sought to divide participants into different meal categories or offered all participants the same meal on one occasion then giving a different meal on another occasion. A common theme in each feeding intervention was the use of meals similar in either energy and/or macronutrient content but differing in the glycaemic load (GL).

The Young and Benton (2014) study carried out in middle and older aged adults, used double-blinding and placed participants into three different breakfast meal groups where meals were sweetened with either 15g of glucose, sugar (sucrose) or isomaltulose. The other investigation of both authors conducted on children, similarly, was double blinded in design and on the two occasions breakfast meals were given, meals were sweetened with either isomaltulose or glucose. Benton, et al. (2007) offered three breakfast meals (high glycaemic load, medium glycaemic load and low glycaemic load) which all participants consumed, but on different days. Blinding did not occur during this intervention. On the other hand, Micha, et al. (2011) though randomly placing participants in high GL and low GL groups, used a 2X2 factorial design examining not just the GL but also the GI of the breakfast meals. Thus, in the high GL group participants received a high and low GI breakfast whilst their counterparts in the low GL group received a low and high GI breakfast. The studies done by Benton, et al. (2007), Micha, et al. (2011) and Benton and Young (2015) were the three studies conducted in children and employed school breakfast clubs as the most effective way of carrying out their respective investigations.

Other studies presented differences within their feeding interventions. Png, et al. (2014) used a double-blinded design similar to other studies reviewed, but offered only two types of meals given to participants 7-12 days apart. Meals offered were either a low GI meal or a normal mixed carbohydrate one. In contrast, Bento and Nabb (2004) grouped the participants into three groups, high rapidly available glucose (RAG) breakfast meal, high slowly available glucose (SAG) breakfast meal and those that fasted in the morning. Duration of the investigations also presented varied results. Cheatham, et al. (2009) and Breymeyer, et al. (2016) were the only two feeding interventions that lasted over a month (Cheatham lasting 6 months and Breymeyer's study - 2 twenty-eight day periods) and offered meals during these periods. In Cheatham's case, participants, after a 7-week baseline outcome assessment were randomly placed into the group that would receive low glycaemic load or high glycaemic load energy restricted diets. Participants received three meals, a snack and a one-a-day multivitamin. Substitution of meals during the study period was allowed and noted as having no effect on study results. Breymeyer's study, employed a randomised crossover approach where for 28 days participants of one group were given high GL meals, allowed a "washout period" of 28 days to eat their regular meals, then 28 days of low GL meal consumption. The reverse occurred for the other group. Additionally, this investigation uniquely used a self-administered food intake checklist daily to monitor compliance of participants.

3.3.4: Blood Glucose Testing

Five of the papers reviewed carried out blood glucose testing as part of their respective interventions, all of which were feeding interventions but differed in the times when blood glucose was tested. Young and Benton (2014) was the only study that reported conducting blood glucose testing in older adults. This was done due to the unique characteristic of the study that sought to examine the glucose tolerance of participants.

Prior to testing day, blood glucose was conducted every 30 minutes for two and a half hours via finger pricks using an ExacTech Sensor. This was also done on the following testing day before the breakfast intervention. Micha, et al. (2011) was also unique in the blood glucose testing aspect, as it was the only study conducted in children (aged 11-14 years) that carried out blood glucose testing. Testing occurred at baseline, before, and after mood/cognition, tests were carried out using an Accu-Check Aviva BG Meter finger prick. Brown (2014) also carried out blood glucose test using Accu-Check before, during and after dance activities were conducted whilst Benton and Nabb (2004) used a Medisense Optium sensor to carry out their testing at baseline, then at the interval 20th - the 410th minute after breakfast was consumed. Similarly, Png, et al. (2014) also carried out testing before breakfast and then at various intervals from the 15th- the 720th minute after breakfast consumption. Differently, Mwamburi, et al. (2011), though not a feeding intervention also measured blood glucose for fasting blood insulin purposes.

3.3.5: Overnight fasting

Four studies required all participants to fast overnight before taking part in testing. Reasons for this were not mentioned. None of these studies placed emphasis in examining or discussing the second meal effect. Two of the studies conducted in children required mandatory fasting in order to take part in the intervention. Png, et al. (2014) included overnight fasting but this was because of participants observing a religious rite during the holy month of Ramadan. This investigation also did not examine the second meal effect. Benton and Nabb (2004) had one subgroup, which was required to fast throughout the morning, and alcohol consumption throughout the previous evening was recorded. The second meal effect was only examined in this study. This was done within the context of alcohol consumption the previous evening by all participants.

3.3.6: Mood Assessment Tools

The Profile of Mood States (POMS) was employed by most investigations (5) as the tool to assess mood among their participants. The POMS is a validated assessment tool developed in 1971 and used extensively over the years in various mood and behaviour studies. It was developed by factor analysis to provide a self-report measure of six discrete mood states responsive to fluctuations in affect (McNair, et al., 1971). The measure consists of six mood factors: Tension-Anxiety, Depression-Dejection, Anger-Hostility, Vigour-Activity, Fatigue-Inertia, Confusion-Bewilderment (Shacham, 1983). Each mood factor presents various adjectives and respondents, using a 5-point Likert scale format (0-not at all to 4-extremely) will indicate how much each adjective of the different mood factors correspond to their mood. A total mood score can then be calculated as well as score for each individual mood factor.

Micha, et al. (2011) employed the POMS 95-145 minutes after breakfast was consumed on four separate occasions. In addition to the POMS, they also concurrently carried out the Activation-Deactivation Adjective Check List (ADACL) which is a validated rapid self-assessment test which examines two fundamental dimensions: energetic arousal (including tiredness) and tense arousal (including calmness) (Thayer,1986) (See Appendix 3B for an example of the test). In their randomised trial Young and Benton (2014), on one testing day, employed the POMS before breakfast and after breakfast at 30,105 and 195 minutes. In the case of Breymeyer, et al. (2016) the POMS was administered on 3 occasions over a longer period of time assessing mood at baseline of the study and at the end of each of their 28- day periods. In contrast, Chealtham, et al. (2009), assessed mood using the POMS only at baseline and month 6 of their study whilst Benton and Nabb (2004), though during a small time period (one day), employed the POMS on 10 occasions after breakfast consumption i.e. at 20,50,80,140,200,230,260,310,380, and 410 minutes.

The second most common assessment tool used was the Centre for Epidemiological Studies-Depression Scale (CES-D) administered in both studies that examined depression (Breymeyer's and Mwamburi's studies). The CES-D is a self-administered screening test for depression and depressive disorder measuring symptoms defined by the American Psychiatric Association's Diagnostic and Statistical Manual (DSM-V) (Bohannon, et al., 2003) (Refer to Appendix 3C for an example of the CES-D test). Breymeyer, et al. (2016) used the CES-D at the same times the POMS was employed whilst Mwamburi, et al. (2011) carried out this tool at the beginning of the study as a diagnostic tool.

Other tools employed were used in single investigations. Brown (2014) selected an 11-point single item rating scale called the Hardy and Rejeski Feeling Scale (FS). The FS can be quickly administered during exercise, rating the current feelings of participants on a -5 (very bad) to +5 (very good) self-reporting scale (Hardy and Rejeski, 1989). Png, et al. (2014) used the validated Brunel University Mood State (BRUMS) assessment tool. The BRUMS is similar to the POMS and is comprised of 24 items of descriptors for six different mood scales of anger, confusion, depression, fatigue, tension and vigour (Terry, et al., 1999). Png, et al. (2014) in addition to the BRUMS, rated the level of sleepiness of participants through the 9-point, validated Karolinska Sleepiness Scale (Kaida, et al., 2006). Both scales were administered before endurance-running exercises were conducted and after the consumption of a low glycaemic index meal and a "*normal mixed carbohydrate meal".* Benton, et al. (2007) sought to assess participants (children) through observation using a camcorder to record behaviour on two occasions after breakfast was consumed whilst another study in children, also involving Benton (Benton and Young, 2015) used a generic smiley faces technique to assess the mood of participants on two occasions 1 and 3 hours after eating breakfast.

Table 11: Data Extraction

Author(s)	Size/Sample Characteristics	Design	Mood Assessment Tool employed	Time mood tool was used	Diet Intervention	Source of Funding
Cheatham, et al. (2009)	46 Participants Healthy overweight adults (age 35+/- 5 years; BMI 27.8 +/- 1.6 kg/m2).	Formed part of a randomised controlled trial. Studied the impact of GL on mood during weight loss.	Profile of Mood States (POMS)-computer based format (6 mood subscales).	At baseline and month 6 of caloric restriction. (employed twice)	LG and HG group meals differed in GL and macronutrient composition but were matched for fibre content, energy density and equivalently palatable (based on pilot study).	National Institute of Health T32 grant.
Mwamburi, et al. (2011)	976 Subjects Homebound elderly from the Nutrition, Ageing and Memory in Elderly (NAME) study characterised for depression status and glycaemic intake. Age 60+	A cross-sectional study. Studied the relationship between depression and glycaemic intake in the elderly, and whether antidepressant use modifies relationship.	Centre for Epidemiological Studies Depression Scale (CES-D)	Beginning of Study	GI, GL and fasting blood insulin levels were measured. Using a semi-quantitative FFQ a dietary history of the previous year was taken. If more than 12 food items were left blank on the questionnaire the results were considered invalid and excluded from analysis.	National Institute of Health Grant.
Breymeyer, et al. (2016)	82 Subjects Participants of the CARB study, healthy, free-living, non-smoking from Seattle, Washington.	Randomised, crossover controlled feeding study testing low-compared to high-glycaemic load diets.	Profile of Mood States (POMS) Centre for Epidemiological Studies-Depression Scale (CES-D).	Both POMS and CES-D carried out at baseline and end of both 28-day feeding periods.	Two 28-day feeding periods with a 28-day washout period between both feeding periods where participants resumed habitual diets. Both HG and LG diets were isocaloric with same macronutrient composition.	NIH/NCI grant and Fred Hutchinson Cancer Research Centre.

Author(s)	Size/Sample Characteristics	Design	Mood Assessment Tool employed	Time mood tool was used	Diet Intervention	Source of Funding
Png, et al. (2014)	12 Participants Recreationally active male Muslim runners. Age 27.9 +/- 7.2 years, stature: 173 +/-cm, body mass: 65.0 +/- 8.1kg.	A single-group, cross-over, counterbalanced, double-blind design. The study examined the subjects' subjective, metabolic and physiological responses, and endurance performance during the month of Ramadan after ingesting LGI or normal mixed carbohydrate food (CON) as the last main meal before commencing the day's fast.	Brunel University Mood State (BRUMS) (6 mood subscales)

9-Point Karolinska Sleepiness Scale. | Both measures taken at pre-exercise of 60 min endurance running performed at 12h post-prandial after the ingestion of either LGI or CON meal. | At pre-dawn (4:30AM), subjects reported to the lab and received either a LGI or CON meal of the same macronutrient composition and 450ml of fluid. Meals were consumed within 20 minutes after being served, and participants remained in the lab until exercise time at 17:00PM. LGI meal= GI of 36 CON meal= GI estimated at 57 (using mixed meal calculations). | Not mentioned |

Author(s)	Size/Sample Characteristics	Design	Mood Assessment Tool employed	Time mood tool was used	Diet Intervention	Source of Funding
Benton and Young (2015)	75 Participants [28 boys and 47 girls] Children aged 5-11 years (+/- 8years 8months), from socially deprived backgrounds and in good health as reported by parents.	Repeated-measures double-blinded design. Compared the impact of two breakfasts that offered identical levels of energy and macronutrients (differing in GL) on immediate and delayed memory, attention, reaction time and mood.	A generic eight-point scale of smiley faces ranging from very unhappy to very happy.	Breakfast eaten between 8:15-8:45 AM. Mood and other tests took place twice. First between 9:00-9:45 AM and 11:15 AM-12:00 PM.	On two occasions (at least a week apart) at breakfast club students consumed a meal sweetened with either isomaltulose, (Palatinose) [GL 31.6] or glucose [GL 59.8]. Students ate majority of meals and remaining food weighed. Students were also asked not to eat or drink (excluding water) for the remained of the morning.	BENEO Group Germany for funding and supplying Palatinose and glucose-sweetened foods.
Benton and Nabb (2004)	Total Participants: Fasted 106, Rapidly available glucose (RAG) meal: 108 and Slowly available glucose (SAG) meal: 109. Study included only female undergrads all of good health with a BMI between 20-25.	Randomised Study. The investigation sought to determine if the GI of breakfast and recent history of alcohol consumption would influence mood and memory both during morning and in the afternoon after eating lunch. It was carried out in 3 studies that were presented together due to significantly similar results.	Examined using Profile of Mood States (POMS)	After breakfast at 20, 50,80,140,200,230, 260,310,380 and 410 mins.	Blood glucose carried out upon lab entry. Mood and blood glucose then measured 20-410 mins after breakfast. Lunch was eaten at 240 minutes. Participants were placed into 1 of 3 experimental groups: fasted throughout morning, ate a high RAG breakfast or ate a high SAG.	Danone Vitapole provided partial funding.

Author(s)	Size/Sample Characteristics	Design	Mood Assessment Tool employed	Time mood tool was used	Diet Intervention	Source of Funding
Brown (2014)	10 Participants Healthy female contemporary dance students taking daily dance classes 4 to 6 times per week.	On test day, all participants fasted the night before. Blood sugar was tested before, during and after dancing. Some dancers did not eat and others ate an energy bar within 20 min of dancing.	The Hardy and Rejeski Feelings Scale (FS) - an 11-point single-item bipolar rating scale ranging from-5 (very bad) to +5 (very good).	Before and after dance class.	Moderate glycaemic index energy bars were eaten by some dancers within 20 min dependent on the dancer's self-chosen warm-up. Each bar contained 47.3 g of carbohydrate, 2.1 g fat and 9.6 g of protein.	Not mentioned.
Micha, et al. (2011)	74 Participants 11-14 year old students in good health and free from learning disabilities in 5 London schools.	Randomised controlled trial. The study examined the effects of meals differing in GI and GL on cognition and mood in school children. Children were matched and randomly allocated either in a high-GL or low GL group.	POMS Short Form of the Activation-Deactivation Adjective Checklist (modified using 22 words to assess mood, energy levels, hunger and thirst).	95-140 minutes after breakfast.	4 breakfast meals with differing GI and GL (2X2 factorial design). Meals were either a low-GI high-GL, a high-GI high-GL, a low-GI low-GL, or a high-GI low-GL. The GI of foods obtained from the International Table of GI and GL values or on recently published values of UK products. All participants and researchers were blinded to the meal administered.	Harokopeio University PHD Scholarship School Food Trust.

Author(s)	Size/Sample Characteristics	Design	Mood Assessment Tool employed	Time mood tool was used	Diet Intervention	Source of Funding
Benton, et al. (2007)	19 Participants [10 girls and 9 boys]. Children 6 to 7 years old (mean age-6 years 10 months) from a single class, in an economically disadvantaged area in Wales.	Study sought to exam how the GL of breakfast meals affected behaviour and performance among school children. This was done through a breakfast club where students received different GL breakfasts and then behaviour studied.	Behaviour was observed and recorded (via camcorders) Reaction to frustration was assessed through an old TV game that children were not familiar.	Mood test were done after breakfast between 10:35-11:45 AM. (Breakfast at 8:15-8:45 AM).	At breakfast club (lasted 4 weeks) students were offered 1 of 3 meals, each with different GL. Breakfast meals were classified as HGL, MGL and LGL. Each day all students had the same meal. Meals randomly changed daily. After breakfast and before testing, a 2 hour 30 minute interval occurred where no food was eaten.	Partially funded by the British Broadcasting Corporation (BBC).
Benton and Young (2014)	155 Participants Healthy older and middle-aged adults (aged 45-80 years).	Randomised trial. The examined the interaction between the GL of a meal and cognition and mood. Also considering differences in glucose tolerance.	Profile of Mood States (POMS)	Mood was measured before breakfast and like cognitive performance at 30,105,195 minutes after breakfast.	Glucose tolerance was first carried out on day one. Then the following day i.e. testing day, participants were assigned to either a glucose, sucrose or isomaltulose based breakfast group. Each meal consisted of two slices of who meal toast with reduced sugar jam, 100 g of plain low fat yoghurt sweetened with either 15g of glucose, sugar or isomaltulose and an orange flavoured drink sweetened with 25g of one of the 3 sugars. Each meal was identical in macronutrient composition but not GL.	BENEO group Germany (funding and supplying Palatinose and sugar sweetened products.

3.4: Discussion

The review found that of the 10 studies, eight presented evidence supporting a relationship between the GL and differences in mood outcomes, while the remaining two studies found no connection. From the eight supporting studies, three showed associations between low GL foods and mood states that are considered positive. One study found a high GL/low GI meal was associated with a positive mood. Three of the studies specifically linked depression to the consumption of high GL meals while another suggested a link between a high GL meal and the negative mood of feeling confused. Consuming a moderate GI energy bar was shown to present a positive mood state i.e., pleasure in the last of the eight studies.

Generally, studies in the review presented population sizes of more than 70 participants. This, along with the randomisation occurring in these studies helped to improve their respective power. Though the studies sought to use only physically healthy participants, examination of mood or mental health before study participation was not a common feature. This would have helped in reducing confounders.

Based on the review, some evidence exists of an association between the GL of foods we consume and varying mood outcomes. The review's findings seem to suggest that generally, low GL foods provide positive health outcomes by attributing to better mood outcomes when compared to their high GL counterparts. However, a high GL/low GI meal may also have beneficial mood outcomes in individuals. Several inconsistencies and peculiarities regarding the age of participants, meal variation/composition, the type of intervention, timing of mood assessment and the second meal effect were found within the studies that must be addressed.

Age of participants

The age of participants can have a significant impact on the results of any study. Young participants present better glucose tolerance than adults (Chee, et al., 2018). Children present larger cerebral mass and tend to be more physically active (Chugani, 1998). These two characteristics of young participants suggest an increased energy requirement (glucose) for the optimal function of the body. As we age, our cerebral metabolic rates and control of postprandial blood glucose levels decrease, presenting consequences for not only cognitive function, but also changes in mood (Chee, et al., 2018)

The review highlighted three studies suggesting a link between low GL food consumption and positive mood outcomes. One study was carried out in middle and older adults aged 45-80 years while the other two in 6-7 year olds and 5-11 year olds respectively. This would suggest beneficial outcomes of low GL foods regardless of age group. It is posited that the heightened glucose requirement experienced in young children begins its descent at the beginning of the teenage years (Chugani, 1998). The slow and steady release of energy because of low GL consumption could be the premise for positive moods in all individuals. The studies in adults showed that those with better glucose tolerance are better able to manage their blood glucose levels, benefited more from consuming a lower rather than a higher GL meal. These results were consistent with effects on cognitive performance and mood in children (who have more optimal glucose tolerance) when low GL meals are consumed. In older adults, disruption in the metabolism and/or transport of glucose in the brain due in part to the ageing body may be the mechanism behind why those with poor glucose tolerance do not adequately benefit from low GL meals when compared to healthier older adults (Young and Benton 2014).

On the other hand, the study conducted by Micha, et al. (2011) presented evidence of a high GL/low GI meal being associated to positive moods. This study was also conducted in children (11-14 year olds). However, unlike the other two studies conducted in children, the macronutrient content of the meals presented no similarities. This could mean that the response was not due to the GL. Variables of macronutrient content, portion sizes, and calories appear to influence glycaemic response and may present other mechanisms that have an impact on mood outcomes (Micha, et al., 2011). Further, the same study approached the phenomenon of glycaemic response by examining both GI and GL whilst most studies determined this solely by one of the two measures. The age of participants in studies examining GI/GL and their relationship to differing mood outcomes is an important factor when examining results as although the association between the glycaemic characteristics of foods and mood can be seen regardless of age, the intensity of this association could be reduced due to this factor. The review did not find any study of a comparative analysis between children and older adults with respect to the association between GI/GL and intensity of mood outcomes.

Meal variation/composition

The variability in meal composition as well as the meal targeted (i.e. breakfast or snack etc.) could also play an important role in results obtained from the nine feeding studies reviewed. Whilst one should consider the energy content and macronutrient composition of the meals being examined, the existing evidence suggests that the GL of the meal is more important when examining mood outcomes (Young and Benton, 2015). Png et al (2014) whilst using meals of similar macronutrient and energy content found no metabolic, physiological or performance benefits when low GI foods were consumed.

Micha, et al. (2011) on the other hand whilst examining both the GI and GL used a LGI/ HGL (with higher-energy content due to carbohydrates present) versus a HGI/LGL breakfast in their study.

Results for this study highlighted benefits for consuming a low GI, high-GL breakfast. The author of this review suggests that research examining the impact of GI or GL on mood should make clear distinctions as to the origin of a low glycaemic response, i.e. because of both GI and GL or solely via one of the measures. Benton and Young (2014) and (2015) did just this, and concluded that even when macronutrient composition was similar or identical; it was the variation in the GL of the meals acting as the underlying mechanism influencing mood and performance.

Though the evidence supports the GL as being more influential in its effect on mood, it cannot be viewed as the only "variable" within the meal (Benton, et al., 2007). It is the slow release of glucose afforded to the body by LGL foods, which has a positive impact on mood outcomes (Breymeyer, et al., 2016; McCrimmon, 2012). Consequently, within the context of meal composition protein, fat and indeed fibre are all associated with the slow release of glucose and potentially could affect any food-mood relationship (Nabb and Benton, 2006; Bjorck, Lilijeberg and Ostman, 2000). With respect to HGL foods, it is suggested that these foods cause rapid fluctuations and spikes in blood glucose and therefore have negative impacts on mood outcomes. Two possible mechanisms exists that could explain why HGL foods may cause negative moods. The spikes in blood glucose produces free radicals as well as pro-inflammatory cytokines both of which have been implicated in inflammatory diets which increase mood disorder risk (Lucas, et al., 2014). The other mechanism involves changes in hormone secretions and availability of free glucose and fatty acids, which could provoke sensations of hunger and mood change (Cheatham, et al., 2009).

Whatever the mechanism, which ultimately affects mood outcomes, it is the GL, which presents itself as the main commonality.

Breakfast was the target meal for the majority of the studies in this review. Though no specific rationale for breakfast selection were given, the focus on breakfast was perhaps due to its traditional nutritional makeup and importance in Western diets. Breakfast is considered the most important meal of the day, affording the body with its first dose of food energy (Adolphus, Lawton, and Dye, 2013; Mahoney, et al., 2005). Research suggest that between 15-25% of one's daily energy intake should come from breakfast (Betts, et al., 2014). As the first meal, breakfast is often characterised by differing amounts of carbohydrates often consumed to boost ones energy to begin the day (Mahoney, et al., 2005). Throughout the review, no mention was made of individual preferences or differences when target meals were given. This element could have affected the results of some of the studies, as the meals offered could have been rather different from the customary breakfast (assuming also that participants were regular breakfast consumers) of individuals outside of study conditions with significantly different effects.

Another possible rationale for selecting breakfast target meals may be Nakamura, et al. (2008) theory of increased sweetness susceptibility in the morning. This theory posits that diurnal changes may cause humans to be more sensitive to sweetness in the morning and thus the need to consume high carbohydrate foods for breakfast (Nakamura, et al., 2008).

Timing of Mood Assessment

The time of mood assessment occurred at various times in the different studies based on the studies objectives. A large variety of times was observed after foods were consumed. The reviewer found no justification for the variability in the times used in these studies. Existing evidence suggests that glycaemic responses to foods are often observed during the post-prandial period (after consumption) up to 4 hours (Donaldson, et al., 2010).

Conducting mood assessments without a rationale, specifically during the post-prandial period could have a significant impact on study results. In the instance where GL is being examined, mood assessments should be carried out during optimal glucose metabolism.

Additional evidence states that the effects of a food's GL on glycaemia are most optimal 90 minutes after consumption in healthy individuals (Ludwig, 2002; Ostman et al, 2001). This optimal period falls within the four-hour postprandial period when glycaemic responses are observed.

The Second Meal Effect

Related to the postprandial responses period expressed previously is the second meal effect. This phenomenon suggests that the GI of a previously consumed meal can have a significant impact on another meal's prolonged glycaemic response. Existing evidence on this effect suggests a low GI evening meal significantly lowered the postprandial glycaemic response to a meal the following morning when compared to a high GI evening meal (Wolever et al, 1988). Though only one study in the review explicitly mentioned and examined the second meal effect, four studies required overnight fasting of participants.

This suggests that perhaps fasting was required to avoid any impact of the previous meal affecting the target breakfast meals in each study. In effect, though the second meal effect was not noted in these studies, its potential impact was avoided.

Limitations of the systematic review

The limitations of this systematic review are because of the studies involved. The small number of eligible studies found as well as the variability in study types are the main limitations of the review. Regarding the study types, it was found that there was a lack of randomisation and blinding in half of the studies.

Other possible limitations included the observation that most of the studies did not examine the second meal effect or required overnight fasting; testing blood glucose levels through the accuracy of a blood glucose test was not a common theme in all of the studies nor were there any explanations for the timing of mood assessments.

Physical activity of participants were only accounted for in the study of Png, et al. (2014) and Brown (2014) who were also examining physical performance. Physical activity would have affected the amount of glucose used for energy.

In retrospect, perhaps more databases could have been searched to identify other studies fitting the inclusion-exclusion criteria. Having carried out the systematic review in late 2016, the study was unable to capture several studies published in 2017 to present.

3.5: Conclusion

The systematic review found evidence supporting a relationship between GL and mood outcomes. Mood outcomes were however inconsistent, differing among the studies. The reviewer suggests increased study in the area given the limited scope of eligible studies in the area. The stark differences in study design, timing of mood assessment, intervention meals, age of participants, among other issues could have affected the consistency of the findings. The following are therefore recommended:

- A validated mood survey instrument should be used when carrying out these types of studies. Such an instrument should also fit appropriately with the study's aims and objectives. This would aid in improving the reliability and validity.

- Feeding interventions, whilst a better approach for assessing the impact or relationship of food on mood should involve some degree of randomisation and blinding to improve study power and reduce bias and confounding.

- Proper rationale should be given as to why specific target meals are selected. Where a study aims to examine the postprandial mood outcomes it would perhaps be ideal to carry out mood assessment during periods of optimal glucose metabolism. Rationale should also be given as to why postprandial assessment is carried out more than four hours after consumption.

- Where the GL of meals is the focus of a study, attention should also be placed on micronutrient content of meals such as Fibre as this will have an impact on slowing down the rate of glucose release in the blood and thus potentially influencing mood.

- Finally, as is the case in all research, variables should be considered and steps taken to eliminate and or reduce possible confounders.

3.6: Summary

This chapter has presented evidence of existing research into the effects of the GL on mood outcomes. The systematic review found the results to be inconsistent thus requiring further study into the subject matter. The review afforded information of methodologies and procedures that aided in the creation of the research design and other elements of the methodology that are expressed in the following chapter.

Chapter 4: Methodology

4.0: Introduction

This chapter first outlines the research process followed by the research design employed, and makes the case for the use of observational studies in nutritional research. Validity and reliability in the context of the study are reviewed followed by recruitment procedures, sample selection and calculation as well as inclusion and exclusion criteria. Data collection and analysis procedures are then outlined with all methods used explained and justified. All statistical tests are mentioned, as well as ethical considerations and data storage protocol. The chapter then concludes with a succinct summary.

4.1: Research Process

The study employs a positivist research philosophy. This philosophy relies on quantifiable observations that lead to statistical analyses (Collins, 2010). It allows generalisation through statistical probability contrasting with social constructivism where generalisation can only occur through theoretical abstraction (Ramanathan, 2008). Positivism is characterised by the researcher's role being limited to data collection and an objective interpretation of results. It is a philosophy where research progresses from hypothesis (hypotheses) to deduction in contrast to the social constructivist philosophy where the progression involves gathering a lot of data and then inducing ideas from it (Ramanathan, 2008). Some authors opine that positivist studies, such as this one, generally adopt a deductive approach.

The deductive approach is defined as "developing a hypothesis based on existing theory or phenomenon and then designing a research strategy to test the hypothesis" (Wilson, 2010).

This study follows a deductive approach by exploring a phenomenon, i.e. the association between the GL of foods and differing mood outcomes, and tests if the phenomenon is still valid under specific circumstances (older adults with differing physiology and those with dementia). The approach best follows logic and works best with a positivist approach. In contrast to an inductive approach, deduction reasons from the sphere of generalities to specifics (Pelissier, 2008). In effect, it employs a bottom up approach, testing one's hypothesis and *deducing* a conclusion. For the reasons highlighted, the deductive approach was the most suitable choice for this study.

A conceptual framework explains "the main things to be studied- the key factors, constructs or variables and the presumed relationships among them" (Miles and Hubermann, 1994). Maxwell (2013) further posits that the conceptual framework highlights what is going on in the research and should demonstrate the research question(s) and objectives, their relationship with the literature review and the key variables of the study. Though other authors define the conceptual framework in differing context, the research process of this study has followed the concepts of both Miles and Hubermann (1994) and Maxwell (2013) and a conceptual framework was developed after the study was carried out (refer to Discussion section).

The study can be divided into three connected stages. The first stage answers why the study was carried out. It is characterised by a severe gap in knowledge. This gap is due to a small amount to research carried out in the older adult population regarding the impact of GL on mood outcomes. The role of the glycaemic load as a possible *nutritive stimulus* of differing mood outcomes has been studied but almost primarily in subjects under the age of 18. The conclusions drawn from these studies, though relevant to the subject matter being investigated cannot be generalised in adult subjects, especially older ones.

This gap is further exacerbated by an even greater lack of studies involving those with dementia considering the important behavioural symptomatology of the condition. A lack of examination of different types of transient mood is another gap in the existing literature. The importance of nutrition as a determinant of improving health outcomes and the current interest in the role of glycaemic characteristics of foods and health in the field of nutrition also support why a study such as this should be done.

The second stage is perhaps the most important and can be divided into three components. The first component is the in depth exploration of the literature and phenomenon. This was carried out via a systematic review that reinforced the need to carry out this study as well as present and analyse the limited evidence available on the subject. The researcher was able to highlight elements of this study that made it unique. These elements include: the examination of the spectrum of moods instead of focusing on one or two, studying how the GL impacts older adults with varying differences to children and young adults, the incorporation of persons with dementia as study subjects, using a non-invasive approach (observational study) which didn't involve dietary modification and the examination of the GL of meals instead of individual foods.

The second and third components of this process, observation and analysis, adhere to the positivist approach where the authors role was primarily focused on these two components. Observation involved data collection of GL, nutrient profiling and the nutrient density of meals from the menus provided by each care home. Mood outcome data was collected from the Profile of Mood States surveys carried out. All the data were then analysed and interpreted in the analysis component and the initial research question answered. The final stage yields the outcomes that are beneficial to different levels. The entire process is illustrated in Figure 7 on the next page.

Figure 7: The Research Process

Rationale	→	Process	→	Outcomes
• Gap in knowledge regarding the impact of the GL on mood.		• Exploration of literature and phenomenon (Systematic Review) • Observational Study		• Primary • Secondary

Systematic Review:

- Lack of studies in the area in older adults.
- Focus on dietary interventions.
- No study including dementia group
- Gambit of moods not explored.

Observational Study:

- GL of menu meals.
- Nutrient Analysis
- Nutrient Density of meals.
- Mood after target meals eaten.

Anticipated Influential Factors:

- Portion Sizes/Control
- Dining Environment
- 2nd Meal Effect

OUTCOMES

Primary:

GL and nutrient density relationship.

GL impact on mood in dementia and non-dementia older adults

Secondary:

Improvement in Elderly Nutrition.

Modification of Nutritional Recommendations

Use of GL during meal and menu planning.

4.2: Research Design

The selection of an appropriate research design is a pivotal element in the development and completion of any study. In selecting the appropriate design one must consider the existing research in the field and current evidence, the time required to carry out the study, the resources and financing needed and the epidemiologic measures to be considered (Thiese, 2014).

This study can be defined as a non-invasive observational study, more specifically employing a cross-sectional design. Observational studies are characterised by their non-interventional nature where the independent variable is not under the control of the research (Edgar and Manz, 2017). Within Nutritional Science, observational studies are widely used, with cross-sectional studies being the most frequent type (Faraomi and Schaefer, 2016; Szajewska and Shamir, 2013). Whilst observational studies present varying limitations and are not regarded as having the high efficacy as Randomised Control Trials (RCT), when examining similar themes, both study types may present similar effect estimates (Concato, et al., 2000).

The use of an interventional study may not be appropriate for various reasons. Black (1996) opines that in instances where the effect size of a study is too large, observational studies may be preferred to demonstrate effectives. In instances were rare diseases are being studied or sufficient participant's cannot be recruited an interventional study may not be suited. Interventional studies do not offer an accurate "real life" clinical reflection as observational studies do and tend to be inapplicable in real world situations (Szajewska and Shamir, 2013) This is increasingly most evident in nutritional science were much more is gained from simple observations and significant reductions in the investigators power to influence outcome (Faraomi and Schaefer, 2016).

A report by the Cochrane Collaboration (2014) noted that factors other than study design need to be considered when considering reasons why there may be a lack of agreement between results of RCT and observational studies. One such factor which should be considered is how studies are reported and thus interpreted. The STROBE-nut checklist designed to improve the strength and quality of observational nutritional studies was employed in this research (Lachat, et al., 2016).

Though bias and confounding can be regarded as the principal deficiencies of observational studies they offer several advantages that were considered by the researcher. Specifically, cross-sectional studies are inexpensive, less time consuming and allows the research objectives to be carried out more effectively. Cross-sectional designs are normally used when a study is descriptive and incorporates a survey (Levin, 2006). However, this design can be descriptive or analytical based upon how findings of potential associations are assessed (Pandis, 2014). As the name suggests, the objective of this research design is to obtain a representational sample or "cross-section" of a given population (Sedgwick, 2014). In the case of the author's research, a sample of older adults from different care facilities was used to represent the older adult resident in care homes in the UK population. The cross-sectional design also allowed recruitment to occur over a longer period whilst sample measurements were still being taken. This characteristic allowed the researcher to continue with the study whilst awaiting responses from potential care homes to participate. Sedgwick (2014) regards this as an advantage of this research design. Cross-sectional studies are carried out at a time point or over a short period, giving a snapshot of outcomes. They can also be repeated at various time points with the aim of assessing trends (Levin, 2006). For this reason, it is incorrect to suggest a causational relationship when this design is used. Relationships of association can more appropriately be concluded.

These studies allow for control of multiple confounders and can assess multiple outcomes (Thiese, 2014).

In order to combat the issues of bias and confounding, the study was conducted following various procedures in the recruitment, inclusion and exclusion phase of the research, during the data collection, and the presentation of results. It must be noted that the evidence gleaned from any study, be it observational or RCT will rely on how rigorous the study was conducted and the proper interpretation of said evidence (Berger, et al., 2012).These aspects of the research are discussed in different sections within this chapter. As the study was observational in nature, the researcher carried out the study in the environments presented by each care home.

The researcher completed several training courses. These courses better prepared the investigator to carry out research responsibilities and aided in the improvement of the research design. A Good Clinical Practice (Primary Care) and an Informed Consent course carried out by the NHS National Institute of Health Research as well as a Mental Capacity Act (MCA) training course carried out by the Social Care Centre of Excellence. The researcher also completed an assessment by Stephen Hughes M.D, member of staff at Anglia Ruskin University with expertise in mental capacity assessments.

Within the context of study design, both primary and secondary outcome measures were defined. The primary outcome measure in the study is regarded as the matched-pairs difference between the first and second results i.e. mood state (Total Mood Scores) after high GL meal and after low GL meal consumption. This difference in TMS is the Total Mood Disturbance (TMD). The primary analysis is the test that the true mean difference is zero, using the matched-pairs t-test.

It is hypothesised that the mood of the older adults (Total Mood Scores from the Profile of Moods States- short form survey) will be more positive after the low glycaemic load meal is eaten. This low TMS will correspond to a lower TMD score, indicating that low glycaemic load meals are associated with better mood outcomes.

This would therefore answer the research question as to whether there is an association between the glycaemic load of meals and mood outcomes in this group of persons as well as which type of GL meals offer more negative mood outcomes i.e. greater mood disturbances.

The secondary outcomes of the study were defined as the differences in mood results of persons with and without dementia with respect to the consumption of the high GL meal vs the low GL meal, whether the nutrients within the meals offered met current requirements and the relationship between the GL and nutrient density of the meals offered. The primary endpoint of the study is the difference in the Total Mood Disturbance between after consumption of the low GL meal and high GL meal. The primary analysis was to test the null hypothesis, which was that the true mean difference is zero between high and low GL meals. This was tested statistically using the paired t-test. A statistically significant p-value of 0.05 was used in the study.

The researcher employed a quantitative methodology for the study. Quantitative research is characterised by the process of quantification during the collection and analysis of data. Quantification is most often the basis for research techniques such as surveys and questionnaires for the purposes of data collection. The quantitative method also affords the researcher the possibility of using data analysis techniques that will use or produce numerical data (statistics) (Saunders, et al., 2009). The same source further highlights the relationship between the independent and dependent variables that the quantitative method relies upon.

In the case of this study, the association between the glycaemic load (independent variable) and mood (dependent variable) is under investigation. Thus, the researcher is able to test the hypothesis in question and obtain results through statistical means. The quantitative method is the most reliable and objective to assess the findings of this study. Further, consideration must be given to the study's established approach when determining the most appropriate method. Collis and Hussey (2009) posit that the positivist, deductive approach (as is used in this study) is most often associated with a quantitative method.

4.2.1: Importance of research validity and reliability

Validity and reliability are two important characteristics of any study that reflect upon its quality (Lobiando-Wood and Haber 2013). Both measures though they are interrelated are often confused. Sarantakos (2005) notes that any valid instrument is expected to also be reliable but the reverse is not always the case. The importance of these measures to research rigour are expressed in this section.

4.2.1.1: Validity

Validity in the context of quantitative studies is defined as how well a concept is accurately measured. A measure is considered valid when its results give a true reflection of the situation it was selected to study (Heale and Twycross, 2015). A measures validity can be examined from an empirical (empirical validation) or a theoretical (theoretical validation) perspective (Sarantakos, 2005). The same source notes that with empirical validation, the instrument used is considered valid if the findings can be supported by existing empirical findings (*concurrent validity*). The instrument's results can be examined with established criteria known to measure the situation or condition under review (*criterion or pragmatic validity*) (Heale and Twycross, 2015).

An instrument that is expected to have high correlations with future criterions is regarding as being predictively valid (*predictive validity*). The empirical form of validation is therefore used to assess criterion-related validity, concurrent validity and predictive validity.

On the other hand, in instances where empirical validation is not possible, the use of theoretical principles of the situation or condition under review are employed for validation purposes (theoretical validation). This form of validation encompasses content, face, construct, internal and external validity (Hernon and Schwartz, 2009).

In effect, where an instrument covers all possible aspects of a research topic it is considered to have content validity. Face validity is obtained if the instrument measures what it is expected to (Sarankatos, 2005). Where the instrument measures accurately what it purports to (internal validity), and the generalisability of the measure's findings in the population (external validity), are two aspects of theoretical validation that cannot be overlooked in assessing study quality (Hernon and Schwartz, 2009). Differently, construct validity highlights whether or not inferences can be drawn from the results obtained from the measure (Korb, 2012).

4.2.1.2: Reliability

Reliability refers to what extent the data or measurement is consistent i.e. produces consistent results (Hernon and Schwartz, 2009). Reliability thus is obtained when a test or method is repeated several times (including by various researchers) under stable conditions and yields consistent results (Fraenkel and Wallen, 2003). It can also be seen as the degree to which a test is free from measurement errors (Neuman, 2003).

Reliability can be examined using several methods. These methods include a test-retest method where the study participant is given the same survey instrument more than once under similar circumstances or the alternate-form test where the participant receives a different instrument similar to the first in each subsequent test administration (Sarantakos, 2005; Korb, 2012). In both methods, reliability across time (Stability Reliability) is examined (Heale and Twycross, 2015). A central attribute of reliability examined in this study is homogeneity or internal consistency. Internal consistency can be assessed through several methods such as the split-half test, item-total correlation, Cronbach's alpha among others (Shuttleworth, 2015). Cronbach's alpha was used in this study and it is one of the most commonly used methods to assess internal consistency of a research instrument (further information on Cronbach's alpha can be gleaned in section 4.6.4 Statistical Tests Employed).

4.3: Population and Sample

4.3.1: Recruitment

From an ethical perspective, informed consent is necessary for research participation as it promotes and protects the person's wellbeing and respects their self-determination (Buchanan and Brock, 1990). According to Petrini (2010), four aspects must be looked at when seeking informed consent. The possession of competence, voluntariness, the provision of clear and truthful information and the freedom of the participant to withdraw at any time from the study without justification. An online search of 60 care facilities within England was carried out by the researcher. All of these care homes were then sent an email asking for their interest to participate. Those care homes who responded to the email formed part of the study. Consent to use care home facilities was then confirmed through the various Care Home Managers.

The care home managers were made aware of the study's exclusion and inclusion criteria and having access to the existing resident files were able to identify potential candidates. This was done to reduce the selection bias of the researcher as the care home manager had more knowledge of the health and capacity of residents. Resident files were not accessible to the researcher. The care manager then compiled a list of the room numbers of potential participant that could take part in the study. Consent was then sought from these individuals. Through the various facilities' internal mail system, consent forms and participant information sheets were then sent to these potential participants. (See Appendix one). Potential participants were given enough time by the researcher to make an informed decision. The researcher was available to answer any issues or questions potential participants had.

Instances where persons were unable to read or give written consent, but presented capacity to consent, the researcher in the presence of the care home manager went through the participant information sheet and consent form with the potential participant and answered any question he/she had, accepted verbal consent and accepted the signature of someone nominated by the potential participant to sign on their behalf.

Only persons with early or middle stages of dementia were eligible for participation. These persons were assessed using cognitive assessment conducted by the trained researcher. These persons are competent enough to give informed consent. Buchanan and Brock (1990) note that "the area of competence of relevance to the involvement of people with dementia in research is that of decision-making capacity". Many persons with dementia (especially those in the early to middle stages) have sufficient capacity to express their desire to take part in a study and engage in consent discussion (Hougham, 2005). For this reason, informed consent was sought from these individuals. Only persons with capacity to give informed consent regardless of their underlying mental illness formed part of this study. Thus, consultees were not necessary in these situations to make a decision on any participant's behalf.

It is noteworthy that this is the first study (of the researcher's knowledge) where persons with and without dementia are being compared in a "food-mood" association study.

4.3.2: Inclusion and exclusion Criteria

Given the reduction of the cerebral metabolic rate and differences in postprandial blood glucose control in older adults when compared to children, this population was chosen to carry out the research. Older adults form an integral part of the general population and with the continued advancement of medicine persons are now living longer.

Care homes offer the optimal environment to conduct nutritional research in old adults as most persons residing in said homes are over the age of 60. The use of free-living older adults was not considered due to a number of variables with respect to food preparation and consumption as each adult would be consuming a different meal daily, all prepared in a different manner. In an institution such as a care home, there is a structured menu which is rotated monthly. All meals tend to be prepared in a centralised location on site and must adhere to certain industry standards (Food Standards Agency, 2018).

Menus in a care home can therefore be properly examined and analysed thus reducing confounders that could occur in each dwelling of free-living older adults. From the recruitment process, four care homes responded positively to the request to participate and thus formed the research site. These homes also presented an appropriate population size. The care homes were located in England.

Diabetics were not part of the study as glycaemic responses to foods in these persons is significantly impaired which could potentially affect the results of the study. Further, these persons all tend to have special meals made separate from the general menu that could act as another confounder affecting results. Another group of older adults who could not participate in the study were those using medication that pose significant behavioural side effects such as antidepressants and antipsychotics.

Those with digestive disease that could have an impact on glucose metabolism and absorption, on special meal plans due to underlying illnesses, and those with a known/diagnosed mental illness were exempt from taking part in the study. As previously highlighted only residents with early to middle stage dementia with capacity to consent could be included in the study in addition to those without dementia. Table 12 summarises both the inclusion and exclusion criteria used to carry out the study in the respective care homes.

Table 12: Summary of Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Age of Participant between 60 -100 years	Aged below 60 years or above 100 years
Resident in one of the care facilities participating in the study	Does not reside in one of the care facilities participating in the study.
Early-middle stages of dementia	Late stage dementia
Resident does not been diagnosed with Diabetes Mellitus.	Resident has been diagnosed with Diabetes Mellitus.
Resident does not suffer from a known mental illness that requires medication that may cause behavioural side effects.	Resident suffers from a known/diagnosed mental illness and/or is currently using antidepressants or any other medication that may cause behavioural side effects.
Resident does not suffer from digestive diseases that may affect the metabolism or absorption of glucose.	Persons with digestive diseases that may affect the metabolism or absorption of glucose e.g., Liver Cirrhosis.
On the standard meal plan.	On a meal plan different from the general menu. The person is being fed via feeding tube.

4.3.3: Sample Size calculation

Sampling is defined as a process whereby a number of subjects are selected as a representation of a specific population to be included in a study. All inferences resulting from these subjects (sample) can be attributed to the specific population only (Porta, 2014). The sampling process plays a pivotal role in any study. The most common reasons for using sampling were highlighted by Becker (1989) and Selltiz et al (1976). Both sources note that sampling tends to occur when the entire population of focus could not be used in the study i.e. saturation survey. They opine that in some instances the use of sampling provides more advantages as it assesses the target population within a shorter period and offers results that are both valid and comparable. Additional benefits mentioned by both sources are the reduced economical cost and "research labour" associated with sampling when compared to a saturation survey.

Whilst many types of sampling methods exists, this study employs a method characterised as a stratified form of random sampling. Porta (2014) defines this form of sampling as dividing the study population into distinct groups and then selecting random samples from each subgroup. Within the study, the researcher contacted various cares homes within England and those that agreed to participate formed part of the study. Once potential participants met the research inclusion/exclusion criteria and gave consent, they then formed part of the sample. From this sample of four care homes, participants were then divided into two subgroups: those diagnosed with dementia and those without dementia.

A power-based approach was used to calculate sample size. The power-based approach is normally employed where a hypothesis is tested. An existing study by Young and Benton (2014) with similar characteristics, with 155 participants was used as a model to determine an appropriate sample size.

A standard deviation (SD) from this study was 0.28 (primary outcome measure of the difference of the two meals i.e. positive or negative mood states), two-tailed, 80% power and 5% significance.

The Sample Size (SS) was calculated using the formula:

$$ss = \frac{Z^2 * (p) * (1-p)}{c^2}$$

This formula is sometimes represented as:

SS= P *(1-P)* Z ^{2} / c ^{2}

Where: Z = Z value 1.28 for 80% confidence level (as used in Young and Benton, 2014)

p^ = percentage of selecting a choice often expressed as a decimal 0.5

C = confidence interval/margin of error of 0.05

Hence the sample size is:

$$SS = \frac{0.5\ x\ 0.5\ x\ 1.28\ x\ 1.28}{0.05\ x\ 0.05} = \frac{0.4096}{0.0025} = 163.84$$

Sample Size: 163.84 or 164 participants

4.4: Profile of Mood States (POMS)

The POMS is a 65-item mood adjective checklist, which was developed by factor analysis to provide a self-report measure for persons 18 years and older, of six discrete mood states responsive to fluctuations in affect (McNair, et al., 1971). The survey was developed by McNair, Droppleman, and Lorr (1971) to measure transient mood states of people. Shacham, created a shortened version, referred to as the short form, in 1983 with the objective of reducing the time taken to conduct the survey whilst maintaining its validity and reliability (Shacham, 1983). It is noted that the short form is considered more user friendly to those physically ill or present some form of impairment (Curran, et al., 1995). It has been shown to be a reliable and valid measure of mood states in elderly community dwelling adults (Gibson, 1997). The measure consists of six mood factors or dimensions: Tension-Anxiety, Depression-Dejection, Anger-Hostility, Vigour-Activity, Fatigue-Inertia, Confusion-Bewilderment (Shacham, 1983). Each mood factor or dimension presents various mood adjectives. *Tension-Anxiety*: tense, on edge, uneasy, restless, nervous and anxious, *Depression-Dejection*: unhappy, sad, blue, hopeless, discouraged, miserable, helpless and worn out, *Anger-Hostility*: angry, peeved, grouchy, annoyed, resentful, bitter and furious, *Vigour-Activity*: lively, active, energetic, cheerful, full of pep and vigorous, *Fatigue-Inertia*: worn out, fatigued, bushed, exhausted and weary, *Confusion-Bewilderment*: confused, unable to concentrate, bewildered, forgetful and uncertain about things. The word adjectives used in the survey are not stated on the instrument based on the corresponding mood dimension but rather randomly stated to improve reliability of responses. Respondents, using a 5-point Likert scale format (0-not at all to number 4-extremely) then indicate how much each adjective of the different mood factors correspond to their mood.

4.4.1: Justification for selecting this instrument

The POMS presents a number of characteristics that are advantageous from a methodological perspective. The survey in its shortened version can be completed in approximately 8 minutes. In situations where study participants can become quickly disengaged (the elderly) or due to a respondent's ailment(s) selecting an instrument that can be administered effectively in a shortened duration is beneficial. The POMS does not require any equipment, training or additional manpower for its administration. The researcher is only required to give brief instructions to the participant and collect the completed survey in normal instances. It is thus cost effective in this regard. The survey can also be conducted in any location though for the purposes of this study it was administered in the communal rooms and resident rooms of the different care homes. Further, unlike other survey instruments such as the Depression Scale, the POMS examines a wider spectrum of moods at one occasion. The researcher found that the wide use of the POMS when compared to similar instruments such as the BRUMS (as mentioned in the Systematic Review Chapter) and its validation as a psychological instrument (McNair, et al., 1992) made the POMS most appropriate scale to employ in this study.

4.4.2: Reliability and Validity of the POMS

The POMS has been employed in over 2000 publications in varying populations and sample sizes, differing medical conditions as well as healthy individuals. Internal consistency based upon Cronbach alpha rating has found the POMS scores between 0.63 to 0.96 with other forms scoring between 0.76 to 0.95. Examining both versions the correlation of subscales and total score was calculated as 0.84 (McNair, et al., 2003). A review of the usage of the POMS found it to produce reliable scores regardless of the time it was administered, size of population or characteristics of the population. This consistent reliability was maintained above 0.80 when all studies were reviewed (Kivisalu et al., 2014).

Studies using the original POMS and the short form all had a tendency to present reliability above the 0.80 mark with studies employing the original 65-item form scoring higher reliability when compared to the 37-item short form.

4.4.3: Use of the POMS

Due to the design of the POMS survey, it can be administered as a printed survey or administered in the form of an interview. Once it is completed, points are calculated for each mood dimension based on the points received for the corresponding mood adjective. The score range for *Tension-Anxiety* and *Vigour-Activity* is 0-24 points, *Anger-Hostility* 0-28, *Depression-Dejection* is 0-32, *Fatigue-Inertia* and *Confusion-Bewilderment* 0-20. The Total Mood Disturbance is calculated by adding the Tension-Anxiety, Anger-Hostility, Depression-Dejection, Fatigue-Inertia and Confusion-Bewilderment mood dimensions and subtracting the Vigour-Activity score from this sum. From a population assessment the average amounts for each mood dimension is used.

4.5: Data Collection and Procedures

Data collection is considered a key component of any research and is characterised by the methodological approach employed by the researcher (Bryam and Bell, 2015). It involves decisions taken regarding sample determination (see section 4.3) and the procedures/methods used. This section details how the data collection process was undertaken.

The study was carried out in four care homes each visited by the researcher on 3-4 occasions. The four care homes used responded to the call to participate in the study and presented total population sufficient to obtain the researcher's required sample size. The initial visit involved brief introductions to the staff and collection of copies of the menu plan in use. The researcher then had the opportunity to speak with the kitchen staff regarding menu planning and other menu related inquires.

There was also the opportunity to observe the dining and kitchen environs. For the purposes of improving the nutrient analysis that would follow, the researcher was allowed to take photographs of different meals (Refer to Appendix 4 for photographs of meals from different care homes). This would allow a better understanding of portion sizes and servings in the institution. Photographs of meals were also taken during other visits to the care homes (Refer to Direct Food Photography subsection 2.7.3 for further information).

The first aspect of the data collection was the nutrient analysis i.e. collection of nutritional information. This analysis was done using Nutritics Software (refer to 4.6.1 for info and justification). Each food of each day i.e. breakfast, lunch, dinner and tea options of the menu cycle used in the care home were analysed with the software.

With the use of the photographs taken of the different meals and the images of different food portions in the software, the researcher was able to match and approximate the portion sizes of each food for analysis.

Data obtained from the software included macronutrient and micronutrient content, glycaemic characteristics and nutrient content compared to different recommended guidelines. Where a specific food could not be found in the software, a substitute food offering similar energy and macronutrient content was used. This procedure is commonly used in nutritional data collection and analysis, as food databases tend to have missing food data (Johnson, et al., 2017; Summer, et al., 2013). A list of appropriate substitutions agreed upon with a registered nutritionist can be viewed in the Appendix section of the thesis. The data collected was saved and transferred to Microsoft spreadsheets for analysis as well as SPSS for statistical test verification. Using the UK Ofcom Nutrient Profiling and Density Model (see 4.6.2 for info and justification), the nutrient profile data was then collated. The glycaemic characteristics of each food identified in the Nutritics Software was then used to determine overall glycaemic load of each meal offered in the care home. The GI and GL values of foods were verified using the International Glycaemic Values list established by the Human Nutrition Unit at Sydney University (Sydney University Glycemic Index Research Service., 2012). The glycaemic values of this are used in the software.

However, where the glycaemic values were not mentioned in the software for specific foods the researcher referred to the list for guidance. Spreadsheets of GL values of all meals were created and the highest GL and lowest GL meals were identified.

 Nutrient profile data and GL load of meals' values were then compared. The aforementioned processes carried out secondary objectives b, c and d of the study as expressed previously.

The highest and lowest GL meals were then used as the "target meals" of the mood component of the research. It must be reiterated that the study sought to exam the possible association between both HGL and LGL meals in relation to mood outcomes after these types of meals were eaten. The study was not designed to look at mood changes before and after meal consumption. Hence, the mood survey would not be administered before target meals. Resident moods were observed before target mealtime and where any instance of possible mood alteration occurred, (e.g., arguments between residents or with staff) that resident did not take part in the mood survey. Further, the population under study was considered during the research design phase. The time consuming nature of assessing transient mood before and after each target meal would not have been appropriate for the older adults. Survey administration in such a short space of time could have presented biased responses.

The mood survey requirement component required two visits to the institution. Having already received the necessary consent of participants and having knowledge of the target meals dates to visit the care home when these meals would be served were scheduled. Only the researcher was aware of the glycaemic characteristics of the both meals. This "blinding" of staff and participants was done to reduce response bias during survey completion. On the days of each visit the researcher was present at least an hour before food was served. This was done to observe any situations or issues that could have an impact on the mood of participants.

Participants then had the opportunity to eat as they normally would. Due to the common problem of malnutrition in the elderly, most care homes encourage residents to eat as much as possible. Residents were not forced to eat simple because of the study. However, participants who gave consent had to eat the meal. Once all participants had eaten, the mood survey commenced 90-120 minutes afterwards.

Existing evidence notes that the glycaemic responses to foods often occur during the post-prandial period (after consumption) up to four hours (Donaldson, et al., 2010). Further, optimal glucose metabolism is considered at 90 minutes after consumption in healthy individuals (Ostman, et al., 2001). This timeframe was most appropriate to carry out the mood survey (Further information on timing of mood assessments in behavioural nutrition studies can be gleaned in Chapter 3). Consequently, the mood survey was carried out 1.5-2 hours after food consumption in line with optimal glucose metabolism timeframe to better observe the presence of an association between the GL and mood outcomes. Participants were placed in a communal area to complete the mood survey whilst others preferred to complete it in their rooms. The Profile of Mood States (POMS) -short form was selected to carry out this part of the data collection (refer to 4.4 info and justification). Consent and willingness to participate was recorded on both occasions of the mood survey administration specifically for those with dementia due to the fluctuating nature of their mental capacity. All participants were instructed on how to complete the survey and asked how they were feeling right before commencing. This was done to reduce potential confounding factors affecting results as participants may have been in a terrible mood before having their meal. Equally, in instances where persons were not able to write, they were asked how they felt prior to consuming their meal and then the researcher recorded their oral responses. The researcher would then administer the survey. Members of staff were not asked to carry out this survey. Print size of the survey was enhanced to further improve the user-friendly nature of it. Those unable to complete the survey on their own received it in a simple interview format with the researcher. This format was employed in instances where participants could not write but communicate orally.

An example of this was in the case of those with dementia, who, though lucid enough to express how they felt verbally, had difficulty writing. Those in the early to middle stages of dementia (i.e. mild to moderate dementia) also have the competence to complete surveys (such as the quality of life), regardless of their limited capacity (Trigg, et al., 2007). To aid these persons, as well as asking each mood adjective of the POMS orally, the participant with dementia could receive a card with the corresponding *word adjective* placed in front of him or her for better understanding. The researcher also had a card version of the 5-point Likert scale and the respondent could verbally state which number (0-4), for him/her, corresponded to the particular mood adjective in front of them or merely point at the appropriate number on the scale. Where a participant lost mental capacity during the survey or for whatever reason were no longer willing to participate of complete the survey, the collection of their data ceased and did not form part of the study at the data analysis stage. The researcher then collected all completed surveys. Total Mood Scores (including scores for each of the six mood factors), total mood disturbance were then calculated, and comparisons made between those with dementia and those without. Any other (confounding) factors that occurred during the completion of the survey that may have influenced mood were recorded in the researcher's field notes. This was done through observation by the researcher. It is important to reiterate that the study was observational in nature and it had no intention to modify environmental or other   factors observed at the care homes as these factors would prove important in placing any results found into context. The aforementioned procedure was then replicated after the other target meal. Mood Scores after both meals were then compared to determine whether the low GL or high GL meal was associated with a more positive or negative mood state from a population perspective. Mood differences between those with dementia and those without for both meals was also analysed. This was replicated in each of the four care homes in the study.

4.6: Data Analysis

4.6.1: Nutritics Software and Nutrient Analysis

4.6.1.1: Introduction

The nutritional analysis of all the care home menus used in the study were performed using the Nutritics Nutrition Analysis Software (Version 5.09) Professional Basic Edition- Nutritics, Dublin Ireland. The software was developed in 2013 and is currently used by clients across more than 165 countries generating reports in ten language options. Users of this software include healthcare professionals, sports persons, students, researchers and food industry participants offering a variety of services catering to the user's specific nutritional needs. It is considered one of the most updated nutrition software programmes currently available with various advantages when compared to other nutrient analysis software programmes (Nutritics, 2018).

4.6.1.2: Factors to consider when selecting a nutritional software package

The British Dietetics Association (BDA) (2013) notes four basic services any nutritional package should be able to offer to its users. Firstly, the software should allow the user to calculate dietary intake. These calculations should be possible for an individual or group providing options for a food or meal, during a day, a week or more when required offering calculations for all eating occasions based on the duration being examined.

The software in question should be able to calculate the nutrient content of recipes. This should be a complete analysis including both macro and micronutrients. The BDA also notes that considerations for weight gain and loss of a food during the cooking process as well as loss of nutrients should be a component of any good nutritional software with options for converting units of measurements.

Thirdly, the software should be able to analyse food diaries for the purpose of research. To this end, the software should have a database of foods relevant to the user in question.

Finally, nutritional software should be able to analyse a complete menu. The client using the software should be able to input all the days, meal courses and food options required for analysis and obtain the necessary nutrient analysis that would allow for comparison of nutrients based on different days, courses etc. Within the software, the client should also be able to compare results to standards and requirements put forth by various food standard agencies (e.g. Dietary Reference Values (DRV), Estimated Average Requirements (EAR), and Reference Nutrient Intake (RNI).

The BDA (2013) notes that the UK is serviced by as many as 16 nutritional software packages. Examples of these include general offline programmes (such as WinDiets, DietPlan and MicroDiet), online programmes (Nutritics and DietSure), dietary analysis services (Nutricalc and Nutmeg Nutritional Consultancy) and school catering analysis (CRISp, Hport SE School Food Software and DietSure4Schools).

Whilst these programmes offer different features to users, Nutritics software offered a number of benefits and advantages for the researcher's study and was thus selected. The justifications (i.e. benefits and advantages) for using Nutritics are discussed in the following subsection.

4.6.1.3: Justification for the use of Nutritics Software (benefits and advantages)

- Nutritional Database- The Nutritics Software has one of the largest food databases in the world. It currently contains over 330,000 foods with additions made on a daily basis. The database also includes foods requested by users including fortified foods and supplements. All new foods are reviewed and added by the software's dietetics team. The option for users to request additional foods and add recipes for analysis are unique aspects of the software.

The database includes the most extensive and up to date national food database for the UK (2015 COFIDS including McCance and Widdowson 7th Edition- 2015) and several countries around the world to include Australia (AUSNUT-2016), United States (USDA 28) and several European countries. The requested foods from users the world over has also created a global Nutritics database allowing all users to avail themselves of analysing a more diverse list of foods. This global "list" allows searches even for foods with complex nutrient sets such as fatty acids or amino acids. Users also have the added benefit of searching for foods based on manufacturers, sports supplements, health food products as well as restaurant data. A proprietary database of gluten free foods, food additives, preservatives and specialised clinical feeds from part of the Nutritics Software (Nutritics, 2018).

One advantage of the Nutritics database that could not be overlooked by the researcher is the already calculated glycaemic characteristic of foods. Once a food is entered for analysis, the resulting nutritional analysis not only includes macro and micronutrients but also (in over 90% of foods) Glycaemic index and the glycaemic load.

The glycaemic information is licenced by the Glycaemic Index Foundation and uses an established and accepted method (Louie, et al., 2011).

The Louie, et al. (2011) method corresponds to all glycaemic index values represented in the International Table of Glycaemic Index and Glycaemic Load (Atkinson, et al., 2008) and the Sydney University online open glycaemic index database (Sydney University Glycaemic Index Research Service, 2012).

- Nutritional Standards and Recommendations- Nutritics offers users the ability to analyse over sixty different nutrients with customisable dietary reference values. The DRV and Reference Nutrient Intakes (RNIS) include: the Committee on Medical Aspects of Food Policy (COMA) 1991 (with updates from the Scientific Advisory Committee on Nutrition (SACN) 2002, 2011 and 2015, 2017), The Institute of Medicine 2010, The National Health and Medical Research Council (NHMRC) 2006, Nordic Nutrition Recommendations 2012 the European Union Reference intakes used in labelling and the European Food Safety Authority Guidelines- 2017 (EFSA). Whenever a new version of these reference values are released, they are updated on the Nutritics software.

- Food Comparisons and Portion Sizes- Nutritics presents one of the largest numbers of portion size options with over 300+ images. These images correspond to different foods in the database that are sourced from the British Dietetics Association (BDA), the manufacturer's source data or from the trained Nutritics staff who would have directly weighed the food item.

- Users are able to input amounts of a food in grams or use the smart portions option with a relevant reference photo. The smart portion can be increased or decreased accordingly to match the amount required by the user.

Additionally, Nutritics provides the user with an optional demographic portion size where based on the age of the individual, an average demographic portion amount is generated (Nutritics, 2018). These amounts are adapted (with permission) from existing research of the National UK Diet and Nutrition Survey (NDNS, 2016). The image below illustrates the smart portions tool of the software.

Figure 8: Screenshot of smart portions tool of Nutritics Software.
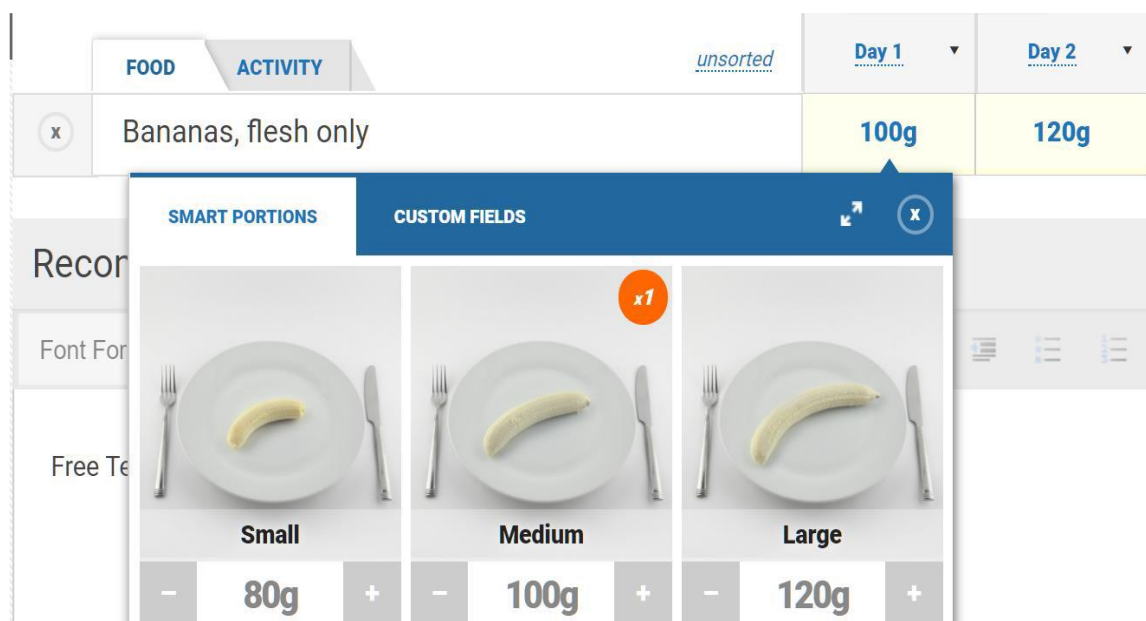
Source: Nutritics (2011)

Regarding food comparisons, as many as six different foods can be compared at once to the different reference intakes (previously mentioned) available. The researcher is not aware of any of the other nutritional software programmes catering to the UK that allows users to carry out these activities (Nutritics, 2018).

- Assistance, Training and Security – Nutritics provides online support to all users during business hours. Additionally, users can contact the Nutritics team via email phone or social media to report any maintenance issues, queries or to give suggestions to improve the user-friendly interface. For users that are not familiar with nutritional software or who are unsure about something, Nutritics offers tutorial videos, webinars and a downloadable user manual. One of the advantageous of Nutritics when compared to many other nutritional software is its security. Whilst a programme only available online may perhaps be viewed as a disadvantage to some, Nutritics' cloud-based feature ensures the user's nutritional data can be automatically synced to several devices once logged in. The programme notes that all data stored on the server is encrypted with an advanced plan for data recovery (Nutritics, 2018).

The software offers other benefits such as meal planning, dieting goal setting, connecting with a client as well as patient management. However, these additional benefits are not pertinent to the study. On the other hand, the financial component of using this software is perhaps its biggest disadvantage.

4.6.1.4: Nutrient Analysis Procedures

The nutrient analysis occurred after visits to the four research sites and copies of all menus obtained. Using the Nutritics software each care home (client) was added individually to the researcher's online account. In each case, a spreadsheet was created for each menu week (consisting of seven columns representing each day of the week). Where an alternative menu existed, an additional spreadsheet was added solely for these foods. A profile representing the demographics of the research site was also created. This was done to ensure that in instances where an image for determining the right portion size did not occur, the demographic average generated from the software could be used. The use of demographic averages is widely accepted in research studies and adapted in the software with permission from the National UK Diet and Nutrition Survey (NDNS, 2016). This profile included the average age, weight, height and physical activity. Information gleaned from the Care Home Managers.

For each day of each specific week, the corresponding food or dish on the menu was searched for in the database. The appropriate option from the database was then selected. This selection was based upon the correct geographic region identified by the software (the United Kingdom in this case), the image and name presented, as well as the correct cooking method outlined. Examples of this would be the type of milk or oil used, whether the food was fried, stemmed or baked, or simply whether it was retail or cooked on site). Once the correct food match was found, the portion size could then be selected.

The photographs taken of serving sizes from each site were then contrasted with the database images, smart portion options, and the correct portion size chosen. Once this was done, the database provided all the nutrient information for the selected food and amount to include its glycaemic characteristics.

The GI and GL information for each food was noted, entered into a spreadsheet outside of the software for the purposes of calculating the GL of all meals, and ultimately identifying the target meals for the mood surveys (refer to section 4.6.3 for information on GL meal calculations). The food with its portion size (including unit of measurement) was then placed into the corresponding column. This was repeated for each food on all the menus for each research site. Nutrient reports were then generated for each site.

Information on reports for select nutrients were then copied into spreadsheets outside of the Nutritics software and mean amounts per nutrient tabulated. This information was then juxtaposed to nutritional guidelines and are presented in the findings chapter of the thesis.

4.6.2: Ofcom UK Nutrient Profiling Model and Nutrient Density Analysis

4.6.2.1: Introduction

The UK Nutrient Profiling Model 2004/5 (UKNPM) was first developed by the Food Standards Agency to assist Ofcom (Office of Communications) to identify foods which could be considered less healthy for children and thus be subject to broadcasting restrictions (Rayner, et al., 2005). Currently, the UKNPM though reliable does not reflect the eating habits of the UK population at present and is currently being modified. Whilst a draft model is currently under review, the researcher opted to use the established 2004/5 version for the purposes of this research. The model can be described as a simple system for scoring foods. It seeks to provide a balance of the contribution of beneficial nutrients from food and drink in one's overall diet alongside the less beneficial components of the diet that tend to have higher amounts of consumption than recommended (UK Department of Health, 2011).

4.6.2.2: Justifications

The researcher opted for the UKNPM to conduct nutrient profiling for various reasons. The UKNPM was the first of its kind developed specifically for the United Kingdom and is recommended by Public Health England (Public Health England, 2018). Other models examined where designed for international use or are country specific. Hence, the NPM would be most suitable for a study conducted in the UK context. Further, many of the other existing models were developed based on the UKNPM. Examples of these include The Adapted FSA NPM for Ireland, South African NPM, Health Star Rating System (Australia and New Zealand), and the Alternative Model of the European Regional Office of the World Health Organisation among other models (WHO, 2010). The nutrient amounts required to score points in this model are given in the nutrient software Nutritics used by the researcher. The software used allows the user to analyse foods in different amounts, including 100g of food or drink which are a requirement for the use of the NPM selected.

4.6.2.3: How the UK Ofcom Model is used

The model first requires the nutrient content present in 100g of the food or drink to be examined. Nutrients are divided into two groups. The "A" nutrients include energy, saturated fat, total sugar and sodium whilst the "C" nutrients include fruit, vegetables and nut content along with fibre and protein. The total score for group C is then subtracted from the total score of group A giving a Final Nutrient Profile Score. The model does not make exemptions for any foods and those foods scoring 4 or above are deemed "less healthy" and drinks scoring 1 or more points are also classified as such (UK Department of Health, 2011).

Determining A points: Table 13 below highlights how points are received for each of the A nutrients. These points are then summed up to give the Total A points. A nutrient can receive points ranging from 0-10.

Where a food or drink being profiled scores a total of 11 or more "A" points, it cannot receive points for protein content unless it obtains 5 points for fruit, vegetables and nuts.

Table 13: The allocation of points for "A" nutrients

Points	Energy (kJ)	Sat Fat (g)	Total Sugar (g)	Sodium (mg)
0	≤ 335	≤ 1	≤ 4.5	≤ 90
1	>335	>1	>4.5	>90
2	>670	>2	>9	>180
3	>1005	>3	>13.5	>270
4	>1340	>4	>18	>360
5	>1675	>5	>22.5	>450
6	>2010	>6	>27	>540
7	>2345	>7	>31	>630
8	>2680	>8	>36	>720
9	>3015	>9	>40	>810
10	>3350	>10	>45	>900

Source: Nutrient Profiling Technical Guidance- UK Department of Health (2011)

Once the total "A" points are calculated the researcher can then calculate the total C points. Table 14 gives the amount of points each food or drink can score dependent on the nutrient component in 100g. Points received for each C nutrient range from 0-5.

Table 14: The allocation of points for "C" nutrients

Points	Fruit, Veg & Nuts (%)	NSP Fibre ' (g)	Or AOAC Fibre ' (g)	Protein (g)
0	≤ 40	≤0.7	≤0.9	≤1.6
1	>40	>0.7	>0.9	>1.6
2	>60	>1.4	>1.9	>3.2
3	-	>2.1	>2.8	>4.8
4	-	>2.8	>3.7	>6.4
5*	>80	>3.5	>4.7	>8.0

Source: Nutrient Profiling Technical Guidance- UK Department of Health (2011)

In summary, overall scores where determined in the following manner:

- Where a food scored less than 11 for group A: Total A points minus Total C points.

- Where a food scored 11 or more for group A but scored 5 points for fruit, vegetables and nuts: Total A points minus Total C points

- Where a food scored 11 or more for group A and less than 5 for fruit, vegetables and nuts : Total A points- Points for fibre + points for fruit, vegetables and nuts (not allowed to score for protein) (Rayner, et al., 2005)

The model used by the researcher gives particular guidelines on calculating fruit, vegetable and nut content that contribute to the final nutrient profiling score. It must be noted that the model refers to fruits and vegetables as those forming part of the national 5 a day programme excluding starchy root vegetables such as potatoes. Only fruits and vegetables deemed intact and those that have undergone little to no processing (peeling, slicing purees etc.) can receive a score.

The justification behind this is that the beneficial impact of these foods are associated with fruits and vegetables consumed as whole products instead of extracted and overly processed components. An example of this would be concentrated fruit juice sugars or powders that would not count in the context of the NPM (UK Department of Health, 2011).

Further specifics relating to calculations such as in instances where food quantity is not in grams, where the portion size is less than 100g, calculating scores for foods which require reconstitution before consumption or products containing dried fruit used in the UK NPM can be seen in the Appendix eight.

4.6.3: How the GL of a meal is calculated

The first step in calculating the GL of a meal is to know the portion sizes of each food item of the meal (Glycemic Index Foundation, 2017). A meal including white rice, chicken curry and garden salad would require portion sizes for each. The carbohydrate content of each food item is then identified and the total amount of carbohydrates calculated by adding the carbohydrates in each item. Next, the percentage of carbohydrates contributed by each food item is calculated by dividing the number of carbohydrates in each item by the known total of the meal's carbohydrates. Each result is then rounded up for accuracy.

Knowing the glycaemic index value of each food item of the meal, the percentage glycaemic value can then be found by multiplying the already identified percentage of carbohydrates contributed by each food item by the respective GI value for that food item. The results of these calculations are then summed up to find the total glycaemic value of the meal in question. Another important aspect of these calculations is the dietary fibre amount. The fibre content of each food item is summed up to determine the total amount of dietary fibre in the meal. The amount of total dietary fibre is necessary to find out the net carbohydrate amount of the meal. The net carbohydrate amount is calculated by subtracting the total amount of dietary fibre from the known total amount of carbohydrates in the meal. Once the net carbohydrate value of the meal is known, the GL of the meal can be determined by multiplying the already known total glycaemic value of the meal by the net carbohydrate amount of the meal. The answer is then divided by 100 and rounded up (Glycemic Index Foundation, 2017).

4.6.4: Mood Survey Analysis

Each participant was assigned an identification number and all mood results placed into a spreadsheet per research site. This was done for all results for the HGL and LGL meals. Subtotals were then calculated for each mood adjective and then a total for the corresponding mood sub-factor. The total sub-factor scores for each participant were compiled and the mean for each sub-factor tabulated. The Standard Deviation (SD) was also found in addition to the mean. The overall Cronbach's alpha and the alpha for each sub-factor for both meals was tabulated to access internal consistency characteristics (refer to the following section 4.6.5 for information on the various statistical tests).

The summation of the averages determined the general overall Total Mood Score (TMS) and the Total Mood Disturbance (TMD) for both the HGL and LGL target meals. The TMS and TMD of each of the 147 participants were tabulated. The TMS was the summation of scores from each sub-factor whilst the TMD is determined by subtracting the Vigour-Activity sub-factor score from the five other sub-factors. The maximum scores for each sub-factor based on the Likert Scale were the following: Tension-Anxiety= 24 points, Anger- Hostility=28, Vigour-Activity=24, Depression-Dejection=32, Fatigue-Inertia=20 and Confusion-Bewilderment=20. This gave a TMS range of -24 to 124. The paired t-test was then employed to test the statistical significance of the difference in TMD obtained between the HGL and LGL meals. The same procedures were then repeated for each research site and on a general level with respect to the dementia status of participants (those with and those without dementia). Pearson's correlation was incorporated to examine the strength of the relationship. Microsoft Excel and SPSS software were both employed in this phase of research.

4.6.4: Statistical Tests

Statistical tests and analyses can be classified into two groups: parametric and non-parametric tests. Parametric tests operate under an assumption that the variable under study is normally distributed with the population whilst non-parametric tests do not assume this principle of normality (Sarantakos, 2005). Parametric tests normally present three characteristics: 1) they involve the evaluation or measurements of parameters, 2) measurements should at least be on an interval scale and 3) they involve many assumptions (assuming that the variables are normally distributed with the particular distribution) (Spiegel and Stevens, 2011). Two statistical tests used in this study reflect the aforementioned characteristics: the paired t-test and Pearson's correlation.

4.6.4.1: Paired sample t-test

The two-sample t-test is used to test statistically significant differences between the means of two samples. This test presents two types. First, where dependent samples are being assessed and where independent samples are examined (Sarantakos, 2005). The dependent samples (matched or paired) include paired data from the same subjects. The data should follow several assumptions when the paired sample t-test is employed.

Assumptions of the paired/matched sample t-test (Spiegel and Stevens, 2011):

- Dependent variable that is continuous (i.e., interval or ratio level)
  Note: The paired measurements must be recorded in two separate variables.
- Related samples/groups (i.e., dependent observations)
  The subjects in each sample, or group, are the same. This means that the subjects in the first group are also in the second group.
- Random sample of data from the population
- Normal distribution (approximately) of the difference between the paired values (not a strict condition)
- No outliers in the difference between the two related groups (if normal)

The study variables met all the assumptions highlighted above making the paired sample t-test appropriate to use. The mean value results of the Total Mood Disturbance (TMD) of the HGL and LGL target meals were tested for statistically significant differences using the paired sample t-test (general outcome measure). The paired sample t-test was also employed to test the statistically significant difference of the TMD for the HGL and LGL meals within the general dementia subgroup. This analysis was then carried out for the general non-dementia subgroup.

Further, as carried out for the general study outcome measure, the researcher carried out the same analyses using the paired sample t-test for the results in each participating care home.

4.6.4.2: Pearson's correlation coefficient (r)

Correlation coefficients indicate the degree to which two variables present a non-random relationship. The indicator varies between +1 and -1 (Porta, 2014). The same source notes that r= +1 suggests a perfect positive relationship, r=-1 indicates a perfect negative relationship and r=0 indicates no relationship exists. It is important to note that for Pearson's correlation according to Porta (2014), a lack of correlation does not mean a lack of relationship between variables put rather a lack of linear relationship on the scale used. The degree of correlation can be further characterised as mentioned by Chen and Popovich (2002). The degree types are expressed below.

Degree of correlation:

Perfect: If the value is near ± 1, then it said to be a perfect correlation: as one variable increases, the other variable tends to also increase (if positive) or decrease (if negative).

High degree: If the coefficient value lies between ± 0.50 and ± 1, then it is said to be a strong correlation.

Moderate degree: If the value lies between ± 0.30 and ± 0.49, then it is said to be a medium correlation.

Low degree: When the value lies below 0.30, then it is said to be a small correlation.

Several special varieties of correlation coefficients exists. These include Kendall's Tau, Spearman's Rank Correlation and Pearson's Product-Moment Correlation Coefficient (Porta, 2014). Pearson's correlation is one of the most commonly used association measure for interval level variables. It is used in examining association or statistical relationships as it is based upon the covariance method (Sarantakos, 2005).

In the study, Pearson's correlation was used to test the statistical relationship between the target meals (HGL and LGL) and their respective Total Mood Disturbance (TMD) scores. This test was then carried out within the subgroups of participants with and without dementia. Once results were determined for the general group Pearson's correlation of the same variables and within the same subgroups was carried out for each of the four care homes.

4.6.4.3: Cronbach's Alpha Test

Cronbach's Alpha is a measure (expressed between 0 and 1) used to test the internal consistency of a given test or scale (Cronbach, 1951). This internal consistency refers to the degree of interrelatedness amongst the items of the instrument or scale (Porta, 2014). It is the most common measure used to test internal consistency due to its ease of use (when compared to other measures) and that it requires a one-test administration (Cohen and Swerdlik, 2010). The value of Cronbach's Alpha will tend to be higher when the items of the instrument are correlated to each other. This however does not mean that a high alpha value (i.e. closer to 1) is always equivalent to high degree of internal consistency. Various factors relating to the instrument used and characteristics of the study sample will have an effect on the alpha value. Thus, it is important to consider the specificities of each study and thus not rely solely on established estimated alpha values of the instrument or scale in question.

Whilst most researchers and reviewers require an alpha score of 0.70 or more for a study to be considered reliable, this "threshold" is arbitrary and required for unspecified reasons (Helms, et al., 2006).

Factors to consider for the interpretation of Cronbach's Alpha values (Spiliotopoulou, 2009):

- The sample size used- A larger sample size may increase the alpha value.

- Data variability- A sample that is more homogenous (e.g. a group of elderly adults) often yields lower reliability estimates when compared to a more heterogeneous sample. The alpha values are thus a reflection of the scores of the instrument completed by a specific group of study participants.

- Data distribution- In instances where the data is not normally distributed and linear, the reliability of the outcome measure will be underestimated by Cronbach's alpha.

- The length and width of the scale- Where a scale is too short, the value of alpha is significantly reduced. In some instances, this can be remedied by increasing the number of items testing the same concept. (POMS long form presents higher internal consistency when compared to the short form used in this study). Additionally, instruments with a width of four points or less may result in an underestimated alpha value.

Within the context of this study, Cronbach's alpha was employed as an auxiliary test to highlight the overall internal consistency of the POMS scale in the older adult population after a HGL and LGL meal were eaten. This test was not employed to meet any of the study objectives but to examine how well internal consistency was maintained given the unique study population.

The consistency of each sub-factor of the POMS in relation to the HGL and LGL meals and similarly the consistency in the subgroups of participants with and without dementia after the HGL and LGL meals were consumed as well as the consistency of each sub-factor of the POMS in the case of both meals

4.6.4.4: Linear regression

Linear regression is used to describe data and explain how one dependent variable relates to one or more independent variables. The linear regression formula is stated as $Y= a+bX$ where Y and X are variables with a and b being constants (Sarantakos, 2005). Linear regression can be used for causal analysis, forecasting an effect and trend forecasting. In the case of this study, linear regression is used to assess causal analysis i.e. the strength of relationship between the nutrient density of a meal (X) and its glycaemic load (GL). Given the different variables that could potentially influence the study outcome, the plotted regression line can be used to highlight how much of an impact variables may have had on the relationship strength between nutrient density and GL (Bewick, Cheek and Ball, 2003).

4.6.4.5: Descriptive Statistics

Descriptive statistics are used to summarise data so that they can be clearly illustrated (Spriestersbach, et al., 2009). Within this study, the descriptive measures used were the sum of participants, the sum of participants per care home as well as the sum of participants based on dementia status. Sums were also used throughout the findings chapter to describe sub-factor and mood adjective results. Other forms of descriptive statistics included mean and standard deviation. The mean can be defined as the sum of values divided by the total number of values or more simply, the most common description of the central tendency (Goos and Meintrup, 2015).

The mean was employed throughout the results to highlight the average GL of both HGL and LGL meals, description of daily nutrient intake within the nutrient analysis section of the results as well as the average sub-factor results of the mood survey. The standard deviation refers to the square root of the variance (Goos and Meintrup, 2015). It therefore assesses how dispersed a sample is. Standard deviation was used in the study to present the variation or dispersion of results with respect to the different sub-factors examined.

4.7: Data Storage and Security

All completed surveys, consent forms and observation notes were stored securely at the Anglia Ruskin University (ARU), Health Building, Young Street. A filing cabinet at the researcher's desk was used to store these documents. Surveys were filed based on the research site, the target meal (whether data was collected after the HGL meal or the LGL) and whether the participant had dementia or not. Only the researcher and both members of the supervisory team had access to these documents via a key held by the first supervisor. All data was entered into a single laptop computer system owned by ARU used solely by the student researcher. The laptop was password protected. Nutritics software was used to collect and analyse nutrient components of menus for each care home and was stored on the Nutritics website and then extracted onto research laptop. A numbering system was used to identify each participant's survey as well as the letter D to identify those with dementia. ARU is an organisation committed to ensuring that all data relating to research by its students meet the requirements of the Data Protection Act.

4.8: Ethical Considerations

The Anglia Ruskin University, Faculty of Medical Sciences Research Ethics Panel, gave ethical approval (See Appendix one). To this end, the research adhered to all the institutional guidelines for ethical approval by Anglia Ruskin University (Scott, 2012).

Given that participants in the study were not part of the university, ethical approval from Anglia Ruskin University alone would not have sufficed. External ethical approval was therefore required. The external ethical approval was obtained from the London-Queens Square Research Ethics Committee under the NHS Health Research Authority (Approval 17/LO/0613 See Appendix one). This approval was sought due to the characteristics of the potential participants targeted by the study.

The required participants were institutionalised older adults, some of whom would be dementia sufferers. As these participants are classified by the Research Ethics Committee as a vulnerable group within society, their approval was required (Bracken-Roche, et al., 2017). The Committee seeks to protect the dignity, right safety as well as wellbeing of all actual and potential research participants in accordance with the Research Governance Framework for Health and Social Care (NHS Health Research Authority, 2018). The Committee therefore required that the research minimised ethical risk to a negligible level. As a result, adherence to the Mental Capacity Act (MCA) of 2005 was utilised in the design of the study to ensure the safety of all participants and ensure negligible risk to all involved. The MCA was designed to protect and empower people who lack mental capacity to make their own decisions regarding care and treatment (MCA, 2005). One group of persons falling under the act are those with dementia. The act is underpinned by five principle tenants that where considered in the design of the study to involve those with dementia. These principles are stated as follows:

- Principle 1: A presumption of capacity (assume a person has the capacity to make a decision themselves, unless it is proved otherwise).

- Principle 2: Individuals being supported to make their own decisions.

- Principle 3: Unwise decisions (do not treat a person as lacking capacity to make a decision just because the decision the make is unwise).

- Principle 4: Best interests (if a decision is made on behalf of someone who lacks capacity, it should be in their best interest).

- Principle 5: Less restrictive option (the treatment and care provide to someone who lacks capacity should be the least restrictive of their basic rights and freedoms) (MCA, 2005).

In this regard, capacity to consent was the chief ethical issue of the research. To overcome this hurdle only participants with the mental capacity to consent (including those with dementia) could take part in the study. The MCA further establishes two stages of determining mental capacity. Firstly the person should have a mental impairment and secondly it must be established if this impairment hinders the person to make a specific decision when required (MCA, 2005). All participants with dementia in the study were give a mental capacity assessment in accordance with these two guidelines of the MCA. The researcher, a Medical Doctor and trained in Informed Consent with Adults lacking capacity- National Institute for Health Research Course (NIHR), the Mental Capacity Act (Social Care Institute for Excellence Course), Good Clinical Practice Course (NIHR), and mental capacity assessment by Doctor Stephen Hughes (Consultant and Lecturer at Anglia Ruskin University) was able to care out these assessments with the highest ethical standards (Refer to Appendix one for certification of stated courses).

Regarding those persons with dementia, the study, to reduce risk only those persons in the early or middle stages of this condition were included. These persons are considered competent enough to give informed consent. Buchanan and Brock (1990) note that "the area of competence of relevance to the involvement of people with dementia in research is that of decision-making capacity". Many persons with dementia (especially those in the early to middle stages) have sufficient capacity to express their desire to take part in a study and engage in consent discussion (Hougham, 2005).

No legal rights were compromised by taking part in the research and participants could withdraw from the study without notice (where applicable, the next of kin could also remove his/her relative without notice). Once ethical approvals were received, consent was obtained from the Care Facility Manager of each of the four participating care institution to use the sites and approach potential participants. Consent from each participant was sought and received regardless of underlying capacity condition under review.

At both instances where the mood survey was carried out, persons with dementia had their mental capacity and willingness to participate assessed by the trained researcher. Where a participant was not willing to complete the mood survey on any of the two occasions, it was not administered. The research was designed to ensure there would not be any undue burden placed on members of staff carrying out daily duties. This burden fell on the researcher who carried out the survey. All consent received was written in nature for all participants. In some instances, after verbal consent was given by a potential participant, a consultee would sign on his/hers behalf if necessary.

4.9: Dissemination of Research Findings

The research findings could be published in a reputable, relevant research journal in the hope of potentially highlighting the need for updating current nutrition recommendations for older adults residing in care facilities. Poster and oral presentations at conferences could also form part of the medium for publicising the research finds. It must be emphasised once more that the confidentiality of care homes and participants in all forms of publication would have to be strictly maintained. A full discussion and break down of the results could also be given to each care home that participated as well as participants if desired.

4.10: Summary

In this chapter the research process, design, primary and secondary outcomes and validity-reliability in the context of the study were discussed. Aspects of the population used were examined to include the detailed recruitment procedures, inclusion and exclusion criteria as well as how the sample was selected and calculated were outlined. The chapter then followed with explanations and justifications for methods used for data collection and analysis such as the Profile of Mode States (POMS), UK Ofcom Model as well as Nutritics Software.

Data collection and analysis procedures were also expressed. All statistical tests employed in the study were then examined, in addition to how the GL of meals and total mood scores (TMS) as well as total mood disturbance (TMD) are calculated. Finally ethical issues, data storage mechanisms and potential methods of result dissemination were highlighted.

The following chapter presents the findings borne out of the different methodological procedures previously expressed. These findings are illustrated in different tables and charts.

Chapter 5: Findings

5.0: Introduction

The findings chapter is divided into four components. The first component includes the field observations and nutritional analyses that are sub-divided into results per each research site. Glycaemic load findings are then addressed also on a research site basis highlighting the target LGL and HGL meals. The third component then examines the results of the nutrient density-glycaemic load relationship. The final component covers the bulk of the results section offering first, general mood survey results followed by site-specific results. A summary then concludes the chapter.

5.1: Field Observations

5.1.1: Care Home 1

5.1.1.1: Introduction
Care home 1 was the smallest care home, which participated in the study. The facility specialised in dementia care and was situated in a quiet neighbourhood. The customary four-week menu was used and *recycled* on a monthly basis. Food items are obtained from a catering company that also sets the menu plan. Deliveries are made on a weekly basis to the home. The meals are then cooked and prepared by the kitchen staff under the guidance of the head chef. Care home 1 did not have a dietitian, nutritionist or nutrition manager on hand, nor was anyone of the kitchen staff trained specifically in any of these fields. However, it must be noted that the head chef completed short courses in food preparation for the elderly and did appear to have some nutritional knowledge. Whilst the menu was a set one, the home provided meal options at all daily meals. Meals included breakfast from 8 am to about a quarter to 10 am, morning tea at 11/11.30 am, lunch from 12:00 pm – 14:00 pm, afternoon tea at 15:00 pm, supper at about 16/16:30 pm-18 pm and evening tea at 19pm if required.

Whilst meals were served at the same time daily, staff accommodated the different times residents wanted to eat, specifically those who required feeding assistance and were bedridden. Breakfast included the general breakfast options of cereals, toast, porridge and fruit. Residents appeared to eat based on their preferences at breakfast. Additionally, a cooked English breakfast could be prepared if a resident requested it. At lunchtime, residents had two options, (one of which was normally a vegetarian option) that were then followed with dessert (pudding). Staff involved the residents in selecting their meal options for the following day where possible. In other instances, residents received meals based on their known preferences.

Suppertime normally began with a soup of the day and then the main meal that was normally "lighter" when compared to lunch (See appendix for images of meals and menu).The alternative menu was employed in the instance where a resident did not want the main meal offered. This menu normally included assorted sandwiches, fresh fruit, yoghurt and ice cream. Tea times during the day usually included tea or coffee served with biscuits. Milkshakes and fortified drinks were also observed being served to residents who appeared to be underweight. Whilst the menu offered was a set one, in some instances where it was noted that a resident might prefer something different, it would be amended. Additionally, residents with specific allergies, diabetes and any other dietary requirements were catered for with specific meals. These residents did not participate in the study. Pureed meals were also offered to residents who required them. It was noted by the researcher that the pureed meals were generally the meals offered to other residents but pureed, (softened form) placed on a plate, and gravy added. The pureed foods on the plate could only be distinguished by the differences in colour, as the foods constituting the meal were not reconstituted or shaped to resemble the food that is pureed (See appendix 4 images research site 1).

The head chef appeared to be of the view that residents were satisfied with the meal offerings and food wastage was not a problem on site.

5.1.1.2: Dining Environment and Meal Presentation

All meals were served in the same dining area daily. Residents were encouraged by staff to have meals in the dining area as much as possible. Some residents due to physical health and preference had meals in their rooms. Visiting family members and friends were also observed sitting with residents during mealtime. The dining area was situated in close proximity to the kitchen and residents were able to smell the meals being prepared for them. Tables and chairs were situated in a way that allowed easy access for those in wheelchairs and for staff to manoeuvre around during the serving phase of the meals. Tables were set prior to each meal and menus were displayed in the dining area for residents to see what the meals of the day were. Once residents were placed at their preferred tables, staff assisted with feeding aprons and serving drinks. Meals were wheeled from the kitchen into the dining room via a hot trolley. The staff member designated to serve meals would then take the temperature of each food upon removing meal covers. This temperature was always recorded. At this point residents could both smell and see the food about to be served. All staff once assisting with feeding residents also wore an apron. The server then served food according to portions that each resident would normally have. Portion guidelines were not followed as care staff appeared to be very familiar with how much residents ate. Residents could also have seconds if they wished. Those participating in the study could only have the initial serving offered. Served meals were then placed at the requisite table and eating/feeding assistance commenced. Pureed meals were not served by the designated server but were already prepared by the kitchen staff and given to the specific residents. All meals taken to rooms were appropriately covered and the cover only removed when eating/feeding began.

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The researcher observed the colourful and welcoming atmosphere of the dining area decorated with art and pictures on the wall, all appropriately following a colour scheme of the tablecloth and napkins on the tables.

Staff were also interacting with residents encouraging them to eat. No music or background noise was heard. Once meals were finished pudding was then served.

The person serving once again determined portion sizes. Pudding was normally finished at a faster rate than the main meal. Residents were then allowed some time to relax before they were taken to the lounge or their rooms. Some residents often requested a cup of tea or coffee. Once the meal had finished and residents had left the dining room, it was then prepared for the following meal or the next day.

5.1.1.3: Utensils
Residents used lightweight silverware, though where required, specialised spoons and forks were available. Residents with motor/mobile difficulties were assisted with feeding. All cups and mugs used were of a plastic, durable material with handles for residents to grip. Sipping cups with two handles were also available for use by some residents. Plates and bowls were also of the plastic variety. The plates used were of adequate size and of a smaller width in comparison to the other care homes. Food fit comfortably in them. Bowls were also of a similar width but deeper to accommodate sufficient soup, with a design to reduce spillage around the surface of the bowl. Desserts were served in similar but smaller plates or bowls, as well as a smaller transparent bowl for foods such as ice cream.

(Images from care home 1 can be seen in the appendix 4 section)

5.1.2: Care Home 2

5*.1.2.1: Introduction*

The second research site visited was recently opened and catered for older adults with and without dementia. A menu rotation of three weeks was followed and residents had the opportunity to offer feedback on meals and suggestions on what could be improved as well as express their general preferences. All meals were prepared in the kitchen and external catering was not used. Foods were fresh, organic, and prepared based on the UK Care Home Framework 2017 as well as the Dining with Dignity Guidelines 2017, used by Care UK institutions. Additionally, all staff were trained in dining and hospitality and had some training and knowledge in diet and nutrition. The home also employed a Food and Services director with apparent knowledge of the food and hospitality industry. Daily meals did not follow a strict schedule but were rather very fluid in nature. Breakfast normally began at 8 am until 10:30 am (based on when all residents had eaten). Lunch began at 12:30 pm and dinner at 17:00 pm. A tea trolley did not form part of the morning or afternoon tea times. After breakfast, residents were free to make themselves a cup of tea or coffee (for those who were able) or could request something to eat which would be prepared by the kitchen. At about 15:00 pm daily, an afternoon tea including cakes and sweets were offered to residents. The site had a snack station where any resident could enter at any time of the day and grab a sweet or chocolate bar.

Breakfast offered was similar to the other care homes studied and included a selection of cereals, porridge, toast and preserves, fresh fruit, yoghurt, tea, coffee and fruit juices. Residents could also request a cooked breakfast (e.g. a full English) from the kitchen. Breakfast was not fixed, i.e. residents could have porridge and or toast for example, and was normally based on their general preferences.

During lunchtime, residents received a "heavier" meal when compared to supper. Lunch began with a starter and then the main meal options followed by dessert. This research site did not offer a vegetarian option at meals as it was observed that food wastage would be increased if this occurred. Instead, the main meal had two choices (though one was vegetarian at times). However, if a resident wanted something else to eat not on the menu, the kitchen prepared it upon request. Additionally, there was an alternative menu where daily options of jacket potatoes, omelettes, sandwiches and salads could be had. Dessert at lunchtime also had two options for residents to select from. At suppertime, the meal began with a soup of the day that was then followed by a light meal or finger food. Once more dessert followed and residents could also have fresh fruit, yoghurt or ice cream as an alternative. Residents were permitted during the evenings to make use of the snack station or kitchen (where possible) to have something to eat. Residents' preferences were noted the day before for the following day's meal options. At mealtime if a residents requested something else it was prepared by the staff. The opinions and inputs of residents appeared to be taken into consideration when menus were prepared. The menu thus offered a wide variety of foods and could not be considered monotonous in nature. Residents who had certain allergies and dietary restrictions were also catered for.

Pureed meals also formed part of the meal options for specific residents (those with dysphagia or swallowing difficulty). These meals were the soften forms of the "normal" meals on offer and were presented to replicate the form/shape of the original meal (e.g. a slice of salmon is shaped into that form).The foods constituting the meal were scooped or placed on the plate using a piping bag or pastry cutter to acquire the shapes required.

Each component of the meal was also presented separated on the plate, instead of all foods being present as one mass. Gravy and or sauces were not added to these modified meals by care staff. Residents appeared to enjoy all their meals and as mentioned prior, were free to give feedback to staff.

5.1.2.2: Dining Room Environment and Meal Presentation

Given the size of the facility, meals were served in different dining areas on different floors. All meals were prepared in a central kitchen and distributed to each dining area via hot food trolleys. Family and friends were encouraged to sit with residents and participate in mealtime. This was observed on different occasions. Guidelines were followed to ensure the dining area was prepared for mealtime. All tables were set at least 15 minutes before the meal, with silverware cleaned and polished, napkins neatly placed on tables along with utensils. Flowers were also placed centrally on the table along with large font menus and condiment pots. All dining areas were very spacious and accessibility for residents was not an issue. Residents tended to sit in specific areas known by the care staff. Once all residents who were desirous to have a meal in the dining area were present, meal serving would commence. All care staff had basic nutrition training at this institution and guidelines were adhered to regarding mealtime and serving size.

Care staff were assigned to carry out dining room duties and stayed in the dining area with the residents for the duration of the meal. Both care staff and specific residents wore aprons. Temperature of meals were taken by the staff member serving, and recorded once food was uncovered. At this point, residents could smell the aroma and see the food that would be served. On some occasions, music preferred by the residents was played softly in the background. Modified pureed meals were already shared by the kitchen and were uncovered and given to specific residents.

Each modified meal was properly labelled with the name of the resident, meal requirement, date prepared, cook and the room number in instances where the resident was not eating in the dining room. Meals were served with specific utensils to adhere to portion size standards. Residents were encouraged to eat by the staff. Once the meal was finished, residents were given time to sit and interact with each other before leaving the dining room. A cup of tea or coffee was also served upon request.

Once residents had gone, the room was cleaned. The room was very welcoming with utensils, tablecloth and room colour matching creating a restaurant like atmosphere.

Artwork was displayed on the walls. Drapes were also drawn to allow natural light into the room. All aspects of the dining area adhered to the homes dining with dignity guidelines. A bathroom was located nearby if a resident required it. The dining area also had a fully functional kitchen where residents who were mobile could get something from the cupboard or refrigerator. Residents were also free to use the microwave and toaster if they needed to.

5.1.2.3: Utensils

Care home two used both non-adapted (normal) and adapted silverware. Adapted silverware was used for specific residents who presented difficulty with lifting silverware or who required assistance with eating. All the plates and bowls used were ceramic, but lightweight. Both plates and bowls were white with a blue wash border that appeared to enhance the visibility of the food in the centre of the plate. The plates used were of specific sizes in line with portion size guidelines. The main course plate had a recommended 10.5-inch diameter and 7-inch eating area, which allowed foods to be properly presented and enhanced use for those with visibility issues or issues with dexterity. A smaller 8-inch sandwich plate with similar characteristics was employed for breakfast (toast), dessert foods and at teatime.

The bowl used was a multipurpose one of about 6.75 inches. It had a rim that allowed easier grip and was deep enough to serve foods such as soup or porridge. Different cups were used in the care home. Plastic cups with handles on each side were available for those with dexterity issues as well as a ceramic variety. Cups could also be covered with a sipping top where necessary. Residents used standard glass cups for the most part at mealtime. (Please see appendix for images relating to care home 2).

5.1.3: Care Home 3

5.1.3.1: Introduction
Care home three catered for both older adults with and without dementia as well as those with other learning disabilities. The home adhered to a common four-week menu model, preparing all meals on site without the need for catering. A food and nutrition manager formed an integral part of the care team. Additionally, the head chef had completed diet and nutrition training. An individualised nutrition approach was taken in the home and residents' weights were assessed and monitored on a weekly basis. These measurements were recorded in the residents' personal record. Residents appeared to be of adequate weight and where required fortified foods were given.

Meal times though of a standard time, (breakfast from 8-10 am, lunch at midday and supper at 16:00 pm) were not rushed, which allowed residents to calmly eat as much as possible, relax, and interact with staff other residents. Tea was given in the morning between breakfast and lunch and in the afternoon before supper. Residents were also free to have a snack from the pantry in the evening. Whilst the breakfast was similar to the other care homes, research site 3 offered a special cooked breakfast option each morning. This ranged from pancakes on Wednesdays to Kippers on Sundays. Lunch options in comparison to other homes were relatively light meals. It included assorted sandwiches, an alternative option, such as soup or jacket potato, a drink and dessert.

Dinner was then a heavier meal, i.e. a heavier main and dessert option. The dinner offered always had two options, one of which was vegetarian. The dessert would also have two options.

Residents with special meal plans, allergies, and diabetics, were catered for and staff welcomed feedback on the quality of the food. Pureed meals were not presented as those in care home two and meal components would at times fuse together.

5.1.3.2: Dining Environment and Meal Presentation

Food was prepared in a central kitchen and then distributed to the various dining areas via a meal trolley. The main dining room was next to the kitchen. It was very spacious and could accommodate a large number of residents. Friends and family visiting were welcomed to sit and participate during mealtime. Staff when working in the dining room area wore disposal aprons. Residents were also offered aprons if they required one. Seating for two, four and a larger table capable of seating eight residents were available. Residents would normally sit in the same place daily based on their preference. The dining room was properly decorated and tables covered with tablecloth. Windows were opened (depending on the weather) and drapes were drawn to allow natural light to enter during mealtime. Tables were set before residents arrived for their meal. Menus were also displayed on a large menu board on the wall with images of the day's meals.

The home also offered a special Caribbean influenced meal option separate from the main menu for any residents who would have liked to try something different. All meal requests were recorded the day before from the residents by the care staff. They were given the choices and asked to select what they would like.

Once all residents who wished to eat in the dining room were present, the meals were then served. The temperature of the meals were always taken and a designated member of staff carried out the serving of the meals. Whilst the home followed portion size guidelines, these guidelines were not followed rigidly, as portion size appeared to vary based on the residents being served.

Hence, the person serving appeared to rely on the portion size guidelines, as well as their knowledge of the eating habits of the residents. Specific utensils were used to ensure portion sizes were standard. Residents were free to have seconds on completion of their meals. Meals were served with the drink preference of the residents (juice drinks or water). All modified diets came labelled and easily identifiable from the kitchen. These meals as well as all others going to the different rooms were properly covered. The covering was only removed when eating/feeding of the resident commenced. Given the proximity of the main dining area to the kitchen, residents were able to smell the food being prepared and could see the food being served from the hot food trolley. At times, music was played during mealtime or the television in the nearby lounge area was left on. Once the meal was finished, residents could have tea or coffee, and interact with each other before retiring to the lounge or their respective rooms. The room was then cleaned once all residents had left.

5.1.3.3: Utensils

Both plastic and ceramic utensils were used in care home three. All silverware was lightweight and adapted versions were available for those with dexterity issues. All cups and mugs were of the plastic standard variety used in most care homes. Cups used to serve cold drinks were transparent whilst cups/mugs used for warmer liquids were thicker with a handle (others had two handles for easier accessibility for some residents). The plates used to serve main meals were smaller than the standard plates used in care home 2. They were able to accommodate correctly portioned meals.

These plates were either ceramic or plastic. Residents with dexterity difficulties also used an adapted plate with a more prominent rim. Other smaller plates were used at breakfast and as well as at dessert time. The bowls used were also common in care facilities and were ceramic and white in colour. They did not present a prominent rim at the surface which could have made gripping them a bit more challenging.

(Images from care home 3 can be viewed in the appendix section).

5.1.4: Care Home 4

5.1.4.1: Introduction
The countryside situation of care home 4, a distance away from the city centre offered residents a peaceful environment. The care home employed the services of a catering company offering a range of foods care homes. The catering company delivered frozen meals twice weekly to the care home. The meals from the company offered a variety of options on a four-week menu cycle. The care homes had the option of selecting the options they required. Thus, the catering company's menu did not appear to be a rigid system that had to be followed by its clients. The meals were heated up in the kitchen, temperature checked, covered and then given to residents. The catering company's system minimised wastage and followed recommended dietary portion sizes and nutritional requirements from the British Dietetic Association as well as Standards set out by the National Association of Care Catering. Kitchen staff had access to the dietary portion size charts of the menus and meals were served using utensils given by the company which appeared to make portion size determination even easier. The kitchen also had access to a catering company handbook that identified all the meal options with their average weight, package size, product code and dietary information.

The research site did not have a nutrition manager, however the head of the kitchen has taken part in training organised by the catering company online.

This training was a regular occurrence regarding food and nutrition. The home had a standard meal schedule i.e. breakfast, tea, lunch, tea, dinner. After dinner, residents if they were hungry could receive something else to eat. Meal options were displayed on a display board daily without photos or images of the meals.

The feedback of residents' was welcomed regarding the meals offered and visitors were welcomed to sit with residents during meals.

Breakfast options were similar to other care homes whilst lunch offered a meat and vegetarian option as well as options for dessert. Dinner in the afternoon began with a soup of the day, followed by the main course that did not appear as heavy as lunch. The catering company offered a range of other options, catering for those on puree diets (pureed meals were presented in similar fashion as care home two), diabetics, residents with allergies/intolerances as well as ethnic options (Asian, Caribbean meals). Fortified meals and supplements were also offered to specific residents especially during morning and afternoon teatime. Each resident had a food chart where their daily intake was logged by staff and inputted on the Nutricare System (The researcher did not have access to this system). The catering company had access to this information and could determine for example, based on consumption patterns, deficiencies in a resident's diet or meal preferences. A few residents ate in their rooms, though they were encouraged to eat with others and interact.

5.1.4.2: Dining environment and meal presentation

Care Home 4 offered two dining areas for residents. A conservatory dining area and a smaller "inside" area close to the kitchen. The conservatory area offered quieter dining with views of the countryside and animals outside. The other dining area was spacious enough to accommodate those with wheel chairs, and both areas were relatively quiet. Tablecloth was not used in either dining area. The walls of the indoor area were *adorned* with photos and there were no windows for natural light in contrast to the conservatory dining area. Music nor background noise was played during meals and carers assisted residents where required. Meals were prepared in the kitchen and presented to residents in the inside area from the kitchen counter.

Residents were given aprons to wear before eating/feeding commenced. A trolley was used to transport meals to the conservatory dining area. Meals taken to the rooms were covered, placed on a tray and delivered to the respective residents. Where required, care staff assist with feeding. Once mealtime was finished, residents had time to sit and relax before moving to the lounge or their rooms. Staff then cleaned the dining areas.

5.1.4.3: Utensils

The care home used lightweight silverware and employed adapted cutlery where required. All plates used to serve main meals were ceramic, of the recommended size and red in colour. The colour of the plates could have had some impact on food visibility. A smaller version of the main meal plates were also used. Two types of bowls were used in the care home. One is a standard white coloured ceramic bowl used to serve dessert and another wider, ceramic red, of lesser depth with a pronounced rim that is used to serve soup. All the cups used were all of thick plastic material easy for residents to grip and use.

Table 15 which follows presents a summary of the different eating environments observed by the researcher in each care home studied.

Table 15: Summarising the eating environments of each care home studied.

Care Home	Food prepare nearby seen and smelled	Social atmosphere, encouraged to eat	Clean spacious decorative dining area	Natural Lighting in dining area	Music/Background Noise
1	Yes	Yes	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes (sometimes)
3	Yes	Yes	Yes	Yes	Yes (sometimes)
4	No (seen and smelled from trolley	Yes	Yes	Yes	No

Note. Table 15 presents a summary of the observations noted at each care home visited.

5.2: Nutrient Analysis

5.2.1: Introduction
The nutrient analysis is given first in reference to the general results of the study (all 4-care homes), and then broken down into the different care homes visited. This was done to enable easier understanding of the data. Please note that the glycaemic analyses includes all meals offered within the care home based on portions used to include the various food combinations residents receive. This information was then used to determine which meals would be the highest and lowest in terms of glycaemic characteristics. The GL of the two target meals were then used and those residents agreeing to participate in the study would have had to eat the target meals on the days the study was carried out. Concerning nutrient analyses, as this is a population-based study, to get the best picture of daily meal consumption, the researcher examined the nutrient offerings, for the first options and the second meal options that would represent options for breakfast, lunch and dinner a resident would most likely consume. However, given the large number of breakfast options, the most commonly eaten breakfast meals were used for analysing nutrients.

The UK: SACN 2017/COMA Recommendations were used as the default for dietary requirement value within the nutritional software employed. The Nutritics software was used to analyse the data (refer to section 4.6.1 for more information).

5.2.2: General Nutrient Analysis Findings

Table 16: Daily mean offerings for selected nutrients in relation to the recommended UK: SACN-2017/COMA target.

Selected Nutrient	Daily mean offering in all care homes (SD)	Recommended UK:SACN-2017/COMA target amount
*Energy	1593.8 kcal (191) O	2025 kcal
Carbohydrates	210.07 grams (20.02) O	253 grams
Protein	59.53 grams (8.82) O	60 grams
Fat	57.2 grams (10.99) O	<79 grams
Free Sugars	64.07 grams (4.63) O	<25.3 grams
Fibre	14.50 grams (2.32) O	30 grams
Calcium	659.50 mg (79.02) O	700 mg
Iron	7.73 mg (0.84) O	8.7 mg
Iodine	81.57 µg (22.33) O	140 µg
Selenium	37.93 µg (8.24) O	75 µg
Vitamin D	2.71 µg (1.67) O	10 µg
Vitamin C	55.76 mg (16.07) O	40 mg
Vitamin B12	4.84µg (2.52) O	1.5 µg
Folates	170.30 µg (22.23) O	200 µg

Note. Analysis includes only main meals offered by the facilities under study. It does not include snacks during the day. Nutrient above lower limit not target recommendation= O; Nutrient meets or is above the target recommendation= O ; Nutrient is below or does not meet the target recommendation= O ; *=Not a nutrient but relevant to the analysis.

Table 16 illustrates the daily mean intakes of various nutrients relative to the recommended targets based on menu offerings. The table points to several daily nutrient amounts being below the recommended targets to include: vitamin D, selenium, iodine, fibre, carbohydrates, calcium, folates and iron were all below the recommended target. Calcium (>400mgs), iron (>4.7), iodine (>70), folates (>100) though they did not meet the target recommendation were above their lower limits (limits expressed in brackets). Fibre, vitamin D and selenium were well below recommended amounts. Regarding macronutrients, carbohydrates were below the target whilst protein and fat met their respective targets. Surpassing targets were vitamin C, B12 and free sugars. The overall average energy amount was 431.20 kcal below the target of 2025 kcal. It must be noted that snacks during the day (which are often high carbohydrates) were not included in the analyses. The rationale and implications for the omission of these snacks can be gleaned in the Discussion chapter (Chapter 6).

5.2.3: Nutrient Analysis Findings per Care Home

5.2.3.1: Care Home 1

Results highlighting the average daily intake of select nutrients are presented below. Intake is relative to the daily meal options (1 and 2) per the week menu. Free sugars, fibre, calcium, iron and vitamin C are given as average daily intakes.

Figure 9: Energy amounts per each weekly menu option in Care Home 1
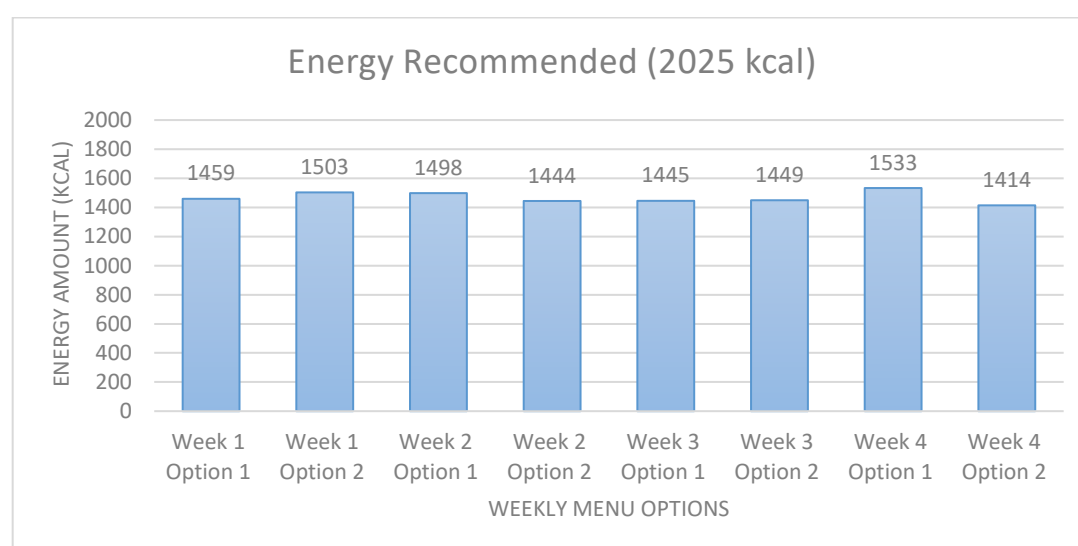
Note. Both options per each week surpass 1400 kcal but do not meet the 2025kcal of energy recommended.

The energy supplied by the meals analysed in care home one do not meet the recommend 2025 kcal. Both the first and second options examined presented average energy amounts of 1483.75 kcal and 1452.5 kcal respectively. Care home one thus has an average of 1468.13 kcal daily food energy. This is below the general average of all care homes (1593.8 kcal).

Table 17: Daily mean offerings for select nutrients in Care Home 1

Nutrients Analysed (recommended target)	Daily Mean in Care Home 1 (SD)	Daily Mean All Care Homes (SD)
Free Sugars (<25.3g)	65.87 g (5.54) 🔴	64.07 g (4.63) 🔴
Fibre (30g)	13.54 g (0.73) 🔴	14.50 g (2.32) 🔴
Calcium (700mg)	646.50 mg (78.61) 🟡	659.50 mg (79.02) 🟡
Iron (8.7 mg)	7.05 mg (0.46) 🟡	7.73 mg (0.84) 🟡
Vitamin C (40mg)	56.75 mg (7.25) 🟢	55.76 mg (16.07) 🟢

Note. Nutrient above lower limit not target recommendation= 🟡 ; Nutrient meets or is above the target recommendation= 🟢; Nutrient is below or does not meet the target recommendation= 🔴 . Nutrients expressed above present similar findings in care home one and all care homes in relation to the recommended targets.

In the table 17 above, it can be observed that in care home one, the daily average intakes of vitamin C and free sugars are above both the recommended and general average amount. Calcium and Iron are below the recommended and general daily average amounts with iron being slightly below. Both of these micronutrients are above their lower limits (calcium>400mg and iron>4.7mg). The daily fibre offering from meals was less than half of the daily recommendation and general average amounts.

Figure 10: Macronutrient amounts relative to each weekly menu option in Care Home 1.
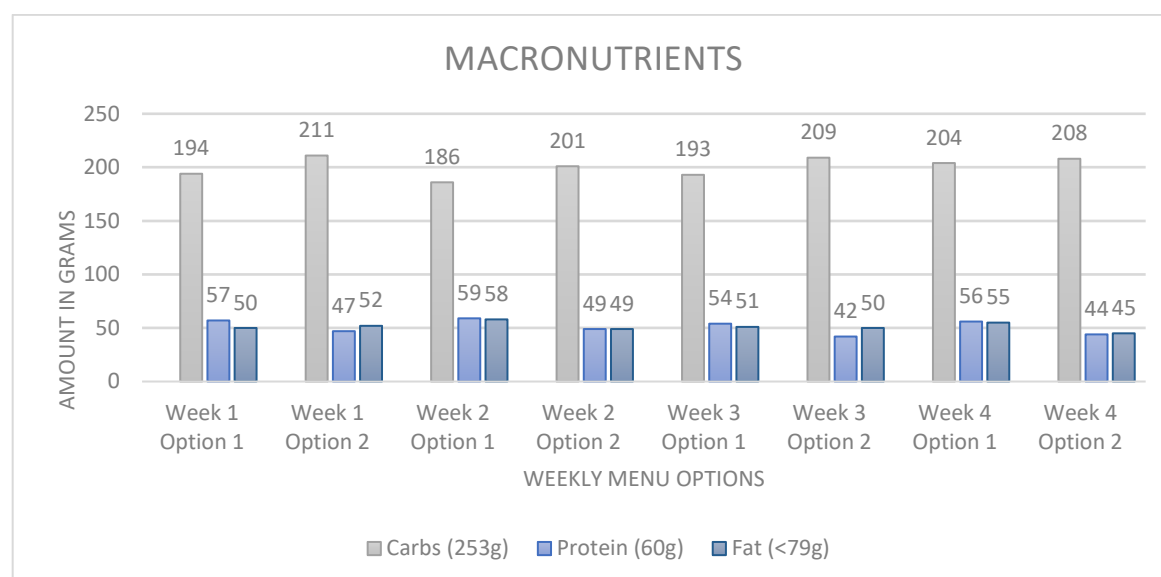
MACRONUTRIENTS

Note. A trend of carbohydrates surpassing all other macronutrients but not meeting the 253 grams target. The protein trend is more consistent but does not the 60 grams target. Fat consistently meets the target of <79 grams.

Figure 11: Select micronutrient amounts relative to option one of weekly menu in Care Home 1.

SELECT MICRONUTRIENTS
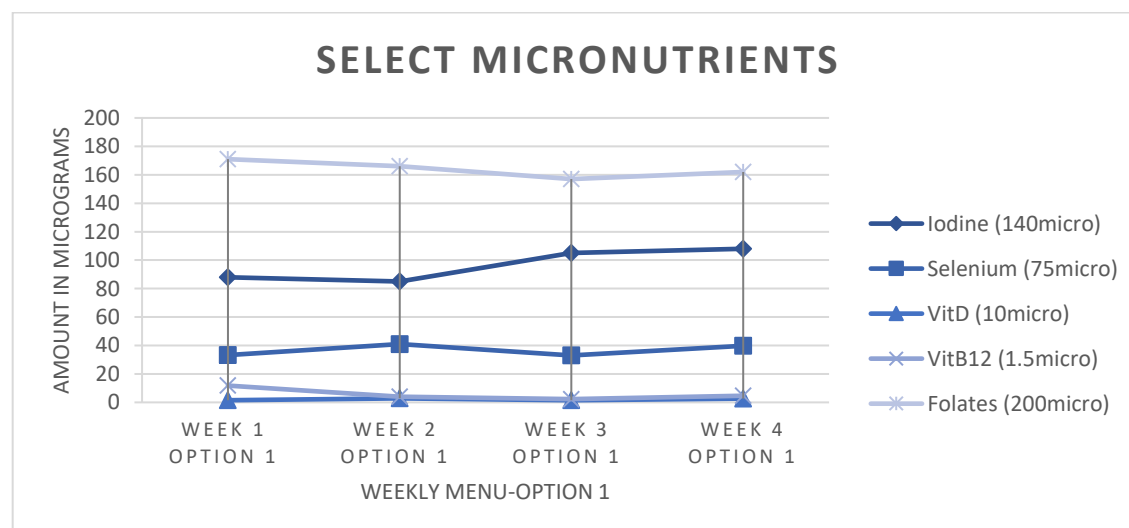
Note. Fluctuations in most micronutrient trends for option 1 meals. Vitamin B12 presented consistent above average amounts. All other micronutrients presented deficiencies in offerings.

Figure 12: Select micronutrient amounts relative to option one of weekly menu in Care Home 1.
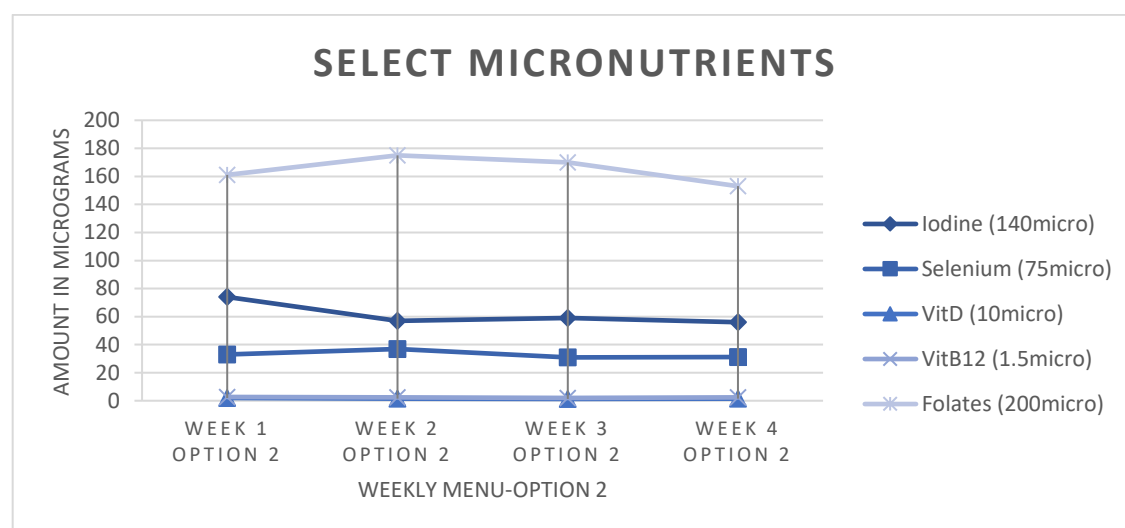
Note. Second options present more stable amounts of micronutrients when compared to first options in Figure 11. Similar trend of daily offering deficiencies for all micronutrients with the exception of vitamin B12.

Regarding macronutrients, Figure 10 shows weekly larger amounts of carbohydrates (regardless of option) in comparison to protein and fat, which were relatively consistent each week with protein always below the recommendation (60 grams). Fats met the target of being below 79 grams consistently. The carbohydrate amounts however did not meet the recommended amount. A trend of micronutrients being below the recommended targets was also observed in care home one. Figure 11 and 12 point to deficiencies for daily offerings of Iodine, Selenium, vitamin D and Folates with Vitamin D and Selenium being significantly below the target amounts. Vitamin B12 on the other presented above average amounts for each week regardless of the option analysed. The second options appear to offer more consistency in terms of the amount of nutrients offered whilst the first options present more fluctuation with a noticeable decrease between week one and four in most micronutrients.

5.2.3.2: Care Home 2

Care home 2 presented a three-week menu cycle in comparison to other care homes. This however did not hamper the nutrient analysis results of its menu as it offered greater food varieties than the other care homes. Above average nutrient amounts were noted for care home 2 and are presented below. Intake is relative to both meal options per the weekly menu. Free sugars, fibre, calcium, iron and vitamin C are given as average daily intakes.

Figure 13: Energy amounts per each weekly menu option in Care Home 2.
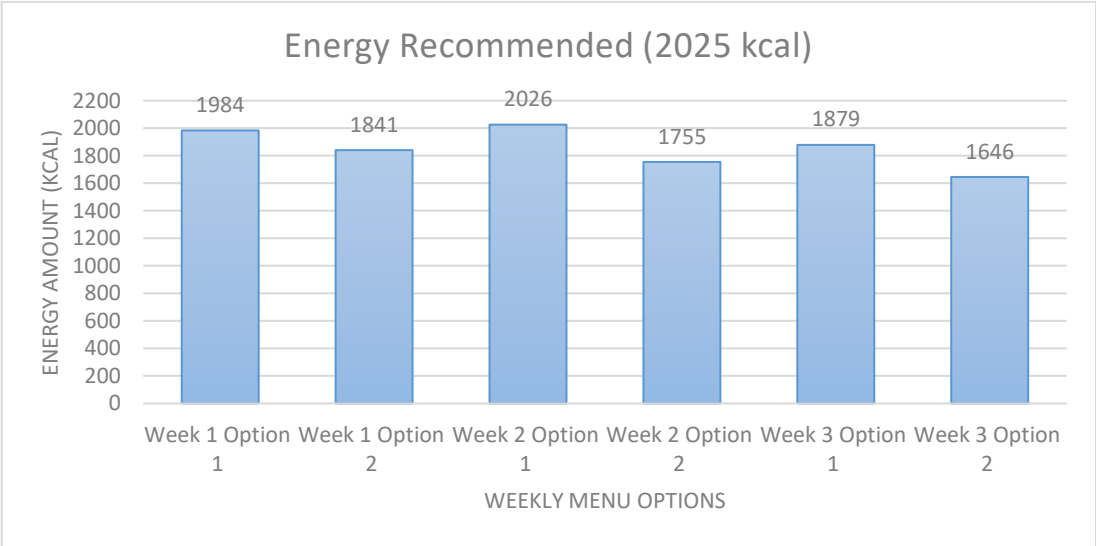
Note. All options surpass 1500kcal with week 2 option 1 meeting the energy requirement recommended.

Figure 13 above illustrates that in care home 2 almost all weeks regardless of option presented energy amounts surpassing 1500 kcal with a low of 1646kcals for week 3 option 2 and a high surpassing the recommended amount for week 2 option 1 (2026kcal). All options present a mean of 1855.17 kcal (SD 141.66). This amount, though below the recommended 2025 kcal is above the general average of 1593.8 kcal (Expressed in table 18) and the greatest amount within the four care homes analysed.

Table 18: Daily mean offerings for select nutrients in Care Home 2

Nutrients Analysed (recommended target)	Daily Mean in Care Home 2 (SD)	Daily Mean All Care Homes (SD)
Free Sugars (<25.3g)	67.67 g (4.37) 🔴	64.07 g (4.63) 🔴
Fibre (30g)	17.5 g (1.62) 🔴	14.50 g (2.32) 🔴
Calcium (700mg)	666.67 mg (43.77) 🟡	659.50 mg (79.02) 🟡
Iron (8.7 mg)	8.27 mg (0.81) 🟡	7.73 mg (0.84) 🟡
Vitamin C (40mg)	78.83 mg (7.47) 🟢	55.76 mg (16.07) 🟢

Note. Nutrient above lower limit not target recommendation= 🟡 ; Nutrient meets or is above the target recommendation= 🟢; Nutrient is below or does not meet the target recommendation= 🔴 . Nutrients expressed above present similar findings in care home two and most care homes in relation to the recommended targets.

The nutrients analysed above in table 18 present differing results in contrast to care home 1 and the general results expressed previously. The fibre content of the meals offered in this home surpassed the general daily average and that of care home one, although it was still below the recommended target. All other nutrients presented higher daily averages when compared to the general results. With reference to the recommended targets, the daily average for vitamin C was almost double for care home 2 whilst free sugars averaged well above the targeted amount. This trend was observed throughout all research sites.

Figure 14: Macronutrient amounts relative to each weekly menu option in Care Home 2.
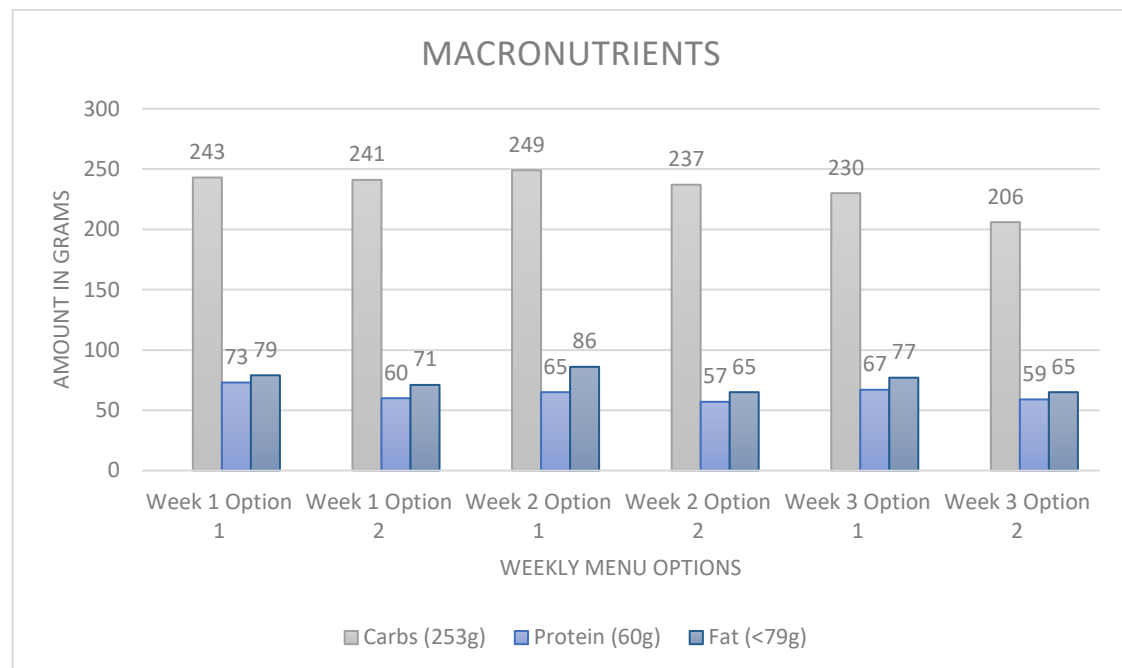
Note. A trend of carbohydrates surpassing all other macronutrients but not meeting the 253 grams target. The protein trend is more consistent meeting or surpassing the 60 grams target in most weekly menu options. Fat surpasses the target of <79 grams on one occasion.

Figure 15: Select micronutrient amounts relative to option one of the weekly menu in Care Home 2.
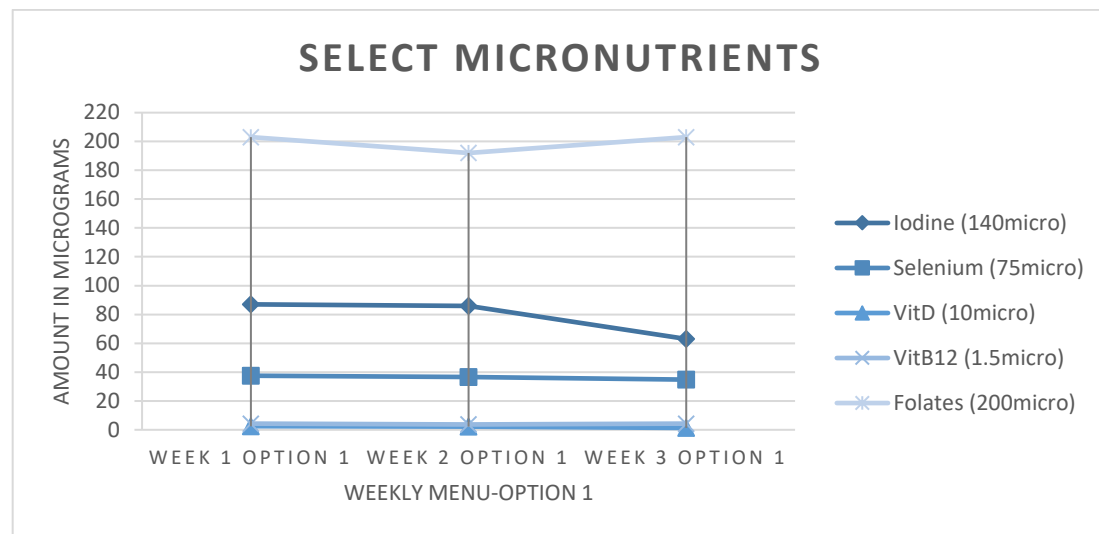
Note. Folates fail to meet target for week 2 only. Iodine though below target decrease in week 3. Vitamin B12 above target throughout. Selenium and Vitamin D are more consistent but do not meet target.

Figure 16: Select micronutrient amounts relative to option two of the weekly menu in Care Home 2.
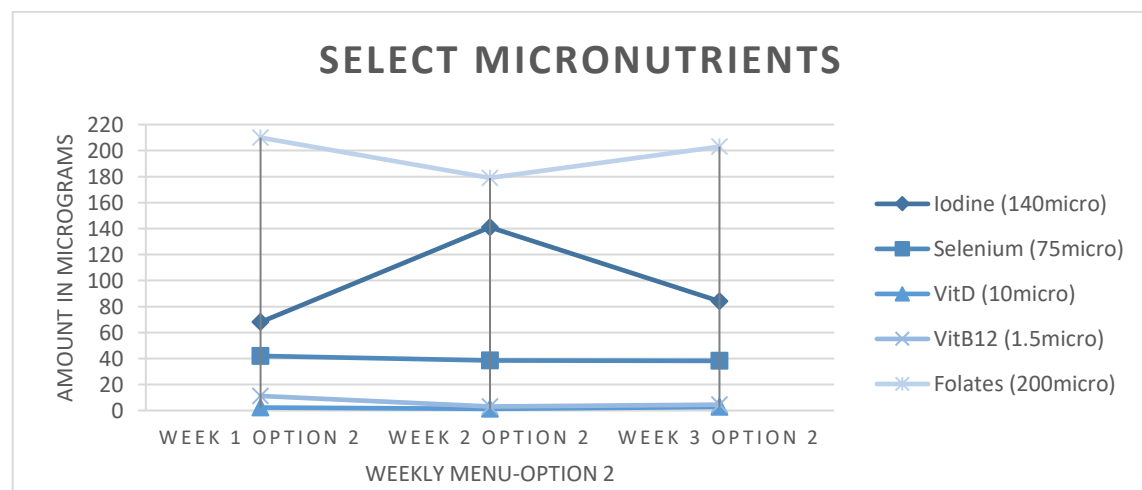
Note. Iodine increase during week 2, meeting target then decreasing sharply in week 3. Folates present an inverse trend, decreasing in week 2 and then increasing once more. Vitamin B12 also decreases in week 2 but still meets target. All other micronutrients relatively constant.

Figures 14, 15 and 16 reflect an observed trend in care home 2 where, all nutrients with the exception of vitamin D were above the general average highlighting greater nutrient offerings in relation to other care homes. Regarding macros, protein on average met the recommended target with fat doing similarly only surpassing the target <79 on one occasion. Carbohydrates consistently surpassed the 150 grams mark though failing (as in other care homes) to meet the recommended target. However, carbohydrates on average were not greatly below the recommended target. The absence of snacks being examined should be noted. Similarly, all micronutrients in graphs 15 and 16 above, with the exception of vitamin B12, failed to meet the recommended target with Folates below the target only in week 2. Week 2 was also the most inconsistent with iodine increasing for option 2 and then decreasing for both options in week 3. Vitamin B12 also presented a decrease from week 1 to week 2 in option 2.

5.2.3.3: Care Home 3

Results highlighting the mean daily intake of select nutrients are presented below. Intake is relative to the two meal categories, namely option 1 and option 2 per the week menu. Free sugars, fibre, calcium, iron and vitamin C are given as average daily intakes.

Figure 17: Energy amounts per each weekly menu option in Care Home 3.
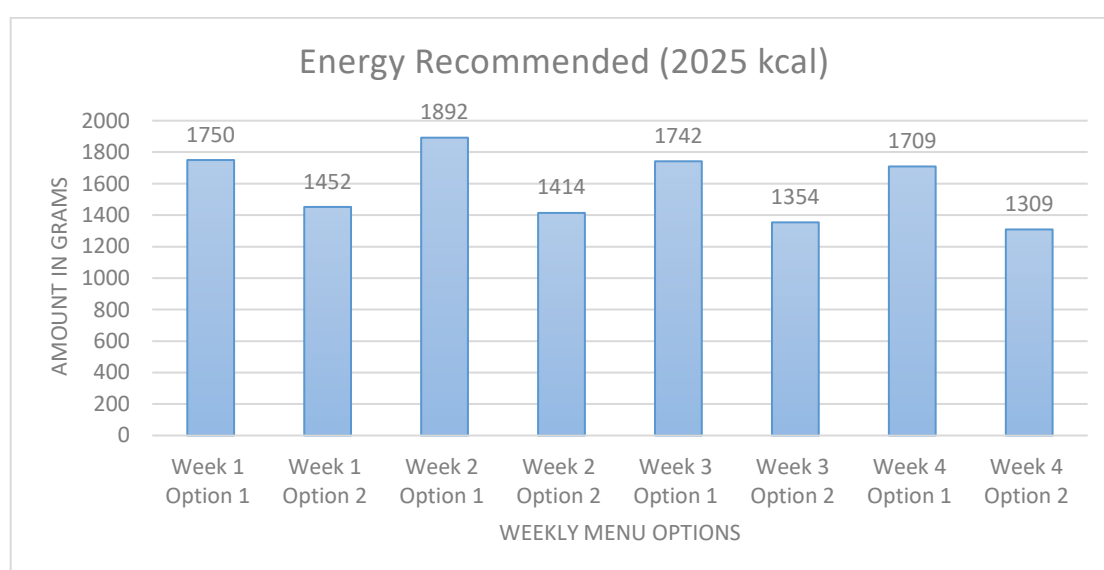
Note. All options failed to meet the recommended target with all option twos consistently lower in energy offering.

Figure 17 highlights weekly energy offering consistently below the recommended target of 2025kcal. Notably all second options presented a trend of lower energy offering never reaching 1500 kcal whilst the first options were consistently above 1700kcal. The disparity in energy offerings is examined in Chapter 6. An average weekly energy intake was calculated as 1577.75 kcal (SD 219.59). This amount was the second lowest of the four care homes and did not meet the general daily average offerings of 1593.8 kcal as presented in table 19.

**Table 19: Average daily offerings for select nutrients in Care Home 3.**

Nutrients Analysed (recommended target)	Daily Mean in Care Home 3 (SD)	Daily Mean in All Care Homes (SD)
Free Sugars (<25.3g)	63 g (2.45) 🔴	64.07 g (4.63) 🔴
Fibre (30g)	12.26 g (1.66) 🔴	14.50 g (2.32) 🔴
Calcium (700mg)	736.65 mg (57.78) 🟢	659.50 mg (79.02) 🟡
Iron (8.7 mg)	7.61 mg (0.99) 🟡	7.73 mg (0.84) 🟡
Vitamin C (40mg)	38.84 mg (12.56) 🟡	55.76 mg (16.07) 🟢

Note. Nutrient above lower limit not target recommendation= 🟡 ; Nutrient meets or is above the target recommendation= 🟢; Nutrient is below or does not meet the target recommendation= 🔴. Calcium amounts in care home 3 surpassed recommended target.

The nutrients analysed in table 19 present lower nutrient daily offerings in care home 3 when compared to the recommended targets and the general daily averages for all care homes with some exceptions. Of note is the daily average fibre offerings which is over 16 grams lower than what is recommended. This amount was the lowest in all four care facilities. On the other hand, free sugar amounts presented the second lowest value of all care homes, though still well above what is targeted of <25.3 grams. Vitamin C and iron were slightly below the targets with calcium surpassing both general daily average and target amounts representing the highest calcium offering in all homes.

Figure 18: Macronutrient amounts relative to each weekly menu option in Care Home 3.
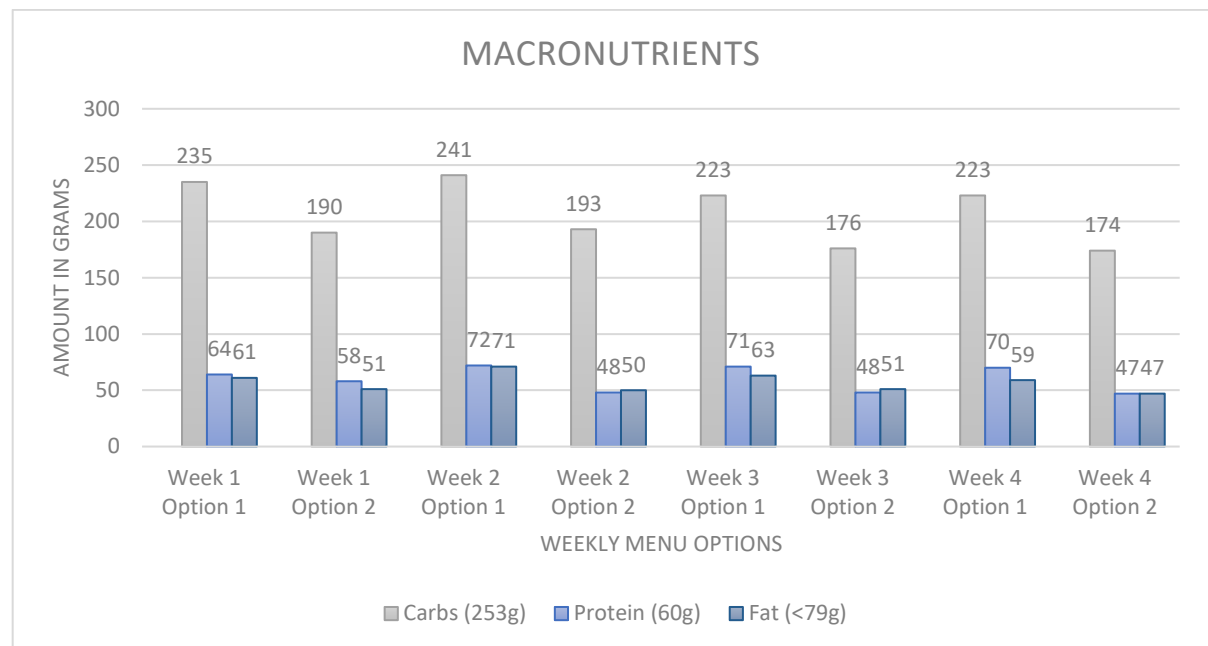
Note. A trend in carbohydrates consistently above other macronutrients though never reaching the target. Protein meets and surpasses the target only for the first options. Fat consistently meets target regardless of option.

Figure 19: Select micronutrient amounts relative to option one of the weekly menu in Care Home 3.
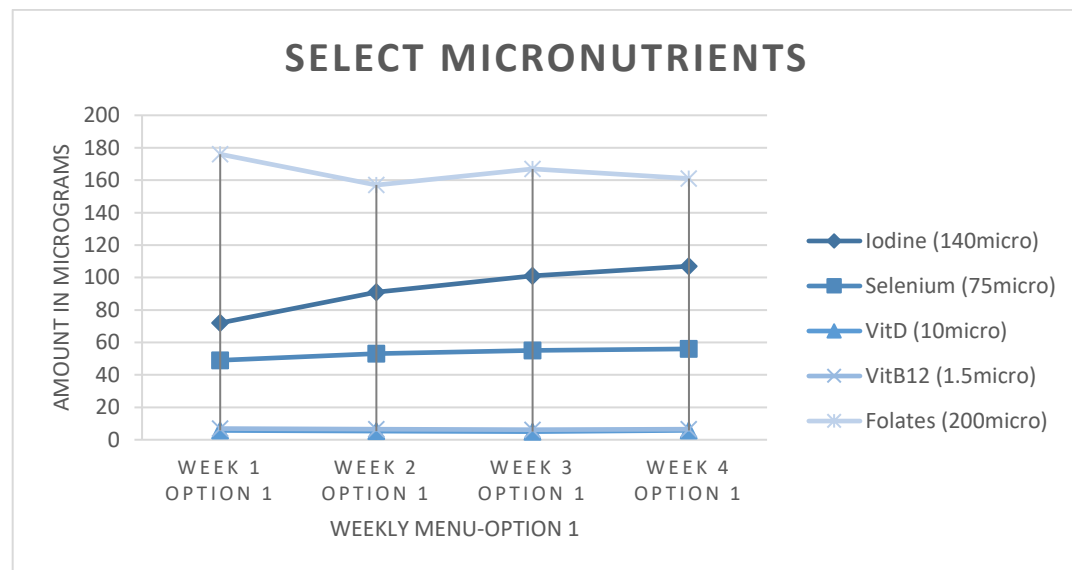
Note. A weekly increase for iodine can be observed while folates fluctuate below target weekly. All other micronutrients are relatively consistent with a slight increase for selenium from week 2.

Figure 20: Select micronutrient amounts relative to option two of the weekly menu in Care Home 3.
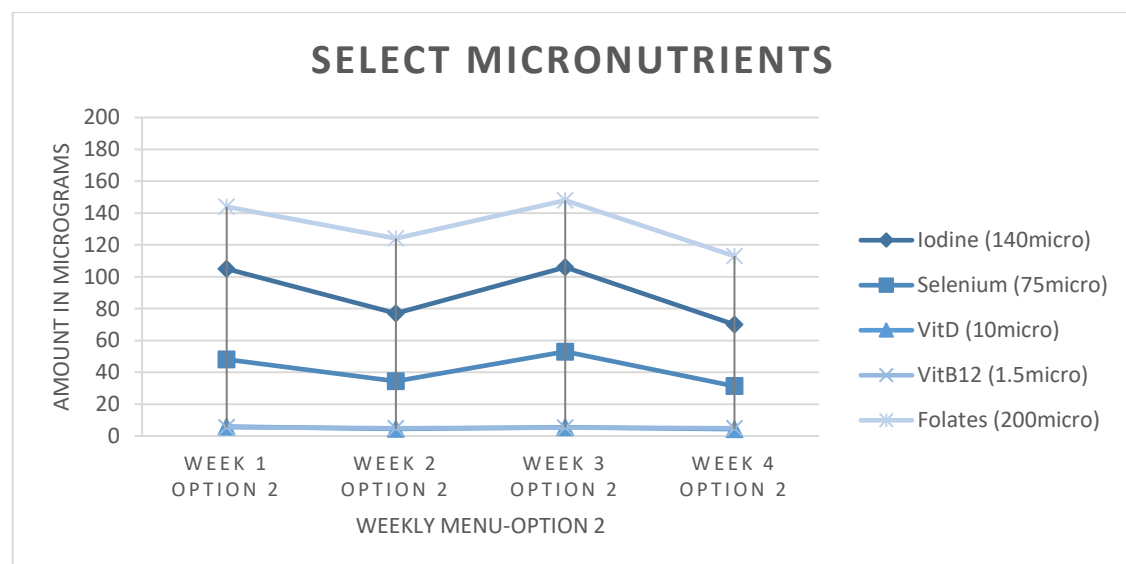
Note. Greater fluctuations in micronutrient amounts when compared to option 1 (Figure 19). While both vitamins remain relatively constant, all other micronutrients follow a similar trend of decreasing, increasing and then decreasing once more.

Regarding the macronutrients examined, graph 18 shows carbohydrate offerings consistently below the recommended target though not greatly (with a calculated average of 206.86 grams). Protein presented fluctuating amounts, surpassing the 60 grams target on four occasions. On average, the weekly protein amount was calculated at 59.75 grams. Fat however consistently meet the target amount with an average of 56.63 grams. All macronutrient amounts analysed were below the general averages for all care homes.

When micronutrients were examined, as illustrated in graphs 19 and 20, Iodine (average of 91.13 micro for both options), Selenium (average of 47.46 micro for both options) and Folates (148.75 micro for both options) were all below the targets recommended. Contrasted with the general averages for all care homes, Iodine and Selenium amounts were greater in care home 3 with folates still below the general average. Both options presented some fluctuations each week with the second options presenting greater fluctuations for iodine, selenium and folates. Differences in the nutrient offerings of options are discussed in Chapter 6.

5.2.3.4: Care Home 4

Results highlighting the average daily intake of select nutrients are presented below. Intake is relative to two daily categories, namely option 1 and option 2 per the week menu. Free sugars, Fibre, Calcium, Iron and vitamin C are given as average daily intakes.

Figure 21: Energy amounts per each weekly menu option in Care Home 4
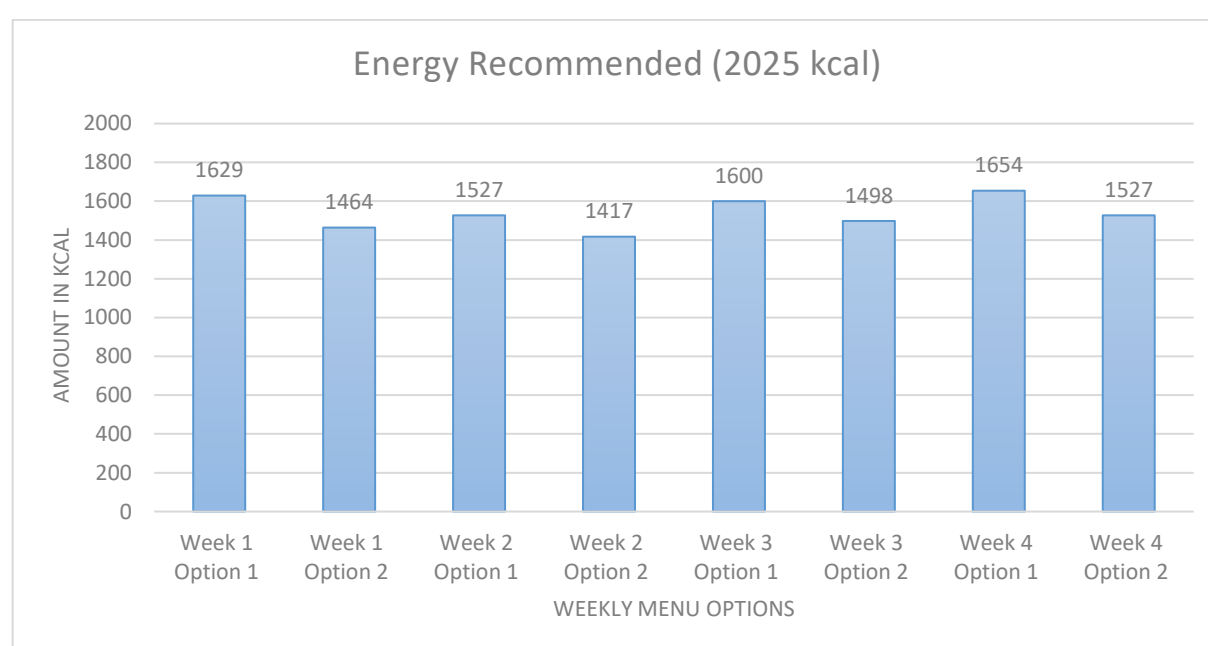
Note. All options failed to meet the recommended target with all option twos consistently lower in energy offering. This trended also exhibited in care home 3.

From the graph above it can be observed that most weekly options offered more than 1400 kcal to residents. The average weekly energy amount was calculated at 1539.50 kcal (SD 82.39). This amount was just below the general study average and as in all other care homes, did not meet the 2025 kcal daily target. Care home four presented the second lowest daily energy amount average of all four homes. Similar to care home 3, energy amounts differed when menu options were compared with option two presenting lower energy amounts than option one.

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Table 20: Daily mean offerings for select nutrients in Care Home 4.

Nutrients Analysed (recommended target)	Daily Mean in Care Home 4 (SD)	Daily Mean in All Care Homes (SD)
Free Sugars (<25.3g)	60.63 g (2.97) 🔴	64.07 g (4.63) 🔴
Fibre (30g)	15.44 g (1.25) 🔴	14.50 g (2.32) 🔴
Calcium (700mg)	589.88 mg (48.83) 🟡	659.50 mg (79.02) 🟡
Iron (8.7 mg)	8.11 mg (0.55) 🟡	7.73 mg (0.84) 🟡
Vitamin C (40mg)	54.58 mg (5.78) 🟢	55.76 mg (16.07) 🟢

Note. Nutrient above lower limit not target recommendation= 🟡 ; Nutrient meets or is above the target recommendation= 🟢; Nutrient is below or does not meet the target recommendation= 🔴. Nutrients expressed above present similar findings in care home two and most care homes in relation to the recommended targets.

Table 20 of selected nutrients analysed, illustrates sufficient amounts of vitamin C offered by meals in care home 4 with that quantity surpassing the recommended target and just slightly below the general average for all care homes. Free sugars amounts were well above the target recommended but the lowest in all care homes. Of note was the fibre daily average which though below the target, was slightly above the general average of 14.50 grams. Iron amounts were also above the general average and almost on par with the recommendations. On the other hand, the average calcium amount offered by meals was the lowest for all care homes, not meeting the recommended target.

Figure 22: Macronutrient amounts relative to each weekly menu option in Care Home 4.
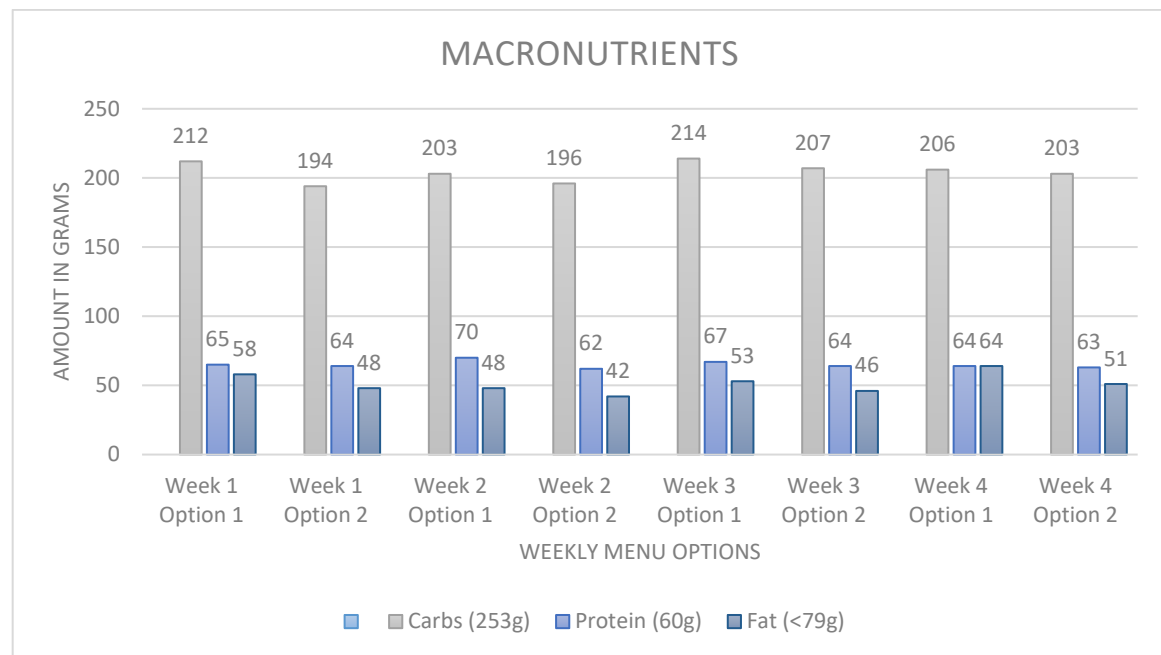
Note. Carbohydrates presented the largest amounts among the macronutrients, consistently trending above 200 grams for the first weekly options and slightly lower for option two. Protein was consistently above regardless of option. Fat was also consistent in meeting the recommended target throughout.

Figure 23: Select micronutrient amounts relative to option one of the weekly menu in Care Home 4.
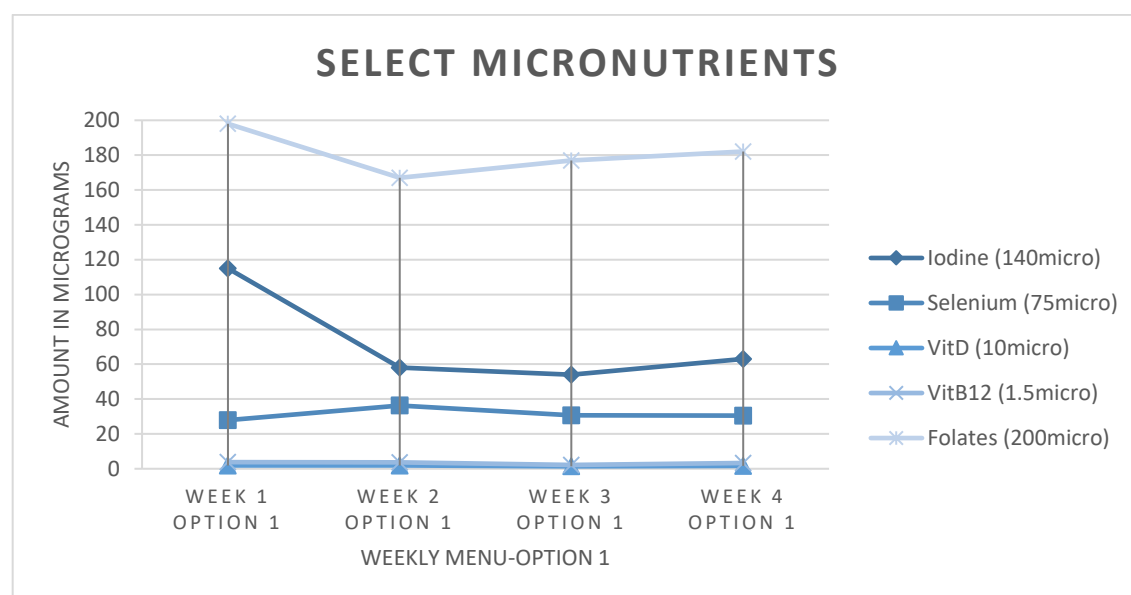
Note. Folates decrease in week 2 then begins to increase in the following weeks. Iodine also decrease but slightly rises by week 4. Selenium increases at week 2 then stabilises in the following weeks. Other micronutrients remain consistent each week.

Figure 24: Select micronutrient amounts relative to option two of the weekly menu in Care Home 4.
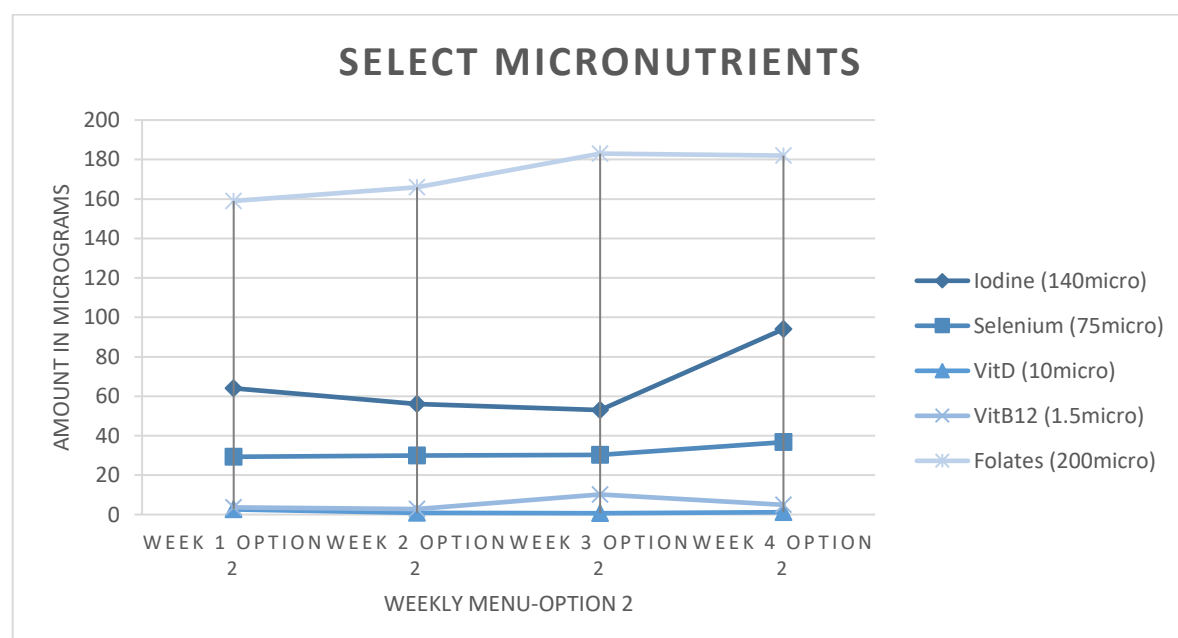
Note. Unlike option 1, folates consistently trend upwards each week before decreasing in the final week. Vitamin B12 also follows a similar trend. Iodine on the other hand decreases each week then trends upwards in week four. Selenium is slightly constant but then also trends upwards in week four. Vitamin D remains consistent.

The calculated averages for protein (64.88 g) and Fat (51.25 g) met the recommended targets (with protein surpassing this amount), the average carbohydrates offering (calculated at 204.38 g) was below the target of 253 grams and the general average of 210.07 grams (Figure 22). Care home four presented macronutrient results only better than care home one. Regarding micronutrients (Figure 23 and 24), both iodine and selenium amounts were lower than the general averages and target. Vitamin D amounts as in all other care homes was low with a 1.54-microgram daily average. This corresponded to the lowest vitamin D amounts when all care homes were considered. Folates also did not meet the target but were above the general average of 170.30 micrograms. On the other hand, Vitamin B12 amounts (4.35 micrograms) were well above the recommended amount and just below the general average of 4.84 micrograms. This vitamin D trend was common throughout all care homes. When the options are analysed, week four appears to offer the greater amount of micronutrients regardless of the option (see figure 23 and 24).

5.3: Glycaemic Load Findings

Glycaemic load and glycaemic index calculations were too voluminous to be placed in the findings chapter, thus, examples of calculations can be seen in the Appendix 6. The care homes presented common breakfast options. The combination of foods used were the combinations most likely and observed by the researcher and in no way is an exhaustive list of all possible food combinations but rather the most frequently consumed. Regarding drinks, orange juice was used as it had the highest GI and was the most common drink consumed after tea and coffee, which both add nothing to the glycaemic load value.

In care home two, a three-week menu rotation was followed. Breakfast options and combos as previously expressed are the same as in care home one however, a marked breakfast combo is mentioned (Full English Breakfast). Elements of the Alternative menu which have GI and GL values of 0 (cheese omelette for example) were not mentioned. The glycaemic analyse for this care home give lunch combinations for both meal options along with options for both dessert choices with and without orange juice (expressed in examples placed in Appendix 6). Supper options are given for dessert option one and a dessert option two (ice cream). Other dessert options were similar in GI and GL content and thus not mentioned. Though some analysed meals presented in the appendix may show very low or high GI and GL, it must be reinforced that the target meals used would have been the combinations eaten by all participants bearing in mind the highest and lowest GL.

Analyse of care home three were carried out on the four week menu cycle. With the exception of a breakfast special, breakfast options were the same as in other care homes. This special was specific to a day of the week. There was no alternative menu in care home three.

The alternative or second option for lunch was always assorted sandwiches. Supper was analysed looking at both meal options in addition to the two dessert options on offer.

Analyse of meals were done with and without orange juice as a drink option. Orange juice, like in the other care homes was the most popular drink and presented the highest GI of all drink options.

In care home four, there was no special breakfast options nor alternative meals forming part of the four-week menu. Lunch was analysed examining both meal options as well as dessert options, with and without orange juice as a drink choice. Where a meal offered the option of two potato based foods (example roast potatoes or mashed potato, oven chips or boiled potatoes) the food with the higher GI was used in the analysis. This option also proved to be the most commonly consumed by residents. Additionally in some instances, the menu offers choices between a potato-based food or rice (example vegetable rice or sauté potatoes). These choices had a tendency to correspond to one of the lunch meal options and were analysed thus. Meal offerings for supper did not include dessert options.

Please refer to the Appendix for an example of a menu used (appendix 10), sample images of foods (appendix 4) and a list of foods substituted during analysis (appendix 11).

5.3.1: Target Meals selected from Menu GL analysis

From the glycaemic characteristics of the meals offered at each care home highlighted previously, the target meals (highest and lowest glycaemic load meals) were then selected for each institution. It must be noted that some combinations of food options may present higher or lower GLs than the foods selected. This is because there were a variety of meal options that were not eaten by residents on a particular day participating in the study.

5.3.1.1: Care Home 1

Highest Glycaemic Load Target Meal**:** Lunch meal served on Monday of Week 4. Mild chili con carne served with braised rice, sides included mashed potatoes, courgettes and mixed vegetables, dessert was treacle tart served with custard. Meal was analysed with a standard cup of orange juice as the drink of choice. **<u>GL= 71.37 and GI=66.08</u>**.

Lowest Glycaemic Load Target Meal: Super meal served on Wednesday of Week 2. Scotch broth appetiser, Kippers and poached egg and dessert was trifle. Meal analysed with a standard cup of orange juice. **<u>GL= 16.15 and GI=48.48.</u>**

5.3.1.2: Care Home 2

Highest Glycaemic Load Target Meal: Lunch meal served on Wednesday of Week 3. Starter of asparagus risotto, main course of roast turkey, red pepper and tomato pasta, roast potatoes, roast parsnips and sprouts with bacon. Dessert was lemon meringue pie. Meal analysed with a standard cup of orange juice. **<u>GL=89.31 and GI=68.18</u>**.

Lowest Glycaemic Load Target Meal: Supper meal served on Wednesday of Week 2. Soup of the day (vegetable soup), cheddar and onion quiche with coleslaw. Dessert of plum and almond sponge. Meal analysed with a standard cup of orange juice. **<u>GL= 28.86 and GI 48.92</u>**.

5.3.1.3: Care Home 3

Highest Glycaemic Load Target Meal: Supper meal served on Monday of Week 2. Chicken and sweet potato hotpot, served with rice, potatoes, sweetcorn and garden peas. Dessert was Rhubarb crumble with custard. Analysis was done including in a standard cup of orange juice. **GL= 94.54 and GI=65.2**.

Lowest Glycaemic Load Target Meal: Supper meal served on Tuesday of Week 1. Sausages and Onions, creamed potatoes, cabbage and carrots. Dessert was a pot of yoghurt. Analysed with a standard cup of orange juice. **GL=12.05 and GI= 38.9**.

5.3.1.4: Care Home 4

Highest Glycaemic Load Target Meal: Lunch meal served on Tuesday of Week 1. It included a main course of steak pie with flaky pastry top, croquette potatoes, cut green beans and mashed root vegetables. Dessert was clotted cream rice pudding. Analysed with a standard cup of orange juice. **GL=79.01 and GI=61.73.**

Lowest Glycaemic Load Target Meal: Supper meal served on Friday of Week 4. It included a soup entrée of carrot and coriander soup and a main course of braised steak and mushrooms served with West Country cheddar mash. Meal analysed with a standard cup of orange juice. **GL=16.80 and GI 56.**

Average GL and GI of highest GL target meals: **GL=83.56 and GI=65.29**

Average GL and GI of lowest GL target meals: **GL=18.47 and GI=48.08**

The HGL meals selected presented similarities in food components. These meals were observed to present high starch foods such as potatoes, rice and/or high-added sugar foods specifically desserts. On the other hand, the LGL meals generally presented the opposite characteristics with component foods being high in protein, fruits/vegetables or dairy. Table 21 below highlights the components of the HGL meals that contributed the most to the target meals' high glycaemic load characteristics whilst Table 22 that follows, presents those food components of the LGL target meals that contributed most to the low glycaemic characteristics of said meals.

Table 21: Glycaemic characteristics of select foods of the target HGL meals.

Food item	GL	GI
Asparagus Risotto	44	69
Clotted Cream Rice Pudding	38.2	59
Rhubarb Crumble	24.4	63
Lemon Meringue	24.3	63
Treacle Tart	23	63
Croquette Potatoes	21.8	85
Braised Rice	18.9	75
Roast Potatoes	12.1	90
Steak Pie with flaky pastry top	11.8	45

Note. Food items are presented based on their respective glycaemic load in decreasing order.

Table 22: Glycaemic characteristics of foods of the target LGL meals.

Food Item	GL	GI
Vegetable Soup	4.3	60
Scotch Broth	2.4	45
Yoghurt	1.9	20
Coleslaw	1.6	45
Sausage	1.5	28
Fried onions	1.2	45
Kippers	0	0
Mushrooms	0	0
Poached Eggs	0	0
Braised Steaks	0	0

Note. Food items are presented based on their respective glycaemic load in decreasing order.

The glycaemic calculations of the meals (glycaemic index and glycaemic load) for care home three are mentioned in the series of tables from 23 to 47 that follow. This includes calculations for the various meal combinations analysed for breakfast, lunch and dinner. Additional calculations for all other care homes are presented in Appendix 6.

Table 23: Daily Breakfast Specials with orange juice

		Daily Breakfast Specials with orange juice						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic value	**index**	53	66.82	59.74	53	64.12	65.2	53
Glycaemic value	**load**	7.5	26.05	16.12	7.5	21.16	24.77	7.5

Table 24: Main Lunch Meal Option 1 with orange juice- Week 1

		Main Lunch Meal with orange juice for each day of week one						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic value	**index**	64.69	48.06	58.75	63.64	61.62	58.04	43.77
Glycaemic value	**load**	49.81	27.87	18.8	54.09	35.12	28.43	13.13

Table 25: Main Lunch Meal Option1 with orange juice- Week 2

	Main Lunch Meal with orange juice for each day of week two						
	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value	64.43	47.78	59.65	66.4	67.54	50.11	61.62
Glycaemic load value	52.18	35.35	43.45	53.12	31.06	23.05	27.72

Table 26: Main Lunch Meal Option 1 with orange juice- Week 3

		Main Lunch Meal with orange juice for each day of week three						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic value	**index**	45.8	69.62	47.4	48.02	59.96	57.65	49.95
Glycaemic value	**load**	30.22	41.77	18.96	22.08	26.38	28.24	20.47

Table 27: Main Lunch Meal Option 1 with orange juice- Week 4

		Main Lunch Meal with orange juice for each day of week four						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		61.65	46.11	62.97	62.41	65.03	54.41	49.74
Glycaemic load value		39.45	16.59	51	39.31	46.82	16.86	25.86

Table 28: Main Lunch Meal Option 2 with orange juice- Week 1

		Main Lunch Meal with orange juice for each day of week one						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		75.74	59.42	64.83	64.32	65.24	59.96	60.5
Glycaemic load value		46.95	40.4	38.89	51.45	30.66	32.97	32.06

Table 29: Main Lunch Meal Option 2 with orange juice- Week 2

		Main Lunch Meal with orange juice for each day of week two						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		63.24	53.29	59.18	63.08	69.71	59.58	64.44
Glycaemic load value		38.57	37.83	44.97	38.47	46	29.79	47.68

Table 30: Main Lunch Meal Option 2 with orange juice- Week 3

		Main Lunch Meal with orange juice for each day of week three						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		64.87	73.89	52.12	64.83	64.73	56.89	64.73
Glycaemic load value		36.32	56.15	31.27	37.6	39.48	27.87	39.48

Table 31: Main Lunch Meal Option 2 with orange juice- Week 4

		Main Lunch Meal with orange juice for each day of week four						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		59.47	60.35	58.72	62.5	75.74	61.38	61.87
Glycaemic load value		33.3	29.57	35.81	33.12	46.95	30.07	35.26

Table 32: Main Supper Option 1 with dessert 1 and orange juice (OJ)-Week 1

		Main Supper with dessert 1 and OJ for each day of week one						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		63.5	45.64	54.48	61.84	57.02	60.05	62.49
Glycaemic load value		52.07	32.4	43.58	71.11	66.71	49.84	50.61

Table 33: Main Supper Option 1 with dessert 2 and orange juice (OJ)-Week 1

		Main Supper with dessert 2 and OJ for each day of week one						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		60.84	38.9	54.16	64.67	62.22	64.76	56.55
Glycaemic load value		43.8	12.05	40.62	28.45	47.9	47.92	32.79

Table 34: Main Supper Option 1 with dessert 1 and orange juice (OJ)-Week 2

		Main Supper with dessert 1 and OJ for each day of week two						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		65.2	55.66	54.13	64.05	59.25	63.28	53.1
Glycaemic load value		94.54	53.43	52.5	43.55	55.69	51.25	41.94

Table 35: Main Supper Option 1 with dessert 2 and orange juice (OJ)-Week 2

		Main Supper with dessert 2 and OJ for each day of week two						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		64.5	59.33	65.12	61.94	66.04	61.5	60.74
Glycaemic load value		78.69	35.59	52.74	39.02	46.88	43.05	23.08

Table 36: Main Supper Option 1 with dessert 1 and orange juice (OJ)-Week 3

		Main Supper with dessert 1 and OJ for each day of week three						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		59.63	56.92	59.56	66.41	59.4	51.93	61.25
Glycaemic load value		41.94	40.41	61.56	39.18	58.8	36.35	28.17

Table 37: Main Supper Option 1 with dessert 2 and orange juice (OJ)-Week 3

		Main Supper with dessert 2 and OJ for each day of week three						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		59.41	58.78	55.69	59.06	66.04	59.33	65.01
Glycaemic load value		42.18	37.61	40.65	27.75	46.88	39.15	34.45

Table 38: Main Supper Option 1 with dessert 1 and orange juice (OJ)-Week 4

		Main Supper with dessert 1 and OJ for each day of week four						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		62.15	55.57	58.14	55.78	53.71	55.9	55.93
Glycaemic load value		57.17	35	58.14	66.37	38.13	42.48	30.76

Table 39: Main Supper Option 1 with dessert 2 and orange juice (OJ)-Week 4

		Main Supper with dessert 2 and OJ for each day of week four						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		62.89	57.44	55.3	60.66	54.9	48.8	57.82
Glycaemic load value		35.84	35.61	38.71	43.67	37.88	20.98	22.54

Table 40: Main Supper Option 2 with dessert 1 and orange juice (OJ)-Week 1

		Main Supper with dessert 1 and OJ for each day of week one						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		47.13	47.95	51.38	60.75	50.59	57.09	63.94
Glycaemic load value		40.06	35	24.66	71.68	36.93	44.53	51.79

Table 41: Main Supper Option 2 with dessert 2 and orange juice (OJ)-Week 1

		Main Supper with dessert 2 and OJ for each day of week one						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value		42.23	43.84	50.43	61.91	54.04	61.96	58.29
Glycaemic load value		31.67	14.46	21.68	29.71	17.83	42.75	32.64

Table 42: Main Supper Option 2 with dessert 1 and orange juice (OJ)-Week 2

		Main Supper with dessert 1 and OJ for each day of week two						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic	**index**	58.87	57.19	47.5	62.54	52.54	62.77	46.77
value								
Glycaemic	**load**	51.8	45.18	24.22	46.9	34.15	45.82	33.67
value								

Table 43: Main Supper Option 2 with dessert 2 and orange juice (OJ)-Week 2

		Main Supper with dessert 2 and OJ for each day of week two						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic	**index**	55.45	63.72	50.9	60.53	62.8	54.57	48.51
value								
Glycaemic	**load**	36.04	27.39	17.81	42.37	26.37	33.83	15.03
value								

Table 44: Main Supper Option 2 with dessert 1 and orange juice (OJ)-Week 3

		Main Supper with dessert 1 and OJ for each day of week three						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic	**index**	59.91	55.66	57.16	61.87	47.32	49.24	56.76
value								
Glycaemic	**load**	84.47	37.29	33.15	34.64	23.18	23.63	36.32
value								

Table 45: Main Supper Option 2 with dessert 2 and orange juice (OJ)-Week 3

		Main Supper with dessert 2 and OJ for each day of week three						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic	**index**	59.9	57.48	43.5	52.63	55.66	44.69	59.85
value								
Glycaemic	**load**	42.52	35.06	11.74	23.15	11.68	19.66	42.49
value								

Table 46: Main Supper Option 2 with dessert 1 and orange juice (OJ)-Week 4

		Main Supper with dessert 1 and OJ for each day of week four						
		Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic	**index**	42.15	60.69	57.78	46.45	51.5	57.1	52.78
value								
Glycaemic	**load**	23.6	60.69	36.97	42.73	11.84	34.83	27.44
value								

Table 47: Main Supper Option 2 with dessert 2 and orange juice (OJ)-Week 4

	Main Supper with dessert 2 and OJ for each day of week four						
	Mon	Tue	Wed	Thurs	Fri	Sat	Sun
Glycaemic index value	53.61	61.78	51.74	45.04	55.66	46.74	53.45
Glycaemic load value	13.4	61.16	17.59	20.26	11.68	13.08	19.24

5.4: Nutrient Density Findings

The nutrient profile of all foods can be seen in Appendix 7A. Additionally, the nutrient profile for all meals with OJ (orange juice) as a reference drink are also given in Appendix 7B. A lower nutrient profile number means a food or meal is more nutrient dense ("healthier"). The nutrient profiles for the 522 meals examined range from -36 to 64. Figure 25 below illustrates a simple linear regression between the nutrient profile of a meal (in effect its nutrient density) and its glycaemic load. It shows that an increase in the value of nutrient density (X) also leads to an increase in GL (Y). An analysis of this relationship found R^ value of 0.012037 (significance f= 0.012133) and *P*<.001.

Figure 25: The relationship between Nutrient Density (X) and GL (Y)
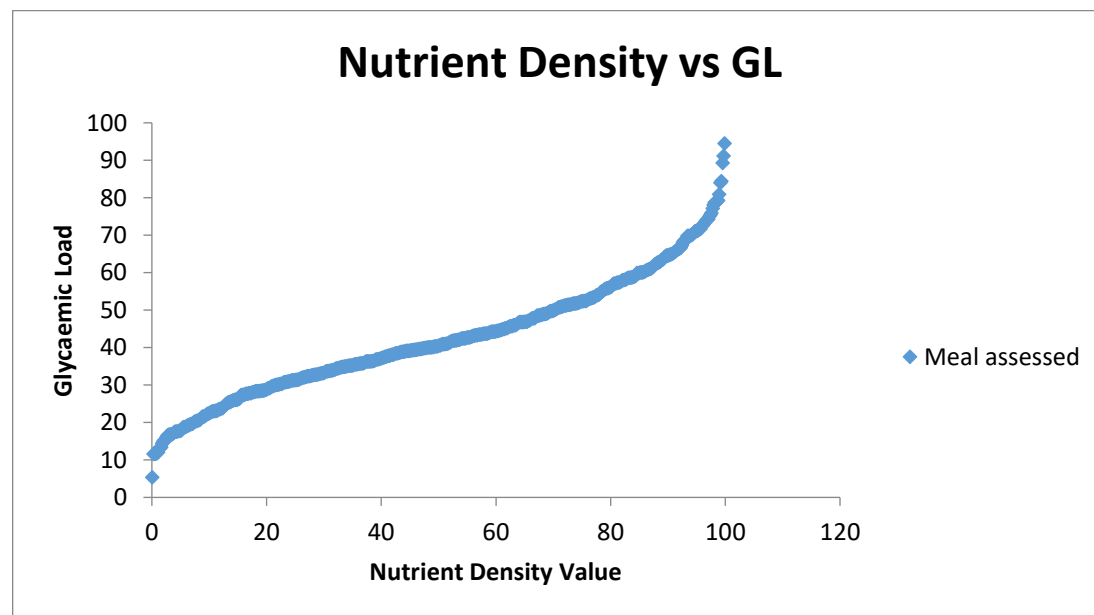
Figure 25 indicates a linearly increasing relationship between the glycaemic load (Y-axis) of a meal and its nutrient density value (X-axis). When the value of Y increases, the value of X also increases. R^=0.012057 f=0.012133 and *P* value < .001.

5.5: Mood Survey Findings

5.5.1: Introduction

A total of 156 older adults consented and met the criteria to participate in the study. Of this number nine participants withdrew for various reasons (detailed in table 48), leaving a final total of 147 participants from four care homes in England. 72 of these persons (49%) did not suffer from dementia while the majority, 75 (51%) presented an Alzheimer's diagnosis. Fifteen (10%) participants were from Care Home 1, 54 (the majority of participants) from Care Home 2, Care Home 3 representing 35% (52 participants) and Care Home 4 contributing 26 participants or 18% of the total number of participants. A more specific breakdown of participants from each care home based on "dementia status" is given in Figure 26. Care Home 3 and 4 research sites contributed more participants with dementia when compared to those without whilst Care Home 1 and 2 presented the inverse.

Figure 26: Participants within each care home.
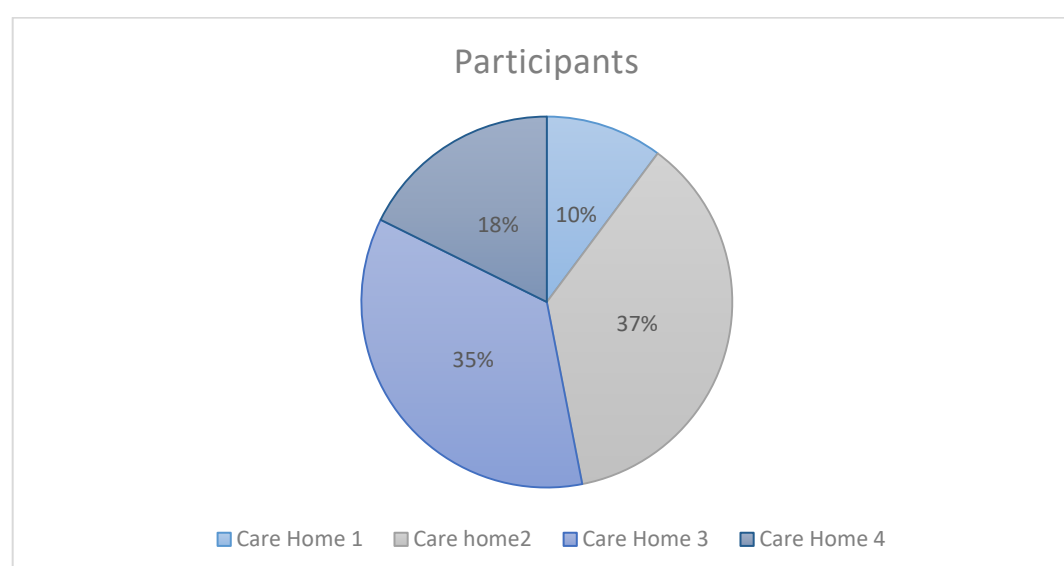
Note: Percentage distribution of study participants in each care home.

Table 48: Reasons for withdrawal

Participants with dementia (4)	Participants without dementia (5)
Health reason- hospital visit (1)	Asleep during 2nd survey (1)
Refusal to complete 2nd survey due to family issue (1)	Refusal to complete 2nd survey due to not being able to go out
Unwillingness during 2nd survey (2)	GP visit (1)
	No longer wanted to participate. No reason given (2)

Note. Nine participants withdrew from the study due to the reasons presented above.

Figure 27: Participants based on "dementia status"
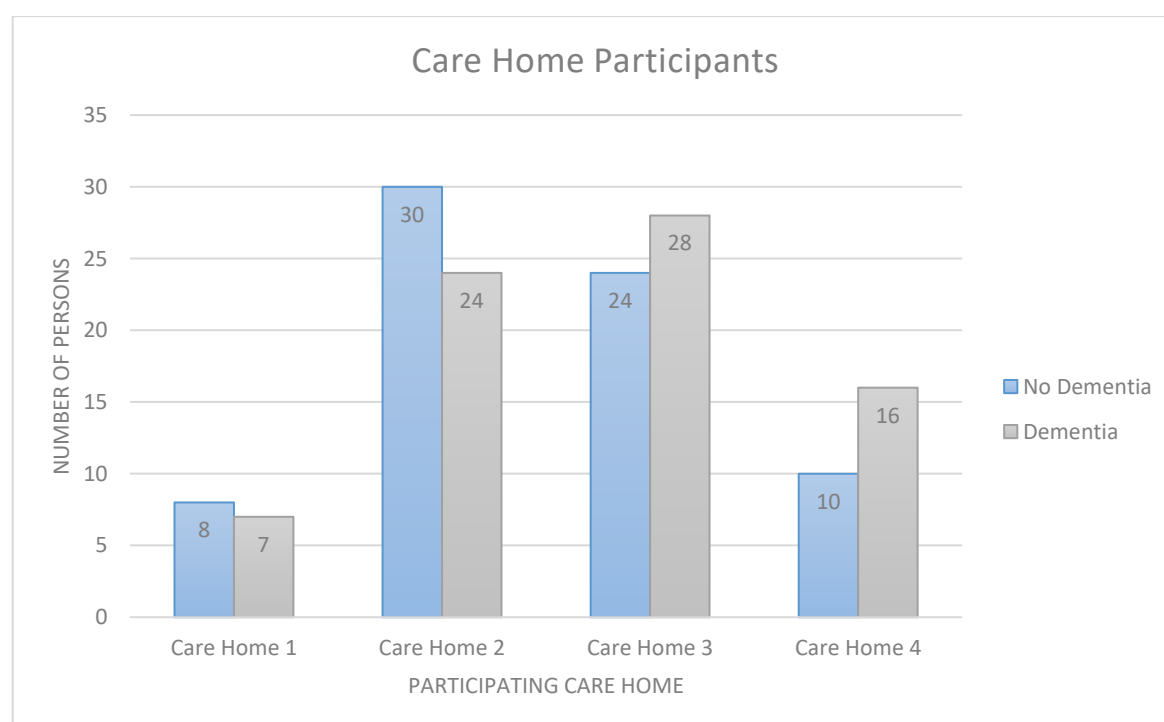
Note. Figure 27 illustrates the dementia status of all participating persons in each care home. Homes 1 and 2 present more participants without dementia whilst homes 3 and 4 present the opposite.

5.5.2: General Mood Survey Findings

The analysis of all results found the mean total mood score (TMS) for HGL meals was 17.39 with a total mood disturbance (TMD) of +4.21. On the other hand, the average TMS for LGL meals was 16.43 with a TMD of +0.67. A statistical difference of 3.54 between the TMD of both meal types (Difference in TMS was 0.96). A lower total mood disturbance for LGL meals implying better mood outcomes after LGL meal consumption. Table 49 illustrates the descriptive analysis examined as well the Cronbach's alpha test results for both HGL and LGL meal groups presented in relation to each mood sub-factor of the POMS. From table 25, it can be observed that the mean TMD values analysed for the sub-factors of Tension-Anxiety (1.47), Depression (1.82), Fatigue (2.76) and Anger-Hostility (0.94) were more pronounced for the HGL whilst only Vigour-Activity (7.88) presented a mean TMD value more pronounced for the LGL. Confusion-Bewilderment was similar for both meal types (HGL=3.81 and LGL=3.80).

When Cronbach's alpha was analysed, internal consistency was 0.63 for HGL meals and 0.60 for LGL meals. Regarding HGL meals, based on sub-factors, consistency was highest for Vigour –Activity at 0.74, followed by Depression and Anger-Hostility at 0.68 and 0.66 respectively. The Tension- Anxiety sub-factor had the lowest internal consistency at 0.52. Similarly, when internal consistency was examined for LGL meals, the Vigour- Activity subfactor was highest at 0.78 internal consistency (higher in comparison to HGL). This was followed by the subfactors for Confusion-Bewilderment and Depression at 0.67 and 0.64 respectively. Fatigue unlike what obtained for HGL meals was the sub-factor with the lowest internal consistency for LGLs at 0.41 in comparison with HGLs at 0.54 Tension-Anxiety. The results for each sub-factor for both meal types are illustrated in figure 28. Table 50 that follows, also details the results for each mood adjective in relation to the meal type.

Table 49: Descriptive statistics and Cronbach's alpha results for both meal types studied in relation to the different sub-factors of the POMS.

Sub-factor of the POMS	Mean HGL	SD HGL	Cronbach's Alpha HGL	Mean LGL	SD LGL	Cronbach's Alpha LGL
Tension-Anxiety	1.47	1.69	0.52	0.82	1.14	0.47
Vigour-Activity	6.59	3.53	0.74	7.88	3.80	0.78
Depression	1.82	2.21	0.68	1.41	1.89	0.64
Fatigue	2.76	2.21	0.54	1.92	1.49	0.41
Anger- Hostility	0.94	1.55	0.66	0.60	1.15	0.62
Confusion-Bewilderment	3.81	2.56	0.64	3.80	2.85	0.67

Note. The table demonstrates the contrast between the mean total mood disturbance values for both HGL and LGL meals in relation to the different sub-factors assessed. The standard deviation (SD) is presented to describe the variation with the data samples for each sub-factor. The table also contrasts between the internal consistencies (using Cronbach's alpha) of both meal types in relation to the analysed sub-factors. A greater mean and internal consistency is associated with the LGL meal and Vigour-Activity. With the exception of Confusion-Bewilderment, all other negative sub-factors present greater mean and internal consistency values for the HGL meal.

Figure 28: Comparison of HGL and LGL meal- mood results in relation to sub-factors in all research sites.
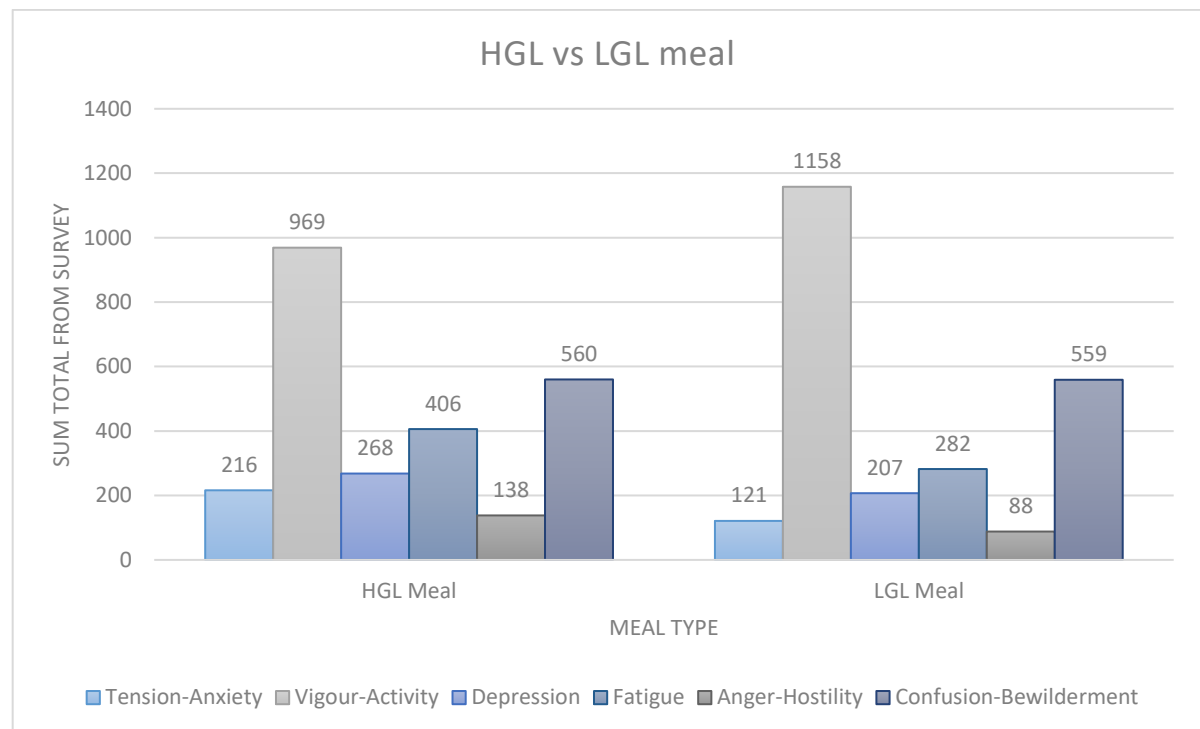
Note. The graph presents general ordinal data of all research sites in relation to both meal types examined and the six sub-factors. Excluding Confusion-Bewilderment which present almost equal values, all other negative sub-factors are higher in relation to the HGL meal. The positive sub-factor (Vigour-Activity) is higher in relation to the LGL meal.

Table 50: Mood adjectives in relation to the HGL and LGL in all research sites.

Mood Adjective	HGL- mood totals	LGL- mood totals
Tense	53	26
On edge	26	13
Uneasy	25	18
Restless	38	26
Nervous	25	13
Anxious	49	25
Lively	288	302
Active	132	157
Energetic	103	131
Cheerful	298	344
Full of Pep	114	170
Vigorous	34	54
Unhappy	50	48
Sad	65	30
Blue	36	22
Hopeless	40	40
Discourage	22	10
Miserable	15	17
Helpless	40	40
Worthless	0	0
Worn Out	108	90
Fatigued	84	60
Bushed	7	8
Exhausted	57	17
Weary	150	107
Angry	22	14
Peeved	9	5
Grouchy	50	29
Annoyed	46	32
Resentful	5	1
Bitter	6	6
Furious	0	1
Confused	148	137
Unable to concentrate	70	88
Bewildered	25	21
Forgetful	180	204
Uncertain about things	137	109

Note. Table 50 presents the general ordinal level data of all mood adjectives corresponding to the different sub-factors of the POMS in relation to the meal types examined.

5.5.2.1: General Findings- Dementia Status

When the results were examined to included dementia status, descriptive statistics and internal consistency differed between both meals and in comparison to those without dementia. Tables 51 and 52 present the findings of those with and without dementia in relation to the various sub-factors. It includes descriptive statistics and Cronbach's alpha test.

In the dementia group, the mean mood values of all negative sub-factors of Tension-Anxiety (1.48), Depression (1.79), Fatigue (2.88), Anger-Hostility (1.0) and Confusion (5.44) in relation to the HGL meal indicate descriptively an association when compared to the LGL results.

The mean mood value of the positive sub-factor of vigour-activity (7.41) presents descriptive evidence of an association between this sub-factor and the LGL in the dementia group (as presented in the tables 51 and 52). The non-dementia group on the other hand mirrored the general results with respect to descriptive statistics with the exceptions of vigour-activity and confusion- bewilderment. The mean mood value for Vigour-Activity (8.36) and Confusion- Bewilderment (2.42), descriptively suggest an association between these two sub-factors and the LGL meal in the non-dementia group. When both groups were compared descriptively (dementia versus non-dementia), for the HGL meal, Vigour-Activity (7.33) and Depression (1.86) were descriptively more associated with the non-dementia group. When the LGL meal was examined descriptively, the mean mood values for the sub-factors of Fatigue (2.07) and Confusion-Bewilderment (5.13) sub-factors were more associated with the dementia group with all others descriptively associated with the non-dementia group.

On the aspect internal consistency relative to dementia status, Cronbach's alpha was lower in the dementia group. This lower consistency could suggest an impact by this disease. (Rationale for this difference in consistency is discussed in Chapter 6). For the HGL, Cronbach's alpha was calculated at 0.52 in the dementia group and 0.65 in the non-dementia group. LGL presented an internal consistency score of 0.48 in the dementia group and 0.63 in the non-dementia group. The non-dementia group presented internal consistency similar to the general results. Noteworthy from tables 23 and 24 are the Cronbach's for the different sub-factors. In the dementia group, sub-factor internal consistency for confusion-bewilderment and vigour-activity in the LGL meal were 0.60 and 0.73 respectively. All other sub-factors for the HGL in this group presented a greater Cronbach's alpha.

The non-dementia group presented higher internal consistencies for the sub-factors of depression, fatigue and anger-bewilderment for the HGL meal whilst all other sub-factors were higher for the LGL meal. Internal consistencies for all sub-factors with the exception of fatigue, for the LGL and HGL meals were higher than the general results in this group.

Table 51: Descriptive statistics and Cronbach's alpha results for the HGL meal type studied in relation to the different sub-factors of the POMS instrument and dementia status.

Sub-factor of the POMS	Mean HGL D	SD HGL D	Cronbach's Alpha HGL D	Mean HGL No-D	SD HGL No-D	Cronbach's Alpha HGL No-D
Tension-Anxiety	1.48	1.60	0.47	1.46	1.77	0.58
Vigour-Activity	5.88	2.91	0.68	7.33	3.94	0.76
Depression	1.79	1.84	0.55	1.86	2.53	0.76
Fatigue	2.88	2.33	0.62	2.64	1.87	0.41
Anger- Hostility	1.0	1.29	0.44	0.88	1.79	0.78
Confusion-Bewilderment	5.44	1.95	0.37	2.11	1.93	0.62

Note. The table demonstrates the descriptive statistical findings of the mean mood values and standard deviation (SD) for HGL meals in relation to the different sub-factors assessed. These findings are contrasted based on dementia status (Dementia-D and Non- Dementia- No-D). The SD is presented to describe the variation with the data samples for each sub-factor. The table also contrasts between the internal consistencies (using Cronbach's alpha) of both groups in relation to the analysed sub-factors. With the exception of Fatigue, stronger internal consistency is exhibited in the Non-Dementia group.

Table 52: Descriptive statistics and Cronbach's alpha results for the LGL meal type studied in relation to the different sub-factors of the POMS instrument and dementia status.

Sub-factor of the POMS	Mean LGL D	SD LGL D	Cronbach's Alpha LGL D	Mean LGL No-D	SD LGL No-D	Cronbach's Alpha LGL No-D
Tension-Anxiety	0.73	0.96	0.27	0.92	1.36	0.60
Vigour-Activity	7.41	3.41	0.73	8.36	4.13	0.81
Depression	1.31	1.62	0.49	1.51	2.13	0.62
Fatigue	2.07	1.61	0.46	1.76	1.36	0.37
Anger- Hostility	0.36	0.71	0.30	0.85	1.47	0.70
Confusion- Bewilderment	5.13	2.62	0.60	2.42	2.37	0.67

Note. The table demonstrates the descriptive statistical findings of the mean mood values and standard deviation (SD) for LGL meals in relation to the different sub-factors assessed. These findings are contrasted based on dementia status (Dementia-D and Non- Dementia- No-D). The SD is presented to describe the variation with the data samples for each sub-factor. The table also contrasts between the internal consistencies (using Cronbach's alpha) of both groups in relation to the analysed sub-factors. With the exception of Fatigue, stronger internal consistency is exhibited in the Non-Dementia group.

Figure 29: Sub-factor comparisons for both meal types in those with dementia in all research sites.
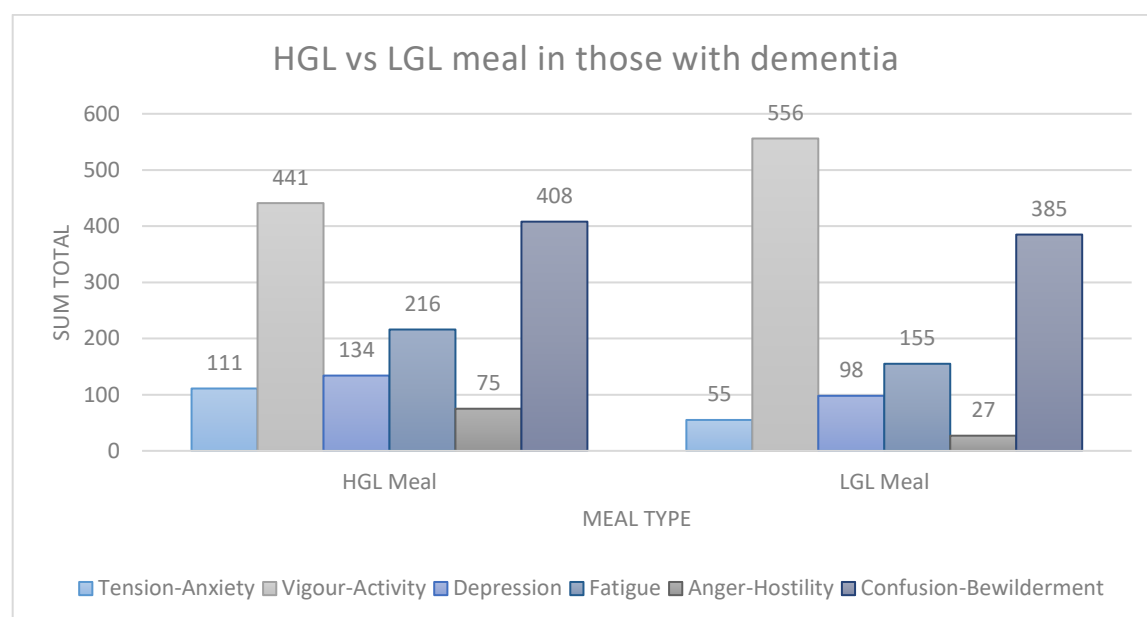
HGL vs LGL meal in those with dementia

Note. The graph presents general ordinal data of all research sites in relation to both meal types examined and the six sub-factors in those with dementia. The positive sub-factor of Vigour-Activity present a larger total in relation to the LGL meal. All other sub-factors are represented by larger totals in relation to the HGL meal.

Figure 30: Sub-factor comparisons for both meal types in those without dementia in all research sites.
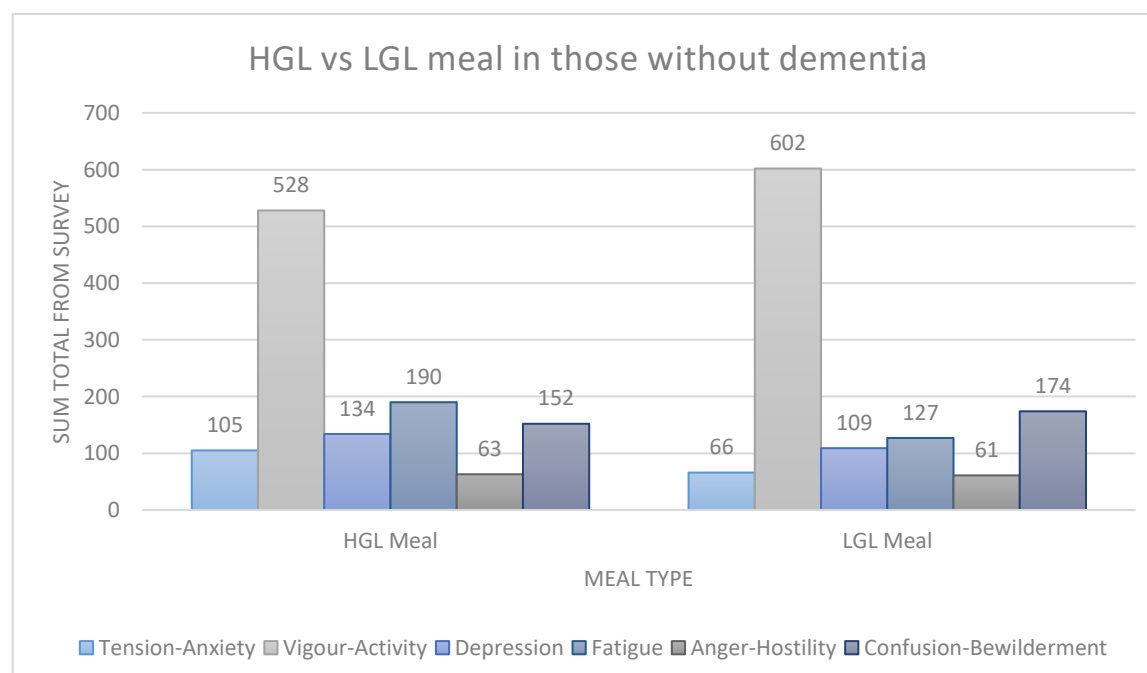
HGL vs LGL meal in those without dementia

Note. The graph presents general ordinal data of all research sites in relation to both meal types examined and the six sub-factors in those without dementia. The sub-factors of Vigour-Activity and Confusion and Bewilderment present larger totals in relation to the LGL meal. All other sub-factors are represented by larger totals in relation to the HGL meal.

5.5.2.2: General Findings- Test of study outcome measures

In the general study population, the HGL meal presented a TMS of 17.39 and a TMD of +4.21 whilst the LGL presented a TMS of 16.43 and a TMD of 0.67. A difference of 3.54 was therefore established between the Total Mood Disturbance (TMD) of both meal types. Using a paired t –test, the analysis found a t(146)= 4.21 and a *P*<.001 (lower than 0.05). These results suggests statistical significance between the differences in TMD for LGL and HGL meals, further concretising the descriptive ordinal data previously presented that LGL meals are more likely to be associated with better overall outcomes. Pearson's correlation provided evidence suggesting a degree of positive linear relationship at 0.28 between mood outcome and the meals.

When the subgroup of participants with dementia was analysed, a TMS of 18.47 for the HGL and a TMD of +6.71 was found whilst for the LGL a TMS of 17.01 and a TMD of 2.13 presented (note that the lower the TMD, mood outcome is considered better). A difference of 4.58 between TMDs resulted. To determine statistical significance and possible correlation, the paired t-test along with Pearson's correlation were calculated. A t(74)= 4.79 and a *P*<.001 was found suggesting greater significance for this result in comparison to the non-dementia population. Pearson's correlation also supported the presence of a linear relationship (0.29). Figure 31 illustrates the association identified in this subgroup.
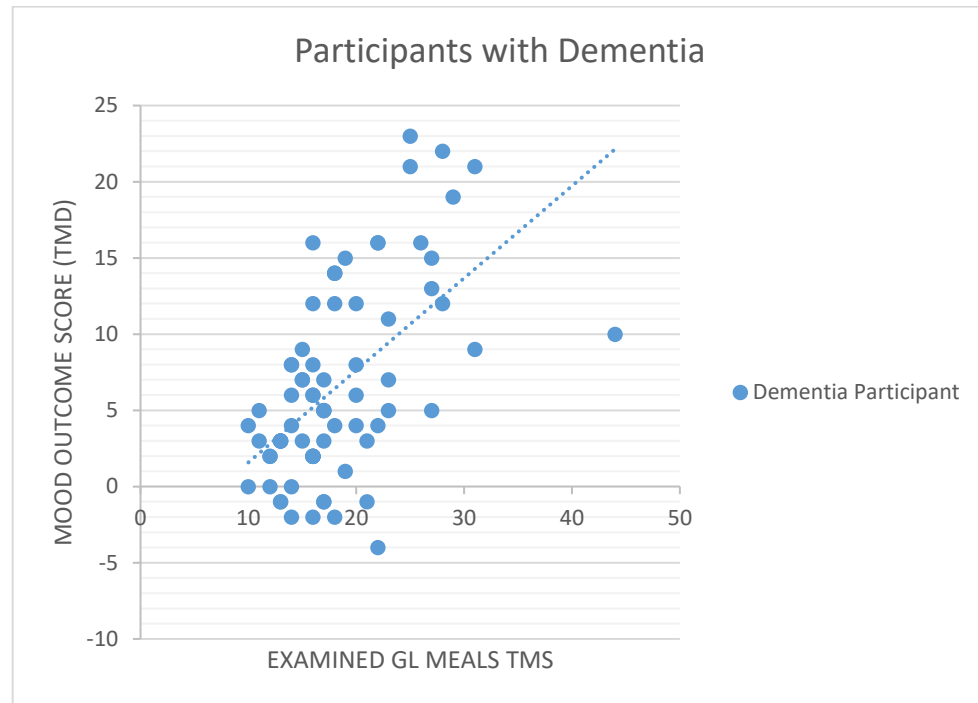
Figure 31 illustrating the presence of a linear association. As TMS (higher TMS equivalent to higher GL) of the corresponding meal increases (X-axis), a trend of poorer mood outcomes (Y-axis) is observed (i.e. increase in the TMD). Pearson's r=0.29 $P<.001$

Regarding the non-dementia sub-group, TMS for the both meals were lower than in the dementia group at 16.28 for the HGL (TMD= +1.62) and the LGL meal at 15.82 (TMD= -0.9). A difference of 2.52 between both TMDs was determined. The paired t-test to establish statistical significance found a $t(71)= 1.92$ and a P (value greater than 0.05)= 0.059. Pearson's correlation was determined as 0.25. Figure 32 that follows illustrates this relationship.

Figure 32: Participants with dementia- Total Mood Scores (TMS) of the examined GL meals in relation to the mood outcome (TMD- Total Mood Disturbance).
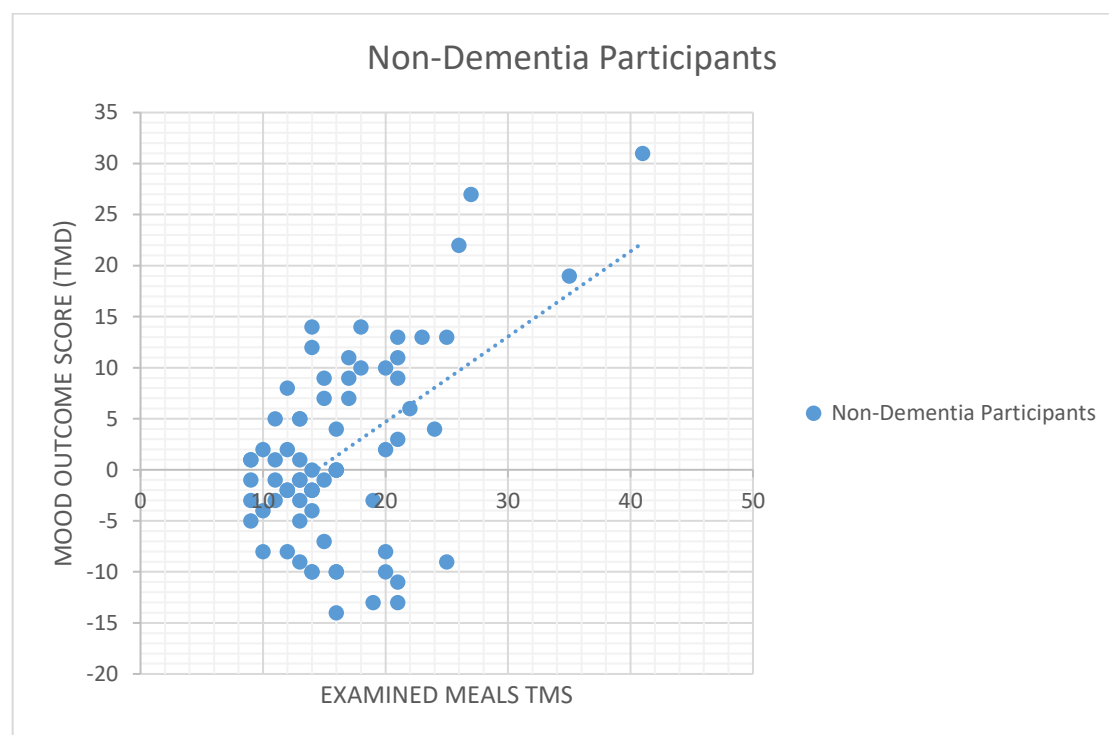
Figure 32 illustrates the presence of a linear association. As TMS (higher TMS equivalent to higher GL meals) of the corresponding meal increases (X-axis), a trend of poorer mood outcomes (Y-axis) is observed (i.e. increase in the TMD). When the TMS is lowered (equivalent to lower GL meals), a trend of improved mood outcomes is observed. Pearson's r= 0.25 *P*=0.059

5.5.3: Care Home 1

5.5.3.1: Mood Survey Findings

In care home one, the total mood score (TMS) for the HGL meal was 21.87 with a TMD of 11.07. For the LGL meal, it was 19.54 with a TMD of -2.86. Differences in TMS and TMD were calculated as 2.33 and 13.93 respectively. A paired t–test found a t(14) =5.78 and *P*<.001 suggesting statistical significance between TMD scores. Pearson's correlation was calculated as 0.11. Pearson's result is presented in figure 33.

Figure 33: Participants with dementia- Total Mood Scores (TMS) of the examined GL meals in relation to the mood outcome (TMD- Total Mood Disturbance).
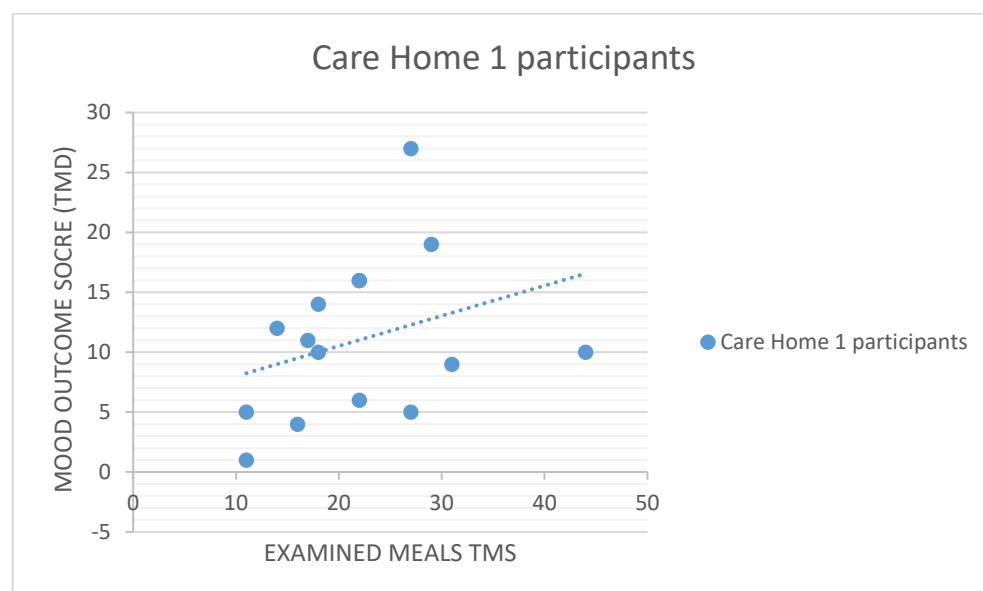
Figure 33 illustrates a Pearson's r= 0.11. As TMS (higher TMS equivalent to higher GL meals) of the corresponding meal increases (X-axis), a weak linear association of mood outcomes (Y-axis) is observed (i.e. increase in the TMD). Pearson's r=0.11 $P<.001$

The first research site had 15 participants (53% without dementia and 47% with dementia). Table 53 presents the results for each mood adjective of the sub-factors for both the HGL and LGL meals. Figure 34 shows the total differences between moods after the HGL and LGL target meals were eaten. The moods are categorised in sub-factors and it was found that the Tension-Anxiety, Depression, Fatigue, Angry-Hostility and Confusion-Bewilderment sub-factor totals were larger when compared to those of the LGL. Tension-Anxiety, Depression and Anger-Hostility were significantly larger with the HGL meal whilst Vigour-Activity sub-factor total was significantly larger for the LGL.

Table 53: Mood adjectives in relation to the HGL and LGL meals in Care Home 1.

Mood Adjective	HGL- mood totals	LGL- mood totals
Tense	14	3
On edge	11	4
Uneasy	10	2
Restless	5	2
Nervous	5	2
Anxious	6	3
Lively	21	39
Active	14	24
Energetic	11	25
Cheerful	23	42
Full of Pep	8	18
Vigorous	5	21
Unhappy	3	1
Sad	15	1
Blue	7	0
Hopeless	10	6
Discourage	6	2
Miserable	1	0
Helpless	6	1
Worthless	0	0
Worn Out	10	15
Fatigued	13	15
Bushed	4	9
Exhausted	9	2
Weary	19	6
Angry	3	14
Peeved	2	0
Grouchy	9	0
Annoyed	9	0
Resentful	2	0
Bitter	0	0
Furious	0	0
Confused	16	11
Unable to concentrate	10	11
Bewildered	7	4
Forgetful	19	16
Uncertain about things	16	10

Note. The table presents the general ordinal data of all mood adjectives corresponding to the different

sub-factors of the POMS in relation to the meal types examined.

Figure 34: Comparison of HGL and LGL meal- mood results in relation to sub-factors in Care Home 1.
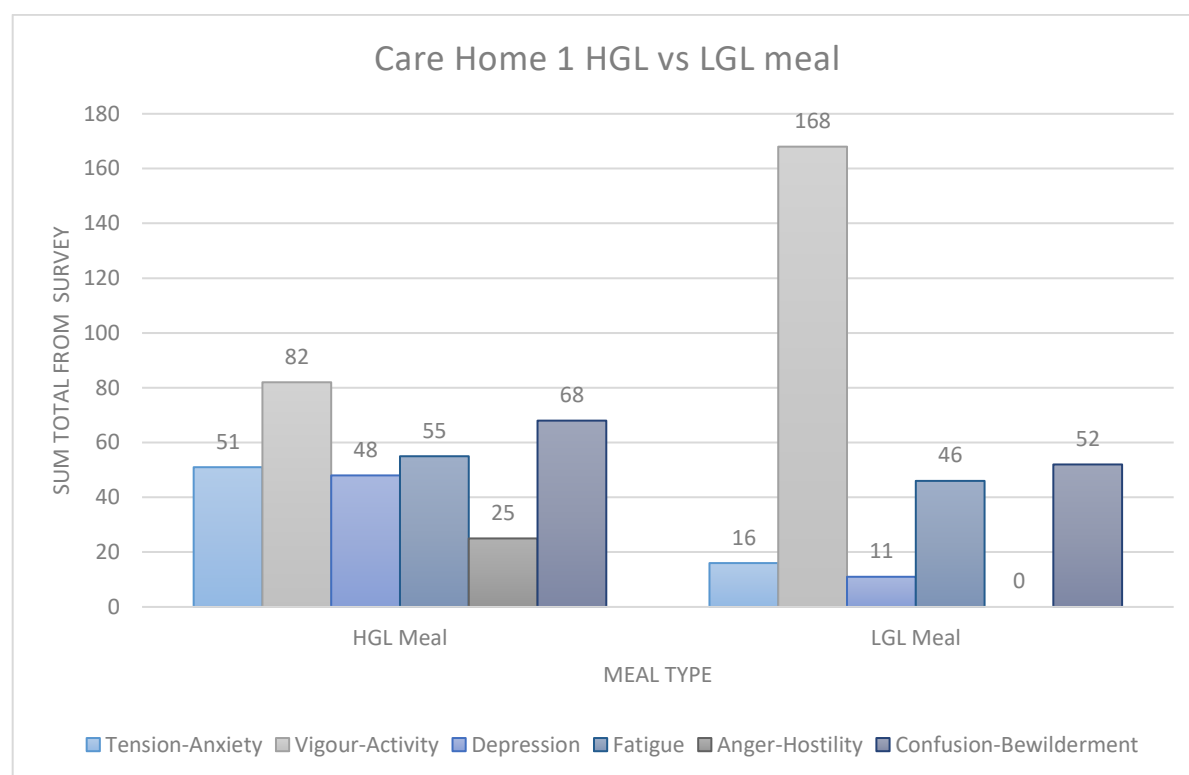
Note. The graph presents general ordinal data for care home 1 in relation to both meal types examined and the six sub-factors. Excluding Vigour-Activity, all other sub-factor totals are higher in relation to the HGL meal.

For those with dementia in care home 1, a TMS of 27.57 and TMD of 12.71 were calculated with respect to the HGL meal. On the other hand, a TMS of 21.14 and TMD of -1.14 were determined for the LGL. This represented a difference in TMD of 13.85 (TMS difference 6.43). . A paired t –test suggested statistical significance between TMD scores, t(6) =5.23 and a P<.001 Pearson's correlation findings are presented in figure 35 identified a negative downhill relationship between both variables (-0.08).

Figure 35: Participants with dementia- Total Mood Scores (TMS) of the examined GL meals in relation to the mood outcome (TMD- Total Mood Disturbance).
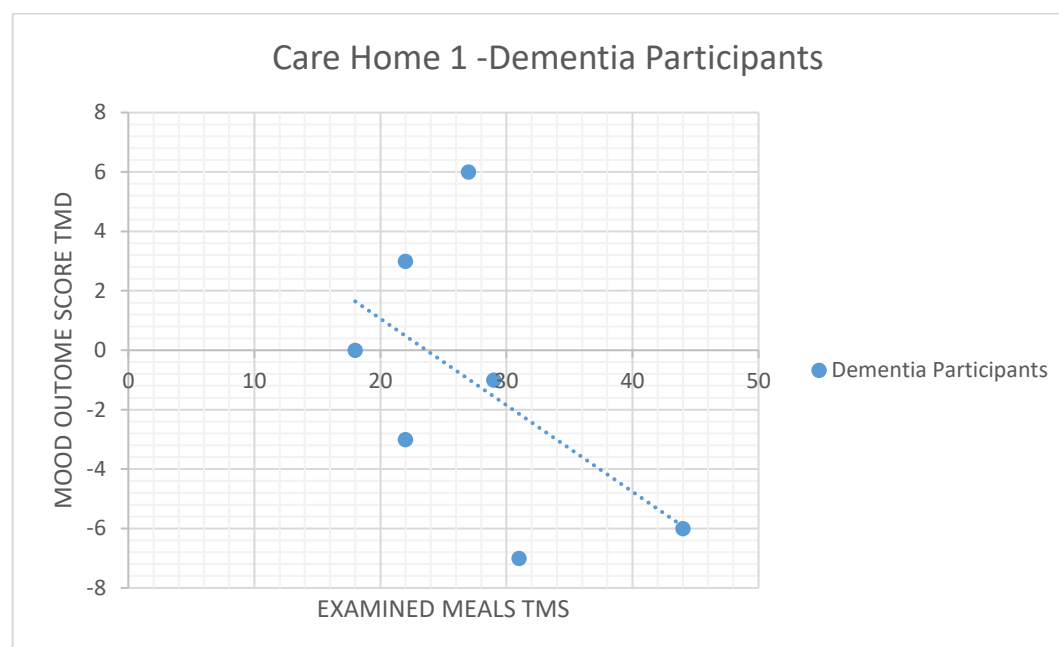
Figure 35 illustrates a negative relationship where a high TMS (equivalent to high GL of the corresponding meal) (X-axis), is more likely to correspond to a lower mood outcome score (Y-axis). Pearson's r= -0.08 *P*<.001

In those without dementia, the HGL yielded a TMS of 17.01 and TMS of 9.51 whilst the LGL corresponded to a TMS of 18.13 and TMD of -4.37. Differences in TMS and TMD were calculated as 1.12 and 13.88 respectively. Positive statistical significance using the paired t-test was found, t (7)= 3.38 and a *P*= 0.012. Pearson's correlation was calculated as -0.27.

Descriptively, the results for each sub-factor were not very significant with major differences only in the confusion-bewilderment, vigour-activity and depression sub-factors. On the other hand, when the LGL meal was considered in relation to dementia status differences were more pronounced in the Tension-Anxiety, Fatigue and Confusion-Bewilderment sub-categories. Anger-Hostility registered no value when the LGL meal was examined in relation to dementia status. Figure 36 illustrates ordinal data results for both meal types in relation to dementia status.

Figure 36: Meal types and dementia status in relation to mood sub-factors in Care Home 1.
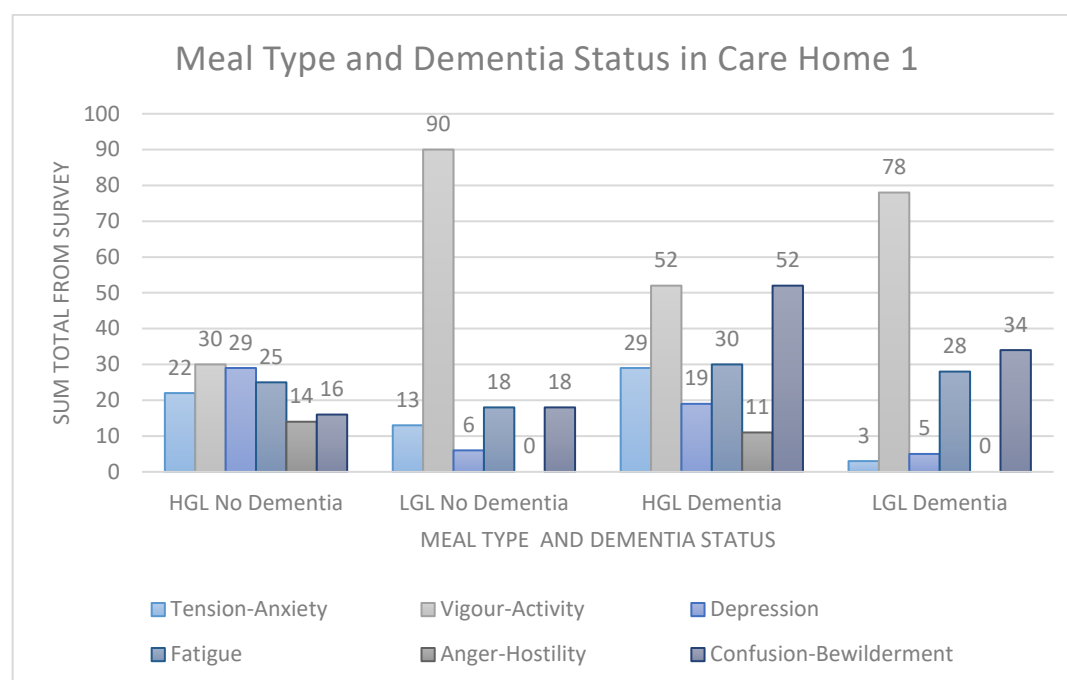
Note. Figure 36 illustrates the ordinal data totals for each sub-factor examined in relation to both the dementia status and meal type. The positive sub-factor of Vigour-Activity is most represented in both LGL meal groupings with a total of 90 in the LGL No dementia grouping. The other negative sub-factors are largely represented in the HGL groupings with higher amounts presented in the HGL Dementia grouping. Anger-Hostility sub-factor is not recorded in either LGL grouping.

5.5.4: Care Home 2

5.5.4.1: Mood Survey Findings

Care home two included the largest of participants (54) of which, 56% of those did not suffer from dementia. The descriptive analysis of the data when comparing the HGL and LGL meals found equal quantities for Anger-Hostility sub-factor. Differences favouring the HGL were found for the Tension-Anxiety sub-factor whilst Vigour-Activity favoured the LGL. All other sub-factors presented similar findings for each meal type. Table 54 below shows all the mood adjectives in relation to both meal types whilst Figure 37 illustrates the differences based on each sub-factor for both meals. A TMS of 15.98 and TMD of 1.4 were calculated for the HGL meal whilst a TMS of 15.92 and a TMD of -0.3 for the LGL were determined. Paired t-test results found no statistical significance between meals in relation to mood, $t(53)=1.41$ and $P=0.16$. Pearson's correlation (0.28).

Table 54: Mood adjectives in relation to the HGL and LGL meals in Care Home 2.

Mood Adjective	HGL- mood totals	LGL- mood totals
Tense	23	8
On edge	4	1
Uneasy	4	3
Restless	13	16
Nervous	11	10
Anxious	20	8
Lively	114	119
Active	53	59
Energetic	43	44
Cheerful	120	135
Full of Pep	48	65
Vigorous	16	16
Unhappy	13	18
Sad	24	12
Blue	13	8
Hopeless	12	15
Discourage	5	3
Miserable	8	9
Helpless	9	11
Worthless	0	0
Worn Out	34	28
Fatigued	12	32
Bushed	1	1
Exhausted	13	3
Weary	33	35
Angry	12	6
Peeved	4	2
Grouchy	10	14
Annoyed	13	11
Resentful	0	1
Bitter	1	5
Furious	0	1
Confused	40	29
Unable to concentrate	17	17
Bewildered	9	9
Forgetful	56	67
Uncertain about things	55	39

Note. Table presents the general ordinal data of all mood adjectives corresponding to the different sub-factors of the POMS in relation to the meal types examined.
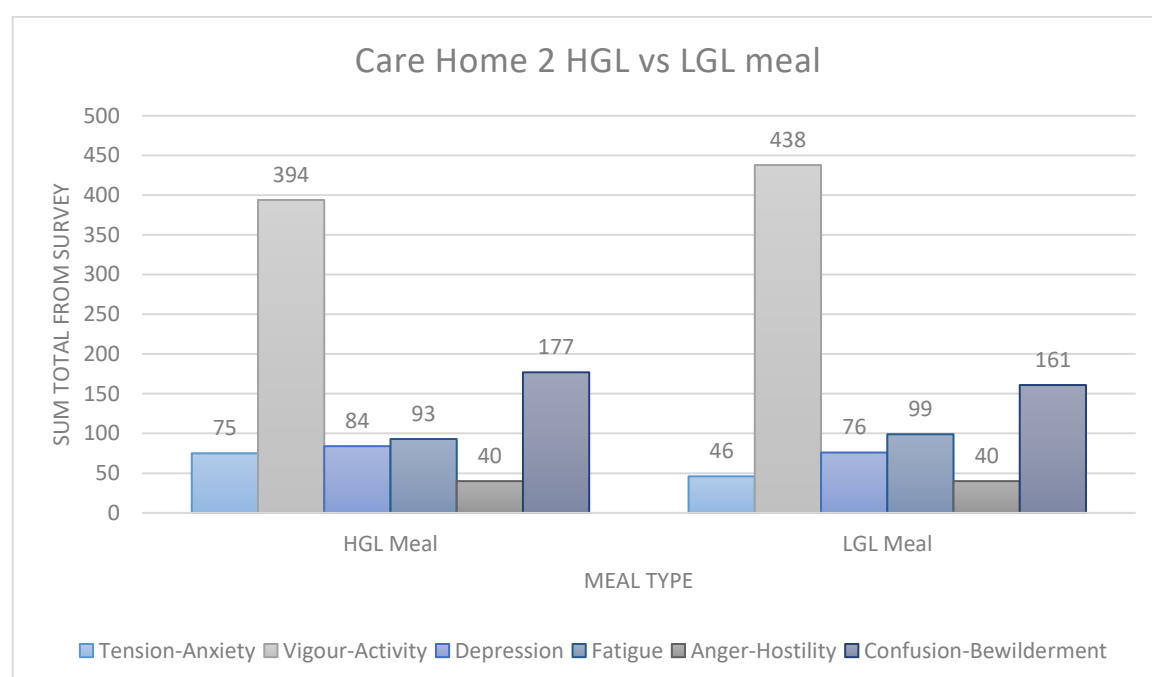
Note. The graph presents general ordinal data for care home 2 in relation to both meal types examined and the six sub-factors .Vigour-Activity and Fatigue were the two sub-factors more represented by the LGL meal. The Anger-Hostility sub-factor was represented equally in both meal types while all other sub-factor totals were more represented by the HGL meal.

Impact of the two meals in relation to mood were then analysed taking into consideration the dementia status of those in Care Home 2. In those with dementia, a Total Mood Score (TMS) of 17.05 and a TMD of 3.71 for the HGL meal were calculated whilst a TMS of 15.79 and TMD of -0.21 for the LGL meal were determined.

These results presented a difference in TMS of 1.26 and TMD of 3.92. A paired t-test done found t(23)= 3.03 with *P*=0.006 that suggested statistical significant. Pearson's correlation (0.27) also supported this finding. On the other hand, participants without dementia had an HGL, TMS of 15.13 and TMD of -0.47 whilst for the LGL meal a TMS of 16.03 and TMD of -0.37 were found. These results for those without dementia represented differences in TMS of 0.9 and TMD of -0.1. T-test results found t(29)= -0.10 with *P*=0.92 suggesting that the difference found between both meals was not significant. Pearson's correlation (0.32).

Further descriptive analysis comparing both groups found that for the HGL, Tension-Anxiety was greater in those with dementia. This was also the case for Confusion-Bewilderment as well as Anger and Hostility. All other sub-factors total sums, favoured those with no dementia. When the LGL meal was considered, all sub-factors excluding Confusion-Bewilderment were larger in those without dementia. These analyses are borne out in figure 38 that follows.

Figure 38: Meal types and dementia status in relation to mood sub-factors in Care Home 2.
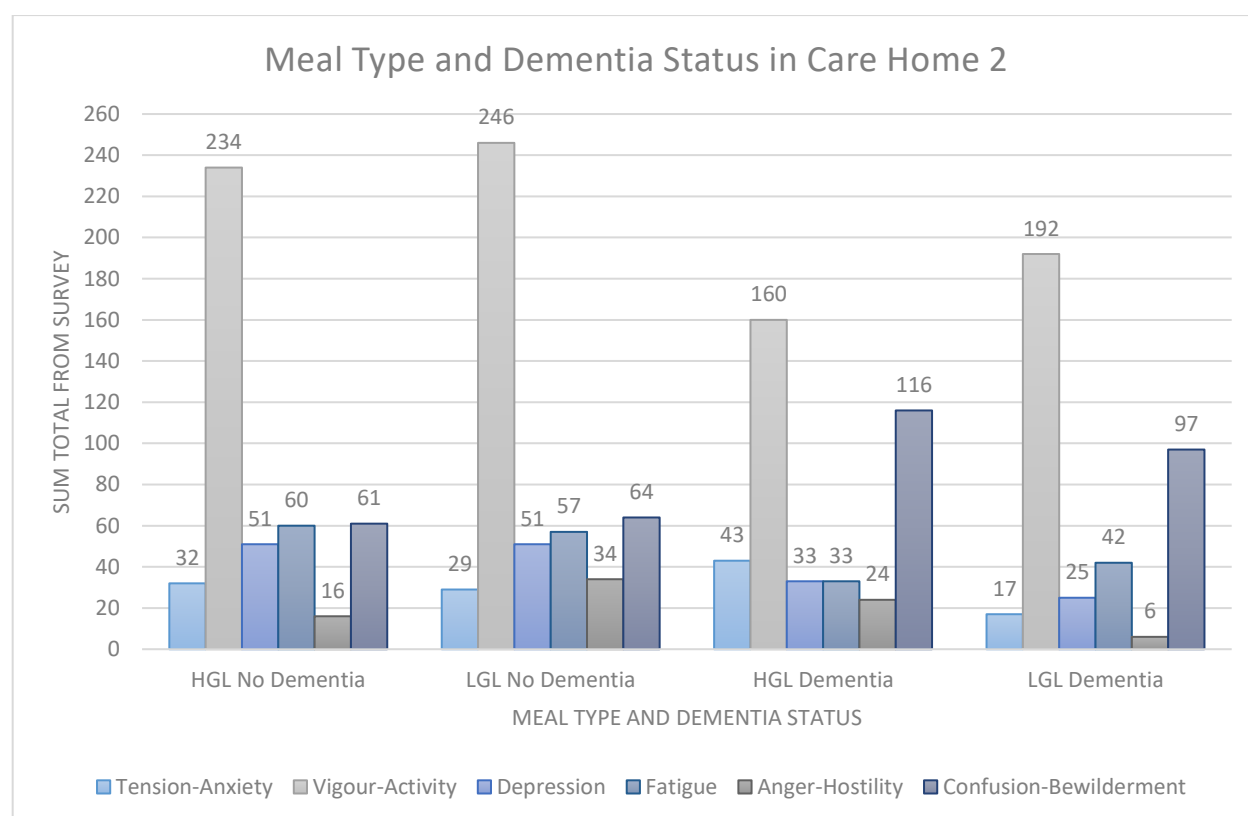
Note. Figure 38 illustrates the ordinal data totals for each sub-factor examined in relation to both the dementia status and meal type. The positive sub-factor of Vigour-Activity is most represented in both No- dementia groupings of HGL (234) and LGL (246) along with the Depression sub-factor at 51 for both meal types and Fatigue (HGL=60 and LGL=57). Inversely, Confusion and Bewilderment is most represented in both Dementia groupings of HGL (116) and LGL (97). The other negative sub-factor of Tension and Anxiety was most represented in HGL meal groups (No-Dementia=32 and Dementia=43). Anger-Hostility is most represented in the LGL No-Dementia grouping at 34.

5.5.5: Care Home 3

5.5.5.1: Mood Survey Findings

The third care home was the second largest (52 participants) with a majority having Alzheimer's (54%). The descriptive data analysis of the ordinal data found all sub-factors analysed excluding confusion-bewilderment being represented by larger sums in relation to the HGL meal. The anger-hostility sub-factor results were the largest in this care home for both target meals when compared to other sites. Table 55 provides a breakdown of each mood adjective assessed for both meal types. Figure 39, which follows, illustrates a comparison of each meal type in relation the different sub-factors/mood dimensions. The general mood results for care home three found a TMS of 18.2 and a TMD of 6.8 for the HGL whilst the LGL had a TMS of 16.1 and a TMD of 5.14. A difference between both meals with respect to the TMS was 2.1 and a TMD difference of 1.66 was calculated. A t-test found no statistical significance suggesting LGL meals were not more likely to produce better mood outcomes, $t(51)=0.91$ and $P=0.37$). Pearson's correlation was 0.29.

Table 55: Mood adjectives in relation to the HGL and LGL meals in Care Home 3.

Mood Adjective	HGL- mood totals	LGL- mood totals
Tense	11	14
On edge	11	7
Uneasy	11	13
Restless	18	8
Nervous	7	1
Anxious	20	13
Lively	88	83
Active	46	40
Energetic	30	28
Cheerful	98	94
Full of Pep	24	32
Vigorous	11	8
Unhappy	34	28
Sad	23	17
Blue	16	13
Hopeless	17	17
Discourage	11	5
Miserable	5	8
Helpless	17	24
Worthless	0	0
Worn Out	36	26
Fatigued	49	12
Bushed	1	4
Exhausted	27	8
Weary	66	34
Angry	6	8
Peeved	2	3
Grouchy	29	15
Annoyed	21	18
Resentful	3	0
Bitter	5	1
Furious	0	0
Confused	58	71
Unable to concentrate	31	43
Bewildered	9	8
Forgetful	59	85
Uncertain about things	47	48

Note. Table presents the general ordinal data of all mood adjectives corresponding to the different sub-factors of the POMS in relation to the meal types examined.

Figure 39: Comparison of HGL and LGL meal- mood results in relation to sub-factors in Care Home 3.
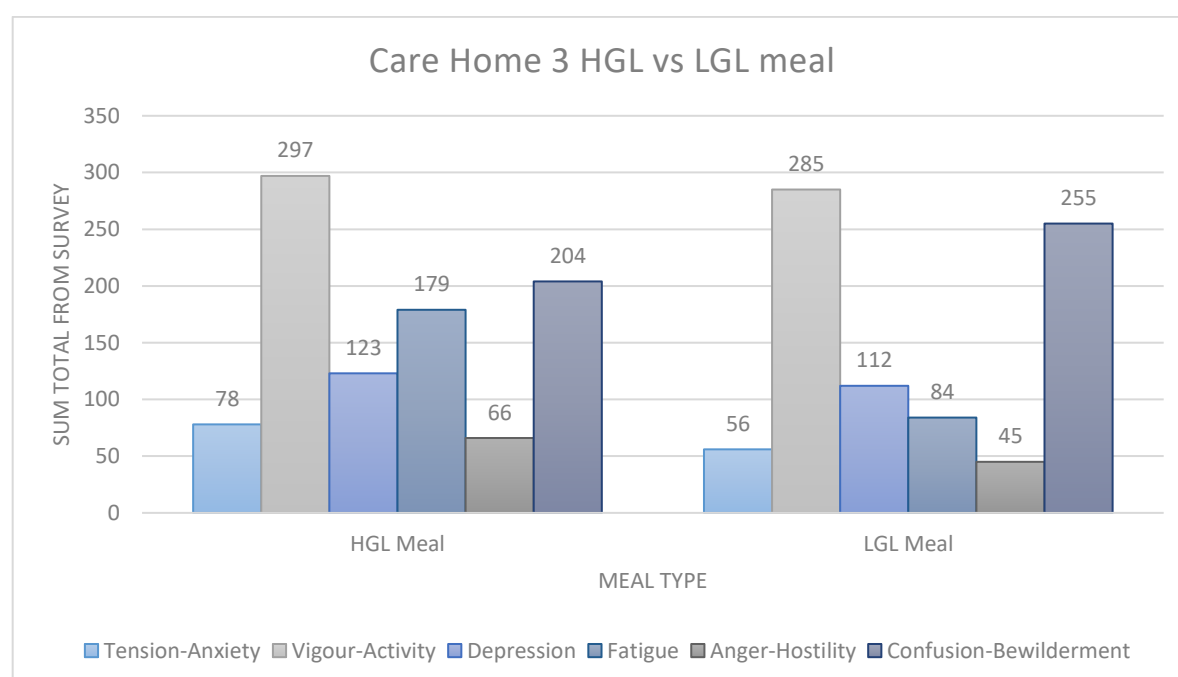
Note. The graph illustrates general ordinal data for care home 3 in relation to both meal types examined and the six sub-factors. All sub-factors with the exception of Confusion-Bewilderment were most represented in the HGL Meal type.

The impact of both meals was then assessed taking into consideration whether participants had dementia or not. In the dementia group, the HGL meal presented a TMS of 19.22 with a corresponding TMD of 9.36. The LGL meal had a TMS of 17.47 and a TMD of 8.04. The difference in TMS was thus 1.75 and TMD difference was 1.32. Paired t-test revealed t(27)= 0.81 and P= 0.43 that suggested findings were not statistically significant. Pearson's correlation was 0.17. Similar calculations on the non-dementia group found a TMS of 17.05 and TMD of 3.79 for the HGL meal whilst the LGL meal presented a TMS of 14.80 and a TMD of 2.05. A TMS difference of 2.25 and a TMD difference of 1.74 between both meal types was thus calculated. Statistical test found t(23)=0.74 and P=0.46 that also indicated no statistical significance. Pearson's correlation was calculated as 0.23.

Descriptive comparisons of the ordinal data between both groups found that for the HGL meal, all sub-factors were greater in the dementia group, except for Tension-Anxiety and Vigour-Activity that favoured those without dementia. In the LGL meal analysis however, only Anger-Hostility and Vigour-Activity sub-factors were greater in those without dementia with all other mood sub-factors assessed favouring the dementia group. Figure 40 below illustrates these differences found in the descriptive data.

Figure 40: Meal types and dementia status in relation to mood sub-factors in Care Home 3.
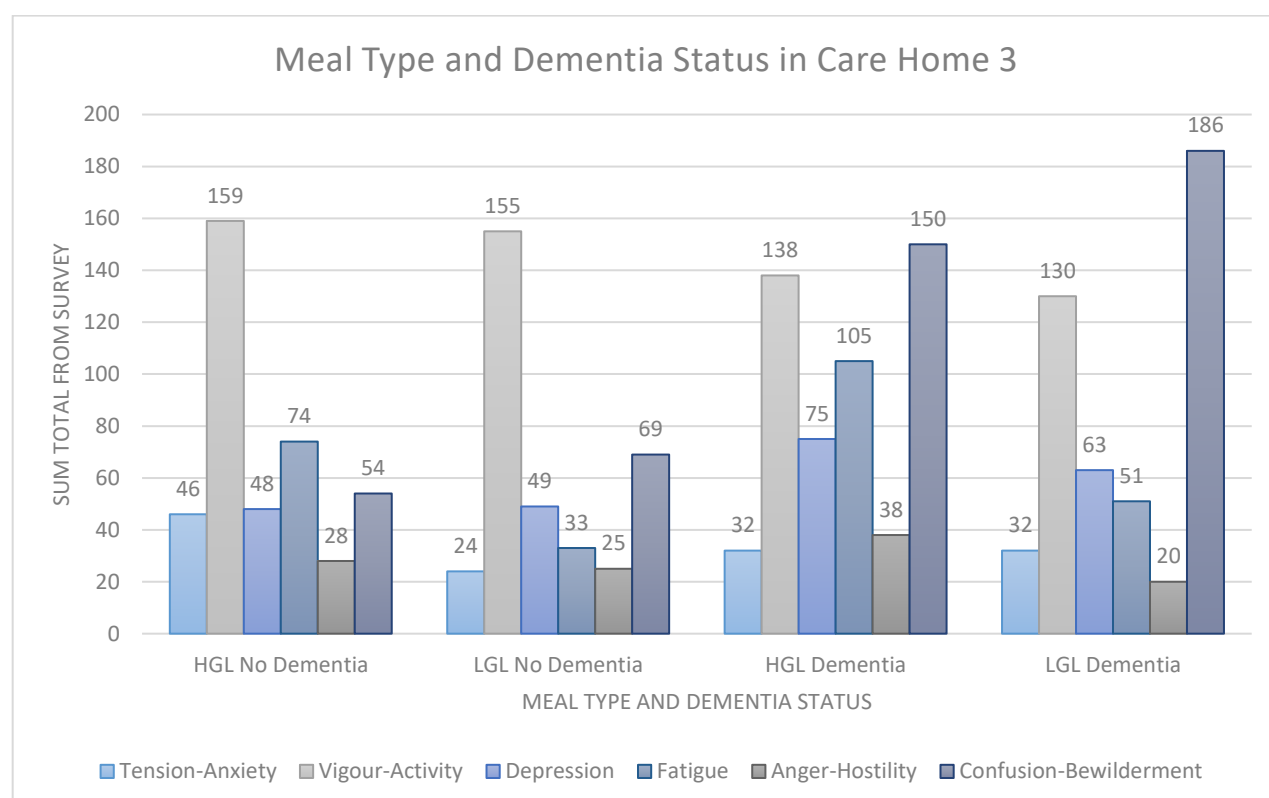
Note. Figure 40 illustrates the ordinal data totals for each sub-factor examined in relation to both the dementia status and meal type. The positive sub-factor of Vigour-Activity is most represented in both No- dementia groupings of HGL (159) and LGL (155) whilst Confusion and Bewilderment is most represented in both Dementia groupings of HGL (150) and LGL (186) along with the Depression sub-factor (HGL=75 and LGL=63). The other negative sub-factor of Tension and Anxiety was most represented in the HGL No-Dementia group at 46 and equal amounts in both the HGL Dementia and LGL Dementia groups at 32. Anger-Hostility is most represented in the LGL No-Dementia grouping at 34. Fatigue was most represented in HGL groupings (No Dementia=74 and Dementia=105) along with Anger- Hostility (No Dementia=28 and Dementia= 38).

5.5.6: Care Home 4

5.5.6.1: Mood Survey Findings

The final research site visited had 62% of its total 26 participants suffering from dementia. General descriptive analysis of this site found subfactors of Tension-Anxiety, Depression and Anger-Hostility were lower when compared to other sites. When both target meals were assessed. Sub-factors of Fatigue and Confusion-Bewilderment were higher for the HGL meal whilst, on the other hand, Vigour-Activity was higher for the LGL meal. Table 56 gives specific results for each mood adjective assessed for both target meals. Figure 41 illustrates a comparison of both meals with respect to the sub-factors assessed follows this.

In general, for the HGL meal a TMS of 16.08 and TMD of 1.0 were calculated. The LGL had a TMS of 16.36 and TMD of -4.18. Differences in the TMS of both meal types of 0.28 and TMD of 5.18 were found. Paired t-test found t(25)= 3.53 and *P*= 0.002 implying statistically significant result in differences between both meals. Pearson's correlation was calculated as 0.25.

Table 56: Mood adjectives in relation to the HGL and LGL meals in Care Home 4.

Mood Adjective	HGL- mood totals	LGL- mood totals
Tense	5	1
On edge	0	1
Uneasy	0	0
Restless	2	0
Nervous	2	0
Anxious	3	1
Lively	65	61
Active	19	34
Energetic	19	35
Cheerful	57	73
Full of Pep	34	55
Vigorous	2	9
Unhappy	0	1
Sad	3	0
Blue	0	1
Hopeless	1	2
Discourage	0	0
Miserable	1	0
Helpless	8	4
Worthless	0	0
Worn Out	28	21
Fatigued	10	7
Bushed	1	1
Exhausted	8	0
Weary	32	24
Angry	1	0
Peeved	1	0
Grouchy	2	0
Annoyed	3	3
Resentful	0	0
Bitter	0	0
Furious	0	0
Confused	34	26
Unable to concentrate	12	17
Bewildered	0	0
Forgetful	46	36
Uncertain about things	19	12

Note. Table presents the general ordinal data of all mood adjectives corresponding to the different sub-factors of the POMS in relation to the meal types examined.

Figure 41: Comparison of HGL and LGL meal- mood results in relation to sub-factors in Care Home 4.
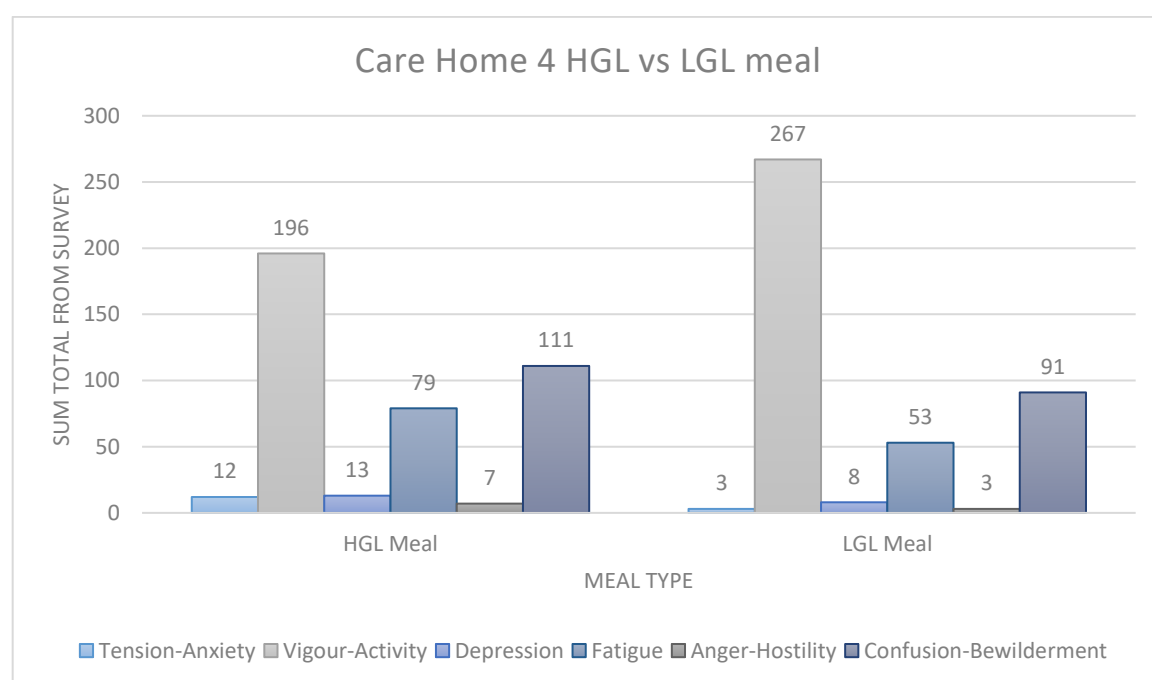
Note. Figure 41 illustrates general ordinal data for care home 4 in relation to both meal types examined and the six sub-factors. All negative sub-factors were most represented in the HGL Meal type while the positive sub-factor of Vigour-Activity was most represented in the LGL.

The target meals were then both assessed relating to the dementia status of the participants. In the dementia subgroup, a TMS of 15.33 and TMD of 3.95 were calculated for the HGL meal. The LGL meal had a TMS of 16.69 and a TMD of -2.81. Differences in TMS and TMD were 1.36 and 6.76 respectively. T-test results found t(15)=4.44 and P<.001 indicating significance with Pearson's correlation calculated as -0.27.

Within the non-dementia group, for the HGL meal, a TMS of 17.3 and TMD of -3.7 were calculated. The LGL had a TMS of 15.8 and TMD of -6.4. Differences in TMS and TMD were 1.5 and 3.59 respectively. The t test done in the non-dementia group found a t(9)= 1.18 and P= 0.27 which unlike the dementia group was not a significant result.

Pearson's correlation was calculated at 0.44 and indicated a stronger linear relationship when compared to the dementia grouping.

Descriptive comparisons of the ordinal data for both groups i.e. dementia and non-dementia found a larger sum in the dementia group of the HGL meal for the Confusion-Bewilderment sub-factor. Other sub-factors were also slightly greater for those with dementia. For the LGL meal, it was found that those with dementia had higher results for every sub-factor when compared those without dementia. These results were pronounced in the sub-factors of Vigour-Activity, Fatigue and Confusion-Bewilderment. Figure 42 below highlights the comparisons of both groups.

Figure 42: Meal types and dementia status in relation to mood sub-factors in Care Home 4.
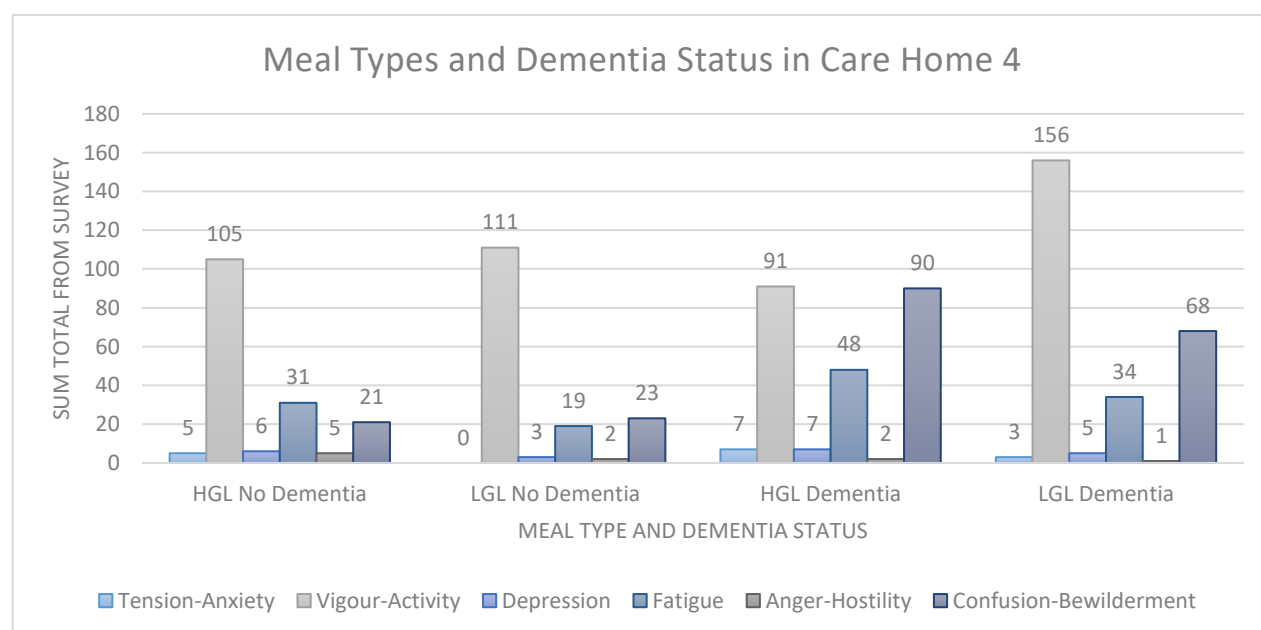
Note. Figure 42 illustrates the ordinal data totals for each sub-factor examined in relation to both the dementia status and meal type. The positive sub-factor of Vigour-Activity is most represented in both LGL groupings (No-Dementia=111 and Dementia=156). On the other hand, Tension-Anxiety was represented most in the HGL groupings (No-Dementia=5 and Dementia=7) along with the Depression sub-factor (No-Dementia=6 and Dementia=7). Anger-Hostility was most represented in the HGL No Dementia grouping with 5. Confusion-Bewilderment was most represented in both Dementia groupings (HGL=90 and LGL=68) along with Fatigue (HGL=48 and LGL=34).

5.5: Summary

In summary, the nutritional analysis findings indicated general satisfactory macronutrient results with fibre being a major exception with deficiencies. Micronutrients to include calcium, vitamin D, selenium and iodide all presented deficient intakes. Target meals presented similar characteristics among the different research sites. A Positive correlation between nutrient density and the glycaemic load of meals was also presented. The mood results presented descriptive as well as statistical test results. These findings highlighted a relationship between the LGL meals and positive mood outcomes with stronger statistical results in the dementia grouping when compared to the non-dementia group.

The next chapter seeks to critique and discuss these findings obtained.

Chapter 6: Discussion

6.1: Discussion of Findings
6.1.1: Introduction

The previous chapter presented the results obtained from the different data analyses employed. This chapter seeks to discuss these findings in a contextual manner within the framework of the study's objectives. These objectives serve as a guideline for this chapter. In addition to the objectives investigated, all additional findings are critiqued and discussed, drawing from the literature and systematic reviews. Throughout the discussion, contributions to knowledge are also presented.

6.1.2: Discussion regarding the study objectives.

The study sought to answer the question whether there was an association between the glycaemic load of meals and the mood outcomes of older adults residing in care homes. To this end, the objectives were stated as:

Primary Objective

a) To assess the association between high glycaemic load meals and low glycaemic load meals and the mood of older adults within a care home setting.

Secondary Objectives

b) To examine the glycaemic load of meals offered within care homes.

c) To analyse the nutritional profile of food offered within care homes.

d) To examine the possible relationship between the glycaemic load and nutrient density within care homes.

e) To examine the differential relationship of mood and the glycaemic load of meals in older adults with and without dementia within a care home setting.

Current evidence suggests that there is some relationship between the GL and mood outcomes (Young and Benton, 2014; Micha, et al., 2011; Breymeyer, et al., 2016). Young and Benton (2014) carried out a RCT of 155 healthy adults aged 45-80 years to exam the interaction between GL of a meal and cognition as well as mood. Micha, et al., (2011) provided evidence of the aforementioned relationship in a RCT of 74 healthy children from 5 London schools aged 11-14 years whilst Breymeyer, et al., (2016) conducted a RCT of 82 healthy non-smoking adults and founded a relationship between a HGL diet and higher scores for depressive symptoms. The existing evidence however, presents a degree of inconsistency within the findings and cannot be generalised, specifically in the older adult group. A systematic review carried out by the researcher made these very conclusions (refer to Chapter 3). In effect, the systematic review supported previous work highlight some evidence supporting the relationship between GL and mood. In the review, eight of the ten studies found some relationship, the relationships examined provided varying results based on the type of GL meal and mood outcomes examined. Whilst these inconsistencies are of interest to this thesis, it must be reinforced that the study research question sought to determine whether the GL was associated with the mood of older adults in care homes. From the results obtained in this study, it does suggest that the GL can be associated with impact mood outcomes. This finding is a significant contribution to knowledge given the lack of existing evidence for this specific grouping.

6.1.3: Glycaemic load and mood outcomes (primary objective and secondary objective e)

Given the ordinal nature of the initial raw data from the POMS Likert scale, descriptive statistics were used to analyse these results. Once the TMS (total mood score) and TMD (total mood disturbance) were found, more interval-based statistics were done to access the association/relationship under study. This section discusses the general mood findings as well as specific ones in relation to dementia status, sub-factors and research sites.

Bearing in mind that a TMD lower than suggests a positive mood outcome, the findings suggest LGL meals are more likely to be associated with better overall moods. The total mood disturbance, i.e. the difference between the total mood state of the HGL and LGL meal, showed statistical significance. Pearson's correlation provided evidence suggesting a weak positive linear relationship between mood outcomes and the meals.

These results further suggest that in the general older adult population other factors may need to be considered when looking at the GL of meals and mood dynamic. These factors include types of catering, portion sizes, nutrient density, nutritional adequacy, staff training, the second meal effect as well as the eating environment. Having a better understanding of these factors would provide a framework for contextualising the results of the GL of meals and mood relationship.

This however, does not negate the fact that LGL meals appear to be more positively associated with better mood outcomes. Benton, et al. (2007) found fewer signs of frustration after low GL foods were consumed while Micha, et al. (2011) similarly found participants in their study were less nervous, more alert and happier after low GL food consumption.

Both pieces of evidence do support the significant advantages of low GL foods on mood but, like the vast majority of existing evidence, these studies were conducted in children and though they provide support, they should be examined in context, taking into account the physiological differences between children and older adults. To this end, although the evidence is limited in the older adult population, Young and Benton (2014) have shown that low LGL foods are associated with improved cognition and mood in adults aged 45-80. This evidence, similarly to this thesis, employed the POMS to assess mood, finding optimal mood outcomes between 105-195 minutes after consumption.

Though not as extensive as Young and Benton's 2014 study, Aparicio, et al. (2012) and Mwamburi, et al. (2011) also support better mood outcomes through LGL food consumption. Mwamburi, et al., (2011) carried out a cross-sectional study in 976 home bound elderly aged 60+ whilst Aparicio, et al., (2012) also carried out a cross-sectional study but on a smaller scale involving 140 institutionalised older adults (65-90 years) . Mwamburi et al., (2011) employed the use of a food frequency questionnaire (FFQ) whilst Aparicio et al., (2012) recorded energy and nutrient intake. Both studies focused solely on depressive mood states finding that a low glycaemic load diet was less likely to be associated with depression.

General Internal Consistency

The general internal consistency was also within the expected range for the use of the POMS, however at the lower end of the spectrum 0.63-0.96 (Kivisalu et al, 2014). This point to the length of the scale used in research, lack of data variability and study size as key issues that may reduce internal consistency of the survey instrument. The instrument used reflects the aforementioned issues.

It could also be argued the characteristics of the study population (inclusive of persons with early to mid-stage dementia) could have affected the overall internal consistency results, where many respondents may have selected the option " not at all" for one word adjective of a sub-factor (for example blue) then selected "extremely" for the term sad.

From a sub-factor perspective, the internal consistency was highest for the vigour-activity for both meals followed by depression, anger-hostility and confusion-bewilderment all over 0.60. Thus, these sub-factors had the most acceptable internal consistencies. Fatigue and Tension-Anxiety were below the 0.60 consistency amount for both meals. Having these two of the six sub-factors below 0.60 consistency does not negate the acceptability of overall consistency of the POMS (note internal consistency was not a main objective of the study but necessary to this section) and could be due to the characteristics of the study population as previously outlined.

Dementia status- General

Dementia status highlighted a contrasting difference in the TMD when the non-dementia and dementia sub-groups were examined. The dementia sub-group presented a TMD of 6.71 for the HGL and 2.13 for the LGL, a difference of 4.58 between TMD results. On the other hand, the non-dementia sub-group presented a TMD of 1.62 for the HGL and -0.9 for the LGL, a difference of 2.52 between their TMD. The paired t-test showed greater significance for the result of the dementia group with a t(74)=4.79 and *P*<.001 when compared to the non-dementia population which had a t(71)=1.92 and *P*=0.059 (*P* value greater than 0.05).

This implies a positive association was more likely in the dementia group for the LGL meal and positive mood outcomes. Pearson's correlation also supported the presence of a more pronounced positive linear relationship at 0.29 in the dementia sub-group when compared to the general population (Pearson's r=0.28) and non-dementia sub-group (Pearson's r=0.25).

This result supports an interesting suggestion that perhaps those with dementia are more susceptible to the glycaemic effects of foods and that the LGL could be more beneficial in this specific group (given the behavioural symptomatology of the disease) in improving mood outcomes. Research into this disease supports the increase susceptibility of dementia sufferers to glycaemic effects. Feil, et al. (2011) and De Galan, et al. (2009) both suggest an increase in the susceptibility to glycaemic effects in those with cognitive impairment. The results of the non-dementia group supports the evidence found in the dementia group as the results proved less statistically significant as previously expressed.

Internal Consistency- Dementia vs Non-Dementia

Internal consistency was improved when only non-dementia participants were examined with all sub-factors excluding fatigue presented internal consistency between 0.60- 0.81 for the LGL meal with similar results for the HGL with fatigue and tension-anxiety below 0.60, reflecting overall general results for sub-factor consistency. On the other hand, consistency was not as similar for the two meals in the dementia group. Specifically, the differences between consistency for Confusion-Bewilderment, Fatigue and Tension-Anxiety were found.

A possible explanation for this could be due to the dementia. Feil, et al., (2011) conducted a cross-sectional database analysis of 497,900 veterans 65 and older stratified with respect to dementia, age, cognitive impairment as well as antiglycemic medications. The study found that dementia and cognitive impairment were independently associated with a greater risk of hypoglycaemia. De Galan, et al., (2011), in their RCT (included 11,140 patients with type 2 Diabetes aged >55 years) on cognitive function and risks of cardiovascular disease and hypoglycaemia in patients with type 2 diabetes found that severe cognitive dysfunction increased the risk of severe hypoglycaemia (HR 2.10, 95% CI 1.14-3.87; p = 0.018). Further evidence in a retrospective study of 16,667 elderly diabetic patients found that a subject's risk of dementia increased by 26% (HR, 1.26; 95% CI, 1.10 to 1.49) after one case of severe hypoglycaemia, by 80% ((HR, 1.80; 95% CI, 1.37 to 2.36) after two occasions and by 94% (HR, 1.94; 95% CI, 1.42 to 2.64) after three or more times (Whitmer, et al., 2009). The bio-statistical data regarding the relationship between dementia and susceptibility to glycaemic outcomes requires further study.

In addition to this, it could be that those in the dementia group were less susceptible to personal response bias when answering survey questions. In effect, it could be argued that perhaps the dementia participants gave more genuine, honest responses resulting in more variety in responses. Though this is a supposition on the part of the researcher, some evidence suggests that having a limit to cognitive capacity does tend to support honest responses in situations where having more cognitive capacity would enable one to preserve self-interest by lying (van't Veer, et al., 2014).

At the same time, those without dementia could be considered more cautious in responding, paying more attention to specific sub-factors or words on both survey occasions, thus provoking the resulting internal consistency among the group (lying when asked if angry, depressed, forgetful etc.).

It is posited that giving socially-desirable responses and agreeing, might be a learned behaviour for presenting a "good face" regardless of the situation (Ross and Mirowsky, 1984).This could have been the case regarding responses in the study.

Further, one source opines that cognitive ability can predict response bias in reasoning with greater cognitive ability provoking more response bias (Zhu, et al., 2010).

More research is necessary to test the POMS internal consistency among those with dementia as well as contrasting findings with non-dementia groups to ascertain the impact of the disease. This is necessary to ascertain what influences this disease and/or cognitive dysfunction has on internal consistency of mood assessment scales. The creation of a mood assessment tool specifically for those with cognitive dysfunctions could be an important implication based on these results.

General Descriptive Findings

In addition to the already statistical evidence, the research highlighted other descriptive findings. The mean TMD values analysed for the negative sub-factors of Tension-Anxiety (1.47), Depression (1.82), Fatigue (2.76) and Anger-Hostility (0.94) were more pronounced for the HGL whilst only Vigour-Activity (7.88) presented a mean TMD value more pronounced for the LGL. Confusion-Bewilderment was similar for both meal types (HGL=3.81 and LGL=3.80). This further supports the already established perspective that LGL meals are more likely to present positive mood-outcomes (Young and Benton, 2014). Likewise, the descriptive results showing the mean TMD values for all negative moods for the HGL meal are supported by existing evidence (Breymeyer, et al., 2016). Interestingly however, the Anger-Hostility sub-factor TMD mean values were the lowest of all sub-factors with the HGL= 0.94 and LGL= 0.60.

This could be due to the good environment and service provided by all the research facilities (discussed in another section) or simply the personal biases of participants when responding to negative words as expressed previously.

Care Homes

On a care home level, two of the four care homes (1 and 4) saw statistically significant relationships between LGL meals and positive moods as according to paired t-test results. In care home 1 t(14)=5.73, *P*<.001 and Pearson's r=0.11 while in care home 4 t(25)=3.53, *P*=0.002 and Pearson's r=0.25. From a dementia status standpoint, the dementia groups presented statistical significance (paired t-test) concerning the association between the LGL meal consumption and positive mood in homes one, two and four. In care home one results for this sub-group showed a t(6)=5.23 and *P*<.001, while in home two a t(23)=3.03 and *P*=0.006 and in home four a t(15)=4.44 and *P*<.001. In the non-dementia groups only care home one showed statistical significance for the LGL meal and positive moods with t(7)= 3.38 and *P*=0.012. These results support what was observed in the overall findings i.e. the LGL and positive mood outcomes phenomenon is more likely and stronger in those with dementia.

Descriptively, the ordinal data all of the four care homes showed larger responses for the Vigour-Activity after LGL consumption compared to HGL. The inverse (negative subfactors) showed greater responses for the HGL. Various factors can account for these differences in the results for each research site. These are discussed in another section (Section 6.1.7-Factors to consider when examining the GL-mood dynamic).

6.1.4: Nutrient profile of foods offered in the care homes (secondary objective c)

The nutrient analysis was carried out using the Nutritics Software. The software allows the user to select the recommendations they require. The SACN/2017/COMA nutritional targets were used as they are more universally accepted in the UK. Further, whilst the research is population based and residents were not monitored throughout the entire day, the study of nutrients examined the most frequently consumed meals within all care facilities for breakfast, lunch and dinner (meals referring to all food consumed at one sitting). Of note from the results was the omission of snacks in the nutrient analysis. This omission will be discussed below.

Omitting snacks from overall nutrient analysis is common in nutritional research and is done due to the large variability in quantity, duration and timing of snacking per individual (Vucea, et al., 2017). This variability is often experienced in care homes, where, although "standard snacks" may be offered at a given time period, residents also receive food items from visitors on a daily basis or where able, buy or make their own snacks at various intervals. Additionally, residents will go out with friends or family and their eating habits not known to the care home. Thus, only the standard meal offerings of the care homes could be taken into consideration.

Energy

Based on the software SACN/2017/COMA guidelines, an energy target of 2025 kcal is recommended for the study group in question. On average, the daily caloric energy was found to be 431.2 kcals below target. In contrast, the NHS recommends for an adult male, 2500 kcal and for an adult woman, 2,000 kcal a day (NHS, 2016). Even when compared to the NHS recommendations for the general adult population, regardless of gender, the daily caloric energy results are still insufficient.

When age is examined, the SACN (2011) recommends for the age group 25-34 years, males should obtain daily caloric energy of 2749 kcal and females 2175 kcal. These differences in caloric energy among age groups are expected when one compares older adults to their younger counterparts. Both the SACN (Scientific Advisory Committee on Nutrition) and NHS guidelines are based upon persons maintaining a healthy weight and who are moderately active (NHS, 2016; SACN, 2011). Differences in results based on gender were not a focus of the study. Gender as a variable would not have assisted in meeting the study objectives or answering the research question. Regarding energy, older adults are known (specifically those residing in care homes) to be less active with an overall decrease in appetite with the progression of age (Smith, et al., 2018; Pilgrim, et al., 2015). Food intake drops by about 25% from 40 to 70 years of age (Nieuwenhuizen, et al., 2010). This phenomenon is referred to as the anorexia of ageing (Landi, et al., 2016). Consequently, the software used was calibrated to examine energy offerings of food for light to non-active older persons over 60 and hence why the target recommendations are lower than those previously expressed. Whilst this generalisation afforded the study with the population data required to meet its objectives the inclusion of gender for the examination of energy offerings would have afforded more specific data for this variable. Future research based on the energy findings of this study should consider the incorporation of the gender variable.

A deficit of over 400 kcal was anticipated from the analysis given the exclusion of snacks. Snacks offered or eaten during the day are often high carb or high fat snacks with the aim of increasing overall caloric consumption i.e. weight gain particularly in those residents suffering from malnutrition and weight loss (Public Health Agency, 2014; Zizza, Tayie and Lino, 2007; Caroline Walker Trust, 2004).

This is generally practiced given the susceptibility of older adults to suffer from malnutrition as one of the main contributors to the Geriatric Syndrome as previously mentioned (refer to Older Adult Nutrition).

Further, it has been suggested that smaller, finger foods often more colourful and flavourful are more appealing to residents (especially those with dementia) than set on a plate (Caroline Walker Trust, 2004).

From a care home perspective, all but one care home presented an average caloric intake of 1500 kcal and above. In the facilities with the lowest caloric intakes, it was observed that the second meal options at lunch or dinner were generally affording lower caloric energy to residents. This is due to foods offered as alternatives or second choices being often vegetarian in nature or considered "lighter" meals (having a lower caloric contribution). Additionally, alternative meals are offered where residents do not want the main meal prepared and could consists of sandwiches, soup, salad, quiches, fruit or yoghurt (as per menus examined). In contrast, care home two offered meals of similar caloric content instead of a vegetarian option. This perhaps explains why this care home had the highest daily caloric energy offering at 1855.17 kcal on average. Care homes should thus aim to provide alternative menu options that offer similar caloric energy and macronutrient amounts as the regular options. Ensuring this would require the requisite knowledge in nutrition as well as menu planning.

There are other characteristics within the researched care homes that could explain the differences in nutrient analyses, as well as recommendations that other sites could employ. These are discussed in detail in other subsections of the discussion.

Macronutrients

From the nutrient analysis, macronutrient intake overall was satisfactory. Daily carbohydrate intake was 210.07 grams, protein= 59.33 grams (target 60 grams) and fat= 57.2 grams (target <79). Both protein and fat were within target with carbohydrate intake being 42.93 grams below target. This deficit in carbohydrates was expected given the exclusion of snacks from the analysis (as snacks generally are carbohydrate rich). The inclusion of snacks may have also increased the fat amount, but given the nutritional nature of most snacks it is estimated that daily amount of fat would not have surpassed 79 grams.

Of prime interest to the researcher were carbohydrates. Carbohydrates provide most of our dietary energy (Carreiro, et al., 2016). SACN currently suggest that total carbohydrates (starch, sugars and dietary fibre) should provide 50% of our daily food energy (SACN, 2015).

The Institute of Medicine (IoM) of the US recommends to American and Canadian adults to get 45-65% of daily dietary energy from whole-grain carbs while the WHO also opines a similar goal regarding carbohydrates with the caveat that only 10% of this should come from sugars (IoM, 2005;WHO, 2015). Based on the general results carbohydrates represent 50% of the total dietary energy of all participants. This trend was also generally seen in each care home on a weekly basis with intake most often surpassing the 200 g mark. Differences existed between first and second options in some care homes that can be explained due to "lighter meals" or vegetarian ones being offered as second options. These meals tend to contain less sugar than the first options. Whilst carbohydrates generally did not surpass recommended amounts, results differed where the type of carbohydrates were analysed.

The results in overall carbohydrates could suggest a focus by care homes to ensure sufficient dietary energy to its residents (bearing in mind snacks were excluded in the analysis). The results for the different carbohydrates (fibre and free sugars), however, tell two different tales.

Fibre

Fibre plays a significant role in the release of glucose as it reduces/slows this activity and thus could affect any relationship between the GL and mood outcomes (Lattimer and Haub, 2010; Brennan, 2005). The UKSACN recommends 30g daily of fibre for adults (SACN, 2015). However, the daily average of all care homes was just about half of this amount (14.5g). Respective care homes presented daily fibre amounts between 12.26g-17.5g.

In the UK, according to the British Nutrition Foundation, a deficiency in fibre continue to be a significant challenge in the population regardless of age group (BNF, 2018). The average intake of fibre was 20.1g (men) and 17.2g (women) (BNF, 2018). Both amounts below the recommendation. The general population just is not eating enough fibre in quantities that could be beneficial health wise. Sources of fibre including breakfast cereals, legumes, bread, fruits, nuts and vegetables (Dhingra, et al., 2011) were the most common sources in the care homes studied.

Low fibre intake has been associated with constipation and some gut diseases (Lockyer, et al., 2016) whilst in contrast, high fibre diets can help reduce cholesterol, the risk of type 2 diabetes (by improving glycaemic control), some types of cancers, and could potentially help protect against overweight (Tucker and Thomas, 2009; Weickert and Pfeiffer, 2008; Terry, et al., 2001). The implication of these results could include supplementation within the research sites as well as improving menu-planning (Refer to Contribution and Implication section for further information).

Importance of fibre in the health of older adults

Several studies have pointed to a global trend of insufficient fibre intake in the older adult population (Berner, et al., 2002). This fibre insufficiency is often due to problems with chewing food and other issues associated with food intake (Dror, 2003).

Dietary fibre is important for a number of reasons in older adults. Of interest to this study is the potential positive impact of sufficient fibre intake on the rate of gastric emptying. Slowing down the rate of gastric emptying aids in regulating postprandial glucose response that could result in more positive mood outcomes (Babio, et al., 2010). Dietary fibre has also been shown in older adults to reduce the risk of several chronic diseases to include diabetes, obesity and cardiovascular diseases as well as reducing cholesterol (Anderson, et al., 2009; Krishnan, et al., 2007; Pereira, et al., 2004). One source even suggest that dietary fibre could also play a role in longevity (Park, et al., 2011). In effect, older adults stand to gain from having adequate fibre in their diets, as it will consequently influence health outcomes and quality of life.

Free Sugars

The National Diet and Nutrition Survey (NDNS) 2012-2014 (NB- this is a rolling survey occurring every two years) highlights free sugars (also referred to as added sugars or non-milk extrinsic sugars) as one of the foods being consumed in excess by the UK population (NDNS, 2016). This is the case for all age groups with greater consumption in children 4 to 10 and 11 to 18 years with both groups surpassing the 11/10% food energy limit (NDNS, 2016).

The results from all care homes found a free sugars daily average of 64.07g, more than double the recommended limit of <25.3g (five sugar cubes) of the software used. This amount also passes the NHS current free sugars recommendation for adults of no more than 30g a day (NHS, 2016).

Among the four research sites a range between 60.63g-67.67g was found. This could be because care homes studied, as the general population are not fully aware of the vast amounts of free sugars in the foods consumed daily (Patterson, et al., 2012). What perhaps is even more noteworthy is the amount of free sugars that would be calculated if daily snacks were taken into consideration during analysis. The large amounts observed were attributed to juice drinks as well as the large variation of desserts within care homes (with some offering dessert options). This is another contribution of the study as this information could improve the menu offerings of each research facility.

The evidence could also be used to inform guidelines and daily nutritional recommendations specifically for older adults given the known health implications of excess added sugar in the diet.

Explaining the large consumption of free sugars identified.

Organisations such as the Caroline Walker Trust suggest high carbohydrate (sugar) or high fat diets for older adults including those with dementia (Caroline Walker Trust, 2004). The rationale behind this is that older adults have a reduced appetite and as such tend to consume less food (Pilgrim, et al., 2015). Consumption of less foods results in less caloric energy and can lead to a number of complications, chief among them malnutrition (Demling and DeSanti, 2005). To combat this fact, offering higher caloric diets seeks to counteract this low caloric output from reduced food consumption.

Yet another explanation could be the issues of taste, palatability and sensory-specific satiety. While taste perception may decrease with age, evidence suggests the sweetness threshold is 1.3 times higher in older adults when compared to their younger counterparts between the ages of 19-33 years (Mojet, et al., 2001).

Evidence also points to an increase in higher intakes of sweets and fats (particularly in older women) when sensory perception such as smell is reduced (Duffy, et al., 1995).

Regarding palatability, flavour is known to improve the consumption of a food (Gerstein, et al., 2004). The addition of sugar (to improve sweetness) is one of the main ways of enhancing flavours with this technique being used in older adults to compensate for chemosensory decline due to age (Slavin, 2014; Spillane, 2006). Older adults have been found to choose flavour as the strongest factor influencing their food selections (Krondl, et al., 1982). Nutritional intake in one study was shown to improve in older care home residents when food flavour was enhanced (Henry, et al., 2003).

Whilst flavour enhancement through sweetness is an important aspect of increasing food intake in older adults, it should not be done haphazardly as excess free sugars have been implicated in numerous diseases affecting the older adult population from cardiovascular diseases to type 2 diabetes (WHO, 2015). It is therefore important that care home menus be properly planned from a nutritional standpoint. The results from the study highlight a common trend with the general population. The excessive consumption of free sugars could have serious implications on the health outcomes of care residents. The creation of free sugar guidelines specifically for care home menus could be a way of combatting this trend. Additionally, further study in nutritional science is also vital in finding methods of improving food palatability without increase sweetness.

Select Micronutrients

Currently there is a lack of specific recommendations for older persons where micronutrients (referring to vitamins and nutrients) are concerned (Clegg and Williams, 2018). Existing guidelines promote the same amounts for all adults (BNF, 2009). However, this may be problematic, as it has been shown that with age one's ability to digest and metabolise different minerals decreases (Shlisky, et al., 2017). While almost all micronutrients were analysed in the study, a selection were presented as part of the study results.

The micronutrients mentioned showed generally stark deficient intake while others presented unanticipated outcomes. Most of the micronutrients selected formed part of a National Survey (as presented in the section Older Adult Nutrition) looking at the results of institutionalised older men and women versus their free-living counterparts.

Vitamin D

Vitamin D deficiency is one of the most common micronutrient deficiencies in older adults (ter Borg, et al., 2015). In the UK 1 in 5 persons, have vitamin D levels below 25nmol/L (serum levels) (BNF, 2019b). This vitamin is important to maintain a healthy musculoskeletal structure (Boucher, 2012). The results of the analysis found vitamin D daily offerings at a low of 2.7 micrograms, which is well below the required 10 micrograms daily recommendation. This deficient intake existed in all four care homes, and reflects the national survey results for those living in care institutions (BNF, 2018). Existing evidence also reflects this trend in vitamin D deficiency (Milligan, Bridges and Christides, 2012). The lack of vitamin D in the foods offered in the study care homes is further compounded by two other challenges.

Firstly, the skin of older adults is not as efficient at producing vitamin D from the sunlight (Gallagher, 2013). Secondly, the production of vitamin D from the sunlight requires being in direct sunlight to allow the ultraviolet B rays (UVB) to penetrate the skin and activate this synthesis (Engelsen, 2012). Most institutionalised older adults are less active and go out less in the sunshine further compounding the problem (Boucher, 2012). The study (though it looked at nutrient offerings from the menus) was conducted in during winter in two care homes and if individual vitamin D levels were checked this would have had an effect. Environmental factors such as the geographic location, time of day, season (e.g. winter), weather conditions, air pollution etc. can all affect vitamin D production. During winter, there is naturally less sunshine and the sunlight in question does not contain sufficient UVB radiation (Engelsen, 2012).

The study is confident that residents in the care homes were not receiving sufficient vitamin D from the diet or nature. It is for these reasons why other sources of vitamin D should be afforded to residents. A daily vitamin D RNI of 10 micrograms (400 IU/d) throughout the year for everyone in the UK over the age of four years old (SACN, 2016).

Consumption of sufficient vitamin D reduces the risks of osteomalacia, falls and poor muscle strength in older adults (Mosekilde, 2005; SACN, 2016).

Vitamin C

In contrast to vitamin D, vitamin C was consistently above the recommended amount in all care homes, though falling slightly in some weeks. Based on the analysis, the large supplies of vitamin C came from expected food sources to include fruits, fruit juices, sweet potatoes and green vegetables such as brussel sprouts, cauliflower, spinach etc.

These amounts of vitamin C bode well for the residents. It aids in the production of neurotransmitters, which play an important role in one's mood, assists in the formation of white blood cells (thus boosting the immune system) as well as the formation of collagen which is an important element of the skin, bones and teeth (Pullar, et al., 2017; Carr and Maggini, 2017).

Vitamin B12 and Folates

Vitamin B12 saw an unexpected result and was well above what is recommended. Folates though slightly below the 200 micrograms recommendation was also an unexpected result. Both micronutrients are mentioned here together as they work in partnership in the creation of red blood cells and the proper functioning of iron in the body (Mahmood, 2014). Vitamin B12 deficiency is often common in older adults as with age, the intrinsic factor needed for it be absorbed efficiently is diminished and thus B12 absorption decreases (Hughes, et al., 2013). The absence of major deficiencies in these micronutrients suggests that perhaps some fortification of foods occurs throughout the care homes studied.

Iodine and Selenium

Both iodine and selenium were below the recommended targets of 140 micrograms and 75 micrograms respectively, though not extremely deficient. Iodine is a mineral necessary for the production of thyroid hormones (T4, T3) which regulate growth and metabolism (Lingvay and Holt, 2012; Williams, 2008). The UK population has been considered as having sufficient iodine for decades (Phillips, 1997). The most recent studies however, have shown mild to moderate iodine deficiencies (Vanderpump, et al., 2011; Bath, et al., 2010; Rayman et al., 2008). This level of deficient intake is likewise reflected in the findings.

Though deficiencies in iodine present greater effects during foetal development and infancy (Zimmerman and Boelaert, 2015), the decrease in thyroid function with age can cause cognitive impairment, hypertension, frailty and osteoporosis in older adults (Barbesino, 2019). Though no studies examining the deficiency of iodine in care home residents specifically in the UK were found, evidence from a New Zealand study did find mild iodine deficiency among the elderly in care facilities attributed to poor fortification of foods there (Miller, et al., 2016).

Connected to deficient iodine intake is the deficient intake in selenium. This lack of selenium can provoke an interference with iodide utilisation through reduced deiodinase activation of fT3 and fT4 (Hess, 2010). The results obtained for selenium in the analysis almost perfectly mirrored the generally low selenium content of foods in the UK and Europe (Stoffaneller and Morse, 2015). The estimated intake of this micronutrient in the UK according to the Public Health England- Food Standards Agency Rolling Diet Survey (NDNS, 2016) is 39 micrograms /day compared to the study results of 37.93 micrograms on average daily. Selenium is essential for a number of biochemical functions in the body with its selenoproteins involved in immune function, thyroid hormone protection and sperm formation reactions (Rayman, 2012; Terry and Diamond 2012).

Other nutrients presented.

Iron results were slightly below the recommended amounts of 8.7 mgs with 7.73 mgs on average. Among the care homes daily iron from the menus ranged between 7.05-8.27 mgs. These results the opposite of what is presented in the national survey (refer to Older Adult Nutrition section) which highlighted larger percentages of both institutionalised men and women being below the LRNI for iron. These results suggests that care homes in this study are doing relatively well in offering foods rich in iron.

Testing of participants iron levels would potentially reveal high levels of iron not only from the iron rich foods offered on the menu (red meat, chicken , darken green vegetables) but also due to the offerings of vitamin C rich foods as this micronutrient increases the absorption of non-heme iron (Heffernan, et al., 2017).

Calcium was also slightly below the recommend 700mg daily at 659.5 mg. This result not universal in all care homes as care home three surpassed the recommendation by 36.75 mg on average daily. The reasoning for this appears to be the more balanced nature of meals in care home 3 when compared to other homes. The options in the three other care homes were not similar in calcium offering with the first options offering more than the second does. The deficiencies in the second options would have reduced overall calcium calculations for those homes. The discrepancies should be remedied with better menu planning or fortification (refer to Recommendations) as calcium like vitamin D is important for strong bones and teeth particularly in older adults given their risk of osteoporosis and frailty (Beto, 2015).

6.1.5: Glycaemic Load Analysis Discussion (secondary objective b)

Analysis of the GL of all target meals within the four care homes found a GL on average for the HGL meals of 83.56 and the LGL meals of 18.47. Based on the classification of GL of foods (less than 20 low, more than 20 high) these meals fall into the correct categories ,considering the study examined entire meals and not foods. GL values were consistent among the target meals selected. The GI values mentioned in the results were only used for the calculation of GL (please refer to section 4.6.3 for the explanation of meal GL calculation). The target meals selected were most frequently consumed by the majority of participants and presented similarities with warrant discussion. In prefacing this discussion, it must be stated that the GL of a meal is different from the GL of a single food.

A meal's GL encompasses all its contributing foods and as such high GI/GL foods will play a key role when meal GL is calculated. However, how these foods are prepared as well their constituent nutrients cannot be overlooked.

GL of meals

A review of the HGL target meals in almost all care homes (save one) were the lunch meals. From the study's systematic review, most GI/GL studies of an intervention nature would examine/focus on breakfast. It was anticipated that breakfast would have been a target meal for HGL in this instance. This was not the case however for one reason. Though breakfast does have a tendency to be high carbohydrates in most western countries due to the consumption of starches, sugars and grains (Gaal, et al., 2018), the quantity of food offered in care homes are different between lunch and breakfast. In most of the care homes lunch was not a single food, it consisted of a starter, main, dessert and a drink. Whilst breakfast (though varied) most often included a serving of cereal/porridge, toast with jam/butter, juice, tea or coffee.

Therefore, though one could correctly state that a single breakfast food had a high GL the study examined meals consumed at one sitting, the larger components of the "heavier lunch" meal would potentially contribute a greater quantity of carbohydrates and thus a more optimal selection for the highest GL. On the other hand, all of the low GL target meals were supper. These similarities were expected given what normally constitutes a supper care home meal (i.e. a lighter meal when compared to lunch).

Constituent foods and preparation

The HGL meals selected all were constituted by high starch or high sugary foods. High starch and sugary foods all contain large amounts of carbohydrates, the main macronutrient in determining GL of foods (Brouns, et al., 2005).

The specific foods positively associated with higher GI/GLs included braised rice, treacle tart, asparagus risotto, roast potato, lemon meringue pie, rhubarb crumble, steak pie with flaky pastry top, clotted cream rice pudding and croquette potatoes.

Given the lack of evidence regarding GI and GL of the eating habits in the UK, the existing evidence in other developed countries does point to the type of foods mentioned in Table 21 as contributing significantly to dietary GL. The 2012 National Health and Nutrition Survey, Japan found that regardless of sex, white rice was the top contributor to dietary GL (Murakami and Sasaki, 2018).

Evidence mapping and comparing the dietary patterns of adult Australians during the last two national nutrition surveys found the top twenty food groups contributing the most to dietary GL included white potatoes (5th), flours, cereals grains and starches (4th), sugary sweetened beverages (6th), cake-type dessert (8th), pastries (10th) and bread and rolls being 1st (Ridout, et al., 2016). Further, one major study done on ultra-processed food consumption and chronic non-communicable diseases found that the UK population was consuming more ultra-processed meals when compared to other European counterparts (Rauber, et al., 2018). These processed foods tend to be high in carbohydrates and consequently present high GLs (Poti, et al., 2017).

On the other hand, the low GL target meals whose main constituent were rich in proteins, high fibre, vegetable based or contained dairy. Although these meals also included desserts which high carbohydrates, the GL of the meal was significantly less due to the characteristics of the main constituent groups previously outline. These foods and their respective GL and GI are mentioned in table 22 of Chapter 5.

The glycaemic characteristics of the foods mentioned previously in tables 21 and 22 would have been influenced by preparation methods. Lower sugar content of foods as well as less sugar added during cooking along with the increase of protein and fat

(relative to carbohydrate amounts) would have a reductive effective on the glycaemic characteristics of foods (Wolever, et al., 1994). The presence of cheese or other dairy products being added to foods is a prime example of lowering GI/GL during cooking (Jenkins, et al., 2006). Other ways of lowering GI and by extension GL include the boiling of foods instead of roasting or baking (Bahado-Singh et al, 2006) as well as the addition of nuts/legumes to food (Henry, et al., 2006; Ostman, et al., 2005).

6.1.6: Nutrient Density and its relationship to GL (secondary objective d)

Results pointed to a linear positive relationship between a meal's GL and its nutrient density where R^ value of 0.012037, sig f= 0.012133 and P<.001 pointing to a strong correlation. This suggests that high GL meals are more likely to have a higher nutrient profile number and thus providing the body with less nutrients compared to their low GL counterparts (note that foods with low nutrient profile numbers have great nutrient density). One source opines that foods with a relatively high-energy content, (normally from their added sugars), are commonly less nutrient dense (Troesch, et al., 2015; USDA, 2010). The study findings agree with this source as most of the high-energy foods i.e. carbohydrate rich tended to be present in HGL meals.

From the analysis, individual foods rich in saturated fat, total sugars and sodium tended to include dessert options such as chocolate eclairs (19), jam roly-poly (16), quiche Lorraine (19), lemon posset (23), chocolate cake (19), bacon rashers (20), cheese and potato flan (15) and the like. Whilst those foods which were fruit or vegetables, nuts or contained large amounts of these food items, as well as fibre, as expected were considered more nutrient dense having lower nutrient profile numbers. It should be noted that the UK Ofcom Model was not designed to carry out analyse of meals but rather separate foods (Department of Health and Social Care, 2011). Interestingly however, the analysis was carried out examining both meals and constituent foods.

Even when meals were examined the relationship between the GL and nutrient density was still evident expressed by the same simple regression results mentioned prior. This could suggest that a mixed meal that is largely constituted of protein, fruits, vegetables, nuts or fibre, but also contains foods rich in saturated fats, sodium and/or total sugars will most likely have a lower nutrient profile number (higher nutrient density). Consequently, it will have a low GL when compared of a meal that is largely made up of the inverse.

No previous evidence in literature to the researcher's knowledge, specifically correlating the GL of a meal and its nutrient density has been found. Further study would be necessary to establish a relationship between GI and nutrient density.

6.1.7: Factors to consider when examining the GL-mood dynamic

The factors that are discussed in this section should be considered when assessing the relationship between the glycaemic load and mood outcomes to properly contextualise the findings. Each factor could potentially play a key role not only in this relationship but also in improving the health outcomes of older adults residing in care homes. The linkage between these influential factors and the GL-mood dynamic present a research conceptual framework (Figure 43). This created framework can be used in future as the basis for further research in the behavioural nutrition field where all of these factors a necessary in contextualising research findings. Some of these factors were noted due to observations by the researcher. Two factors mentioned in the image that follows have already been discussed in previous sections of this chapter (Nutrient Density and Nutritional Adequacy of meals) as part of discussions of the research objectives.

Figure 43: A conceptual framework borne out of the GL- mood dynamic and the related factors that could present influence.
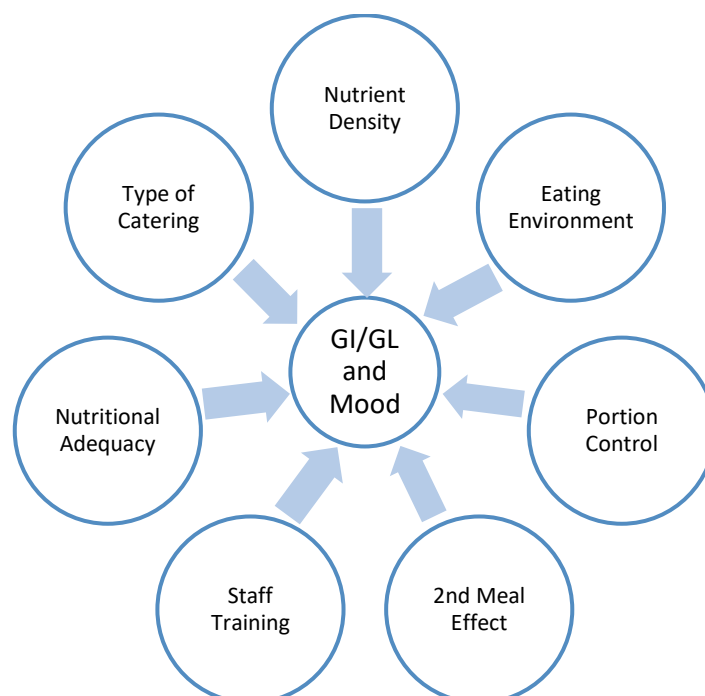
6.1.7.1: Type of Catering

The quality of meals is an important component in ensuring healthy eating patterns in older adults (Holmes and Roberts, 2011). A review of the research sites found that two of the sites received outside catering (site one and four). Site one receives foods from a catering company on a weekly basis, food is stored and then cooked or prepared on a daily basis with the use of the company's menus. In the case of care home four, prepared portioned meals are received twice weekly from another company and meals are heated up on site, temperature checked, unpacked from containers and then given to residents. On the other hand, care homes two and three, both larger in size and occupancy, source only raw materials preparing and cooking all meals on site, with care home two using mostly organic foods prepared in accordance with the UK Care Home Framework 2017 and Dining with Dignity Guidelines 2017.

The aforementioned catering characteristics could have influenced nutrient analyses as homes which prepared all meals on site presented better nutrient adequacy (i.e. met nutritional requirements or presented highest nutrient content as per menu offerings).These sites specifically presented better micronutrient offerings when compared to the sites which had catering. On the other hand, site 4 which received packaged, frozen portioned meals presented much better results for macronutrients (including carbohydrate groups of free sugars and fibre) when compared to general averages with the other catered site presenting the worst nutrient results of the group assessed. This suggest that preparing and cooking meals on site may offer much more nutrients for residents. The notion of freshly prepared meals having more nutritional content than those from frozen is an area of contention as nutrient retention is dependent on food type, duration of frozen storage, temperature during freezing and the different methods used to prepare foods for the freezing process (blanching) (Pupponen-Pimia, et al., 2003; De Ancos, et al., 2000).

Some evidence points to nutrient retention after freezing (Mullen, et al., 2002; De Ancos, et al., 2002) whilst others suggest the contrary (Sahari, et al., 2004; Chaovanalikit and Wrolstad, 2004). What may perhaps affect the micronutrient content of precooked catered meals may be the reheating process, as studies show increased micronutrient loss due to heating (Yuan, et al., 2009).

 It could be argued that the company preparing these frozen catered meals focused on ensuring consumers would receive adequate macros (given the need of older adults to obtain as much caloric energy as possible from carbohydrates and fats) without much consideration for micronutrients. This however cannot be sufficiently supported with evidence. Retention of micronutrients is known to be affected by some cooking methods (Sikora et al., 2008; Cieslik, et al., 2007; Lin and Chang, 2005). The USDA Table of Nutrient Retention Factors highlights the maximum percentage of nutrient loss

from various food preparation methods (United States Department of Agriculture, 2007). Of importance to this section were the effects of freezing and reheating. According to this source, almost all minerals and vitamins are affected by the freezing process with maximum nutrient losses of at least 5% with some nutrients presenting a loss as high as 30% (vitamin C). When foods are reheated the loss of vitamins further increases with an average maximum of about 10% (vitamin C, folates and vitamin B12 having maximum nutrient losses of over 30%) while minerals were unaffected. This could explain the results of the sites that received catering. Care home 2 received catering but present much lower nutrient results than site four. Therefore, the issue of catering is not the only one that should be considered when placing the results in context.

6.1.7.2: Staff Training and Nutritional Knowledge (including menu planning).

Evidence suggests that nutritional knowledge has a significant impact on food intake (Alaunyte, Perry and Aubrey, 2015; Wardle, Paramenter and Waller, 2000). This knowledge could also bode well for proper menu planning. Among the research sites, care home two was the only one that had all staff (both kitchen and care) trained in dining and hospitality as well as diet and nutrition. The home also employs a Food Services manager with experience in the food and hospitality industry. Similarly, care home three also employed someone knowledgeable in Nutrition (Nutrition Manager) as well as ensuring all kitchen staff were trained in nutrition. Care home one had no one trained in nutrition with kitchen staff following set menu form caters whist care home four also followed an established menu given by caters, though with the ability to select the prepared meals they wanted. The head chef however, was the only member of staff with basic training in nutrition received from the catering company. Where these absences of nutritional knowledge existed there appeared poorer nutrient

adequacy of menus based on the study results (as reflected in the poorer nutrient adequacy results for care homes one and four).

Further, care homes two and three both presented much more variety in food offerings when compared to their counterparts. This may have increased the probability of nutritional output due to meal diversity. Care home three, however had greater meal diversity as it used a three-week menu cycle and eliminated the traditional second meal vegetarian option based on resident eating habits. This relationship between nutritional knowledge and nutrient offerings would have been reflected in the design of the menus as those care homes with catering did not regularly update their menus nor consulted frequently with residents during the planning process. The Nutritional Manager in care home 3 and the Food and Hospitality Manager in care home 2 both met regularly with residents to discuss meal suggestions, which aided in the development of menus.

Whilst all homes with staff trained in nutrition presented better nutrient offerings, the glycaemic characteristics may not have been considered. Incorporating the glycaemic index and load of foods on the menu may have a positive result on overall health. The fluctuation in GI/GL values of the meals analysed within the homes suggests that this was not done. This could suggest an overall lack of understanding or knowledge of GI/GL within all care homes (especially those with nutritionally trained staff). Given the evidence, which suggest that most in the food and nutrition sector are not adequately knowledgeable of the GI/GL, this explanation seems most likely (Kalergis, et al., 2006).

One difference with the menus was observed in care home three where the decidedly heavier meal of the day was supper as opposed to lunch (as is common in most care homes and observed in the other study sites). The rationale behind this was to afford residents better sleep during the evening with a heavier meal before bed as the Nutrition Manager observed this. This rationale had no observed effect on the mood

outcome as results from this care home found no t-test significance though Pearson's correlation showed evidence of a linear positive relationship.

Evidence from a cross-sectional study of 867 adults (375 men and 492 women) does suggest however that this practice could have implications for body composition and weight gain as eating later in the day is less satiating and leads to greater daily caloric intake when compared to food eaten in the morning (favouring an increase in weight gain (De Castro 2007; De Castro 2004). More recent data however is finding this suggestion inconsistent as smaller, nutrient-dense, low energy and/or single macronutrient foods (less than 200 kcals), eaten in the evening may hold some benefits (Ormshee, et al., 2015; Madzima, et al., 2014; Kinsey, et al., 2014).

 One factor that could have influenced the results in this as well as other care homes however, is the second meal effect.

6.1.7.3: The second meal effect

The second meal effect though not fully understood could be divided into two groups: breakfast to lunch effect and the overnight effects (Ardvisson-Lenner, et al., 2004). As breakfast was not a target meal in any of the care homes studied, the breakfast to lunch second meal effect can only be considered. Bearing this in mind, only three care homes had lunch as a target meal (homes one, two and four). A review of all breakfast combinations, including the most common generic option of porridge, OJ, toasted bread with jam, all breakfast options tended to have a GI of above 50 with varying degrees of fibre content. (Rationale for high GI/GL breakfasts is discussed in the Systematic Review mentioned in section 3.4). These observations suggest that the second meal effect could not have played a role in the results on mood in the study. Perhaps the phenomenon was present were the supper meals overnight effects on the high GI breakfast options examined. This however was not a focus of the study.

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Supper meals were generally low GI/GL and most likely would have exhibited meal effects had breakfast been identified as a target meal, possibly affecting mood outcomes after this morning meal.

Given that, this phenomenon is still not yet fully understood (Wolever, et al., 1988) these possibilities are mere speculations warranting further investigation. These investigations would require blood samples to track blood glucose and insulin levels to accurately make a conclusion. In this study, the second meal effect most likely had no effect on glycaemic response on the times moods were examined and this was not a confounding factor.

6.1.7.4: Portion Control

In order for older adults in care homes to both achieve and maintain adequate nutrition, knowledge of standard portions and serving sizes is vital (Caroline Walker Trust, 2004). In discussing portion control within the care homes, four influential factors (mentioned in section 2.7.2) are examined.

Care homes with staff presenting knowledge of nutrition were shown to have more standardised portion sizes and serving methods. Both care homes two and three followed established recognised serving guidelines. In care home 2, the British Nutrition Foundation's guide was followed and all staff (careers and kitchen staff) were trained in food handling and nutrition. This care home presented some of the best macro and micronutrient offerings when compared to other sites. Knowledge of correct portions can possibly be overridden however by habitual biases of servers. Home three, presented a Nutritional Manager, kitchen staff knowledgeable of nutrition as well as the use of existing portion guidelines, however, meals were often served based on the servers "knowledge" of residents, offering some residents more/less of certain food items to avoid wastage.

Even in these in circumstances, it is important to offer a balanced meal regardless of the size of the serving (i.e. amounts of proteins, fats should be juxtaposed appropriately to the amount of carbohydrates served).

Offering unbalanced servings, particularly excess carbohydrates (merely on the premise that a member of staff thinks a resident wants more) can significantly influence glucose as well as insulin concentrations in the blood, potentially impacting both mood and other health outcomes (Barton et al, 2000). Inversely, insignificant amounts of carbohydrates could also lead to states of hypoglycaemia characterised by fatigue, lethargy, malaise and even depressive states (Benton, 2002).Degree of knowledge by members of staff is therefore an important factor to consider in aspects of portion control to ensure correct estimations (Blake et al, 1989).

Interestingly, in the final home, where nutritional knowledge was lacking by members of staff, portion control was not an issue, as all meals (frozen) delivered to the home were previously weighed and properly portioned. The portion were in line with the British Dietetic Association Standards set by the National Association of Care Catering. Any adjustments made to serving sizes were done using portion size charts offered by the catering company as well as specific utensils to ensure correct portion sizes. Correct utensils are another important influential factor in ensuring portion control. These serving utensils were also employed in homes two and three. The use of portion charts and correct utensils could be recommended in other care facilities to reduce the habitual serving biases of staff.

One could argue that for care home four, though food consumed was not specifically measured, results for tension-anxiety, depression and anger-hostility, might suggest that offering accurately measured portion sizes supported better glycaemic loads and as a result better mood outcomes (noting also better overall macronutrient results and

above care home average amounts for fibre from a nutritional profile perspective). This cannot be the case however due in part to study design. The study identified target meals (one highest and lowest in terms of GL) consumed by most participants.

The fact that the GLs of meals selected were not vastly different when analysed suggests that regardless of some serving biases or precise predetermined portions, portions were similar among the care homes or that any impact different portions would have had on meals selected was minor. Further, from a descriptive standpoint, given the smaller number of participants from homes such as one and four, one would anticipate generally lower total responses for the sub-factors examined when compared to homes two and three.

Where portion control might have been more impactful would have been the overall nutritional profile of the menus examined where care home four with the most precise portions presented better macronutrient content (the opposite occurring with micronutrients). This situation is better explained in the context of meal quality (refer to section 2.6.2).

In addition to nutritional knowledge, utensils can also influence portion control. As a result, it will also affect consumption behaviour. The size of plateware, cutlery, as well as the shape of glasses will aid in determining how much food is ultimately consumed (Mishra, et al., 2011; Rolls, et al., 2007; Wansink and Cheney, 2005; Wansink and van Ittersum, 2003). Whilst this study analysed care home menus, residents had to consume the target meals selected for the purpose of the mood survey that followed.

Care home one, three and four (care home four plates were slightly smaller) used main course plates that were smaller than the accepted standard used in care home two. The so-called plate-size effect or Delboeuf Illusion was explained by Van Ittersum and Wansink and suggests that the size of an object changes based on the surroundings (Van Ittersum and Wansink, 2012).

In effect, a person will underestimate the quantity of food when it is placed on a large plate (meal appears smaller) or inversely overestimate when it is placed on a smaller one (Wansink, et al., 2006; Wansink and Cheney, 2005). This phenomenon could explain why most of the care homes used smaller than normal plates for main courses. In the case of home four, the plate size though slightly smaller than the standard had no effect on portion control. One could suggest that homes use smaller plates as residents tend to have less of an appetite and thus consume less food. Current evidence however, does not point to a direct effect between plate-size effect and reduction of food intake (Peng, 2017) with studies rejecting the notion that a small plate is most effective for reducing food consumption (Penaforte, et al., 2014; Robinson, et al., 2014).

Two of the homes used plates that were white in colour whilst home four used red plates whereas home two used white plates with a bright blue border for main courses. Colour not only affects the visibility and presentation of foods but also the perception taste (Genschow, et al., 2012; Harrar, et al., 2012). The bright borders around the rim of the plates allows more visibility of foods in care home two, and could positively affect the amount of food consumed and as a possible consequence mood outcomes (Oberfeld, et al., 2009).

On the other hand, home four used red coloured plates instead of white. This means the meals would have been less visible thereby impacting appearance leading to possible decreased consumption and consequently reduced responses to the mood survey. This was not the case however, because of the sensory experience phenomenon (Ou, et al., 2004; Maga, 1974).The sensory experience could have been plausible where the red plates could have become sensory queues. The residents already having prior experience to the colour of the plates, associate them with a particular taste, whilst the white dessert bowls used were associated with another.

This has been argued previously, suggesting a natural relationship between colours and tastes developing as a learned behaviour overtime (Oberfeld, et al., 2009; Deliza and McFie, 1996).

In all care homes similar lightweight cutlery were employed along with similar sized serving utensils. This similarity could explain why even in the home (one) where serving of meals occurred solely by the servers intuition, differences when compared to portion guidelines were small. The lightweight of cutlery would have allowed all participants to easier negotiate or manipulate their meals thus increasing consumption throughout care homes.

Evidence also suggests that the weight of cutlery could have an influence on the sensory qualities of food being consumed (Piqueras-Fiszman, et al., 2012). More research into these influences is necessary to ascertain further definitive conclusions.

The final influential factor on portion control to discuss in this section are the differences in societal norms associated with food portions. These normative ideals of staff, as well as study participants concerning portion control could have an impact. This was not the case in the study however, as all homes participating in the study presented the same societal norms.

Whilst norms did not play a crucial role in portion control in this study, it is important to this discussion to highlight normative assumptions that should be addressed. The term quality of life tends to refer to overall life satisfaction (Post, 2014). For some in the care industry, this may be interpreted as (more so from a nutritional point of view), to allow older adults to have whatever they want to eat, as they deserve it given their age or given their already reduced appetite. Getting older adults to eat as much as possible may be viewed as a positive.

Because of these perspectives, the nutritional dimension of overall life satisfaction and quality are generally overlooked leaving older adults at a disadvantage i.e. not receiving adequate nutrition.

In summary, portion control (nor its related influential factors), did not appear to significantly impact mood outcomes from the target meals as homes using more precise portion methods presented similar mood outcomes to those using less precise methods. Portion control may have been more influential in the nutritional analysis of menus. It plays an important role in contextualising nutrition-based studies.

6.1.7.5: Eating Environment

The life nourishment theory highlights the importance of both social and environmental characteristics in the food consumption process (Keller, et al., 2014). All care homes in the study presented generally similar eating environments suggesting some knowledge of the importance of surroundings to food intake. These similarities further reduced notions of confounding from this considered factor.

Consumption of food is known to be deeply linked to sensory interaction (Stillman, 2002). All dining areas were decorative, bright with matching tableware, flowers, artwork etc.

These well decorated/designed dining areas could have affected flavour perception of meals as well as the phenomenon of sensation transference (Oberfeld, et al., 2009; Nolan and Matthews, 2004; Deliza and McFie, 1996). Bright colours influence consumption expectations and emotion during the eating process where these colour-coordinated rooms could cause the sensation brought on by the colour of tableware etc. to be "transferred" to the meals and consequently provoke a different sensory expectation in a participant's mind, when compared to eating in a dull room (Piqueras-Fiszman, 2011; Deliza and McFie, 1996).

Related to this colour- sensation phenomenon is the presence of natural light. Lighting in addition to noise or music in the background as well as smell (odour) are considered atmospheric factors (Wansink, 2004).Light increases the visibility of foods, thus highlighting whether or not it is appealing (Gal, et al., 2007). Simply seeing a food can stimulate unplanned consumption (Sorensen, et al., 2003). In increasing visibility, natural light is most optimal for highlighting the appearance, textures and colours of food (McCrickered and Ford, 2015).

One source suggests that during the eating process persons are less self-conscious when lighting is low/dim and therefore (due to being less inhibited) will tend to consume more food with this tactic being commonly employed in restaurants to increase the eating duration and increase disinhibition of patrons (Shimizu, et al., 2012; Lavin and Lawless, 1998). All care homes examined used natural light during the day whilst ambient lighting was employed during the evenings. The study cannot state however, whether more food was consumed during the daylight or at supper in the evening as this was not a focus of the study.

Regarding noise and music, only homes two and three had some practice of incorporating music or ambient noise during meal times. This was only normally done at the request of residents. During the survey, days only care home three had ambient noise (TV playing in the living room area). Evidence suggests music or noise during eating can cause persons to reduce time in a dining area as well as increase the speed of consumption without paying much attention to the amount of food eaten (the objective becomes more about eating quickly just to leave the environment) (Caldwell and Hibbert, 2002). None of these effects seemed to have an impact on participants in care home three, as pace in eating rate was not changed.

Further research into these effects is required, however, the lack of influence in participants could have been the fact that the television volume was not high and the distance from the living room to the kitchen might have made it difficult for residents to hear these sounds.

The final atmospheric factor would have been smell/odour. Being able to smell food during the eating process or before, aids in increasing consumption amounts (Chebat and Michon, 2003). In almost all instances of the study residents could smell meals being prepared (excluding home four, where the eating environment was not near the kitchen, however meals on the trolley could be smelled just before being presented to residents).

These favourable smells work by activating a sensory-specific satiety mechanism favouring eating (Pelchat and Schaefer, 2000; Rolls and Rolls, 1997). On the other hand, the researcher speculates that had negative odours been identified, eating duration would most likely be decreased.

All of these environmental factors could have positively influenced the study providing improved results, as said factors were generally favourable in all care homes. A summary of the environmental settings at each care home is expressed in table 15 of Chapter 5.

Socialising and eating with others: Positive reinforcement.

All care homes in the study encouraged residents to eat as much as they could whilst also promoting a positive socialising atmosphere amongst both staff and residents during meal times. Socialisation is known to increase ow much food is eaten with some evidence pointing to an increase of food consumption by as much as 33% when eating with at least one other person (De Castro, 2000). This percentage is improved incrementally to as much as 96% when seven or more people eat together. The reproduced figure below, points to the relationship between social interactions and food consumption amounts (Wansink, 2004).

Figure 44: Highlighting the linkages between social interactions and food consumption volumes.
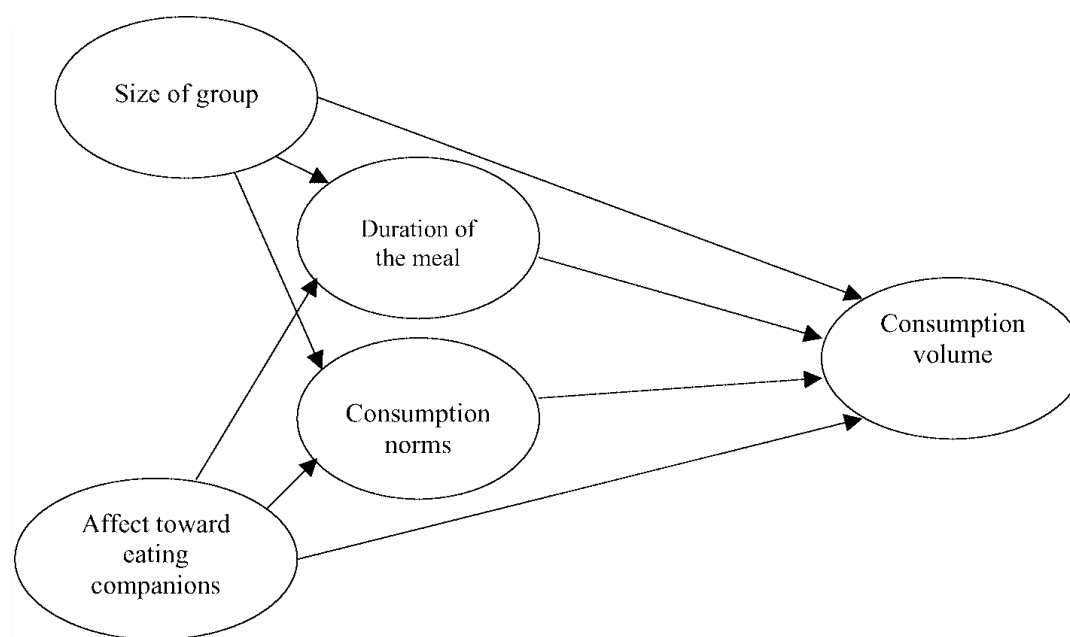
Source: Wansink, 2004

How does socialisation achieve increased food consumption?

Socialisation may cause persons who would normally pay attention to consumption amounts so not to do as self-awareness becomes slightly inhibited. This can also can be translated to those who often eat in their rooms for their benefit as depression and apathy increase when residents are isolated (Volicer, et al., 2013).

 Having a family member, visitor of career sitting with residents in their rooms encouraging them or just being their physically could potentially increase consumption amounts. (Nijs, et al., 2006; De Castro, 2000; De Castro, 1994).

Evidence supporting this notion found that a person eating alone ate less than a group of two or more people, with this increase in consumption dependent on time (longer time spent eating together means more consumption) (Pliner, et al., 2003). Thus, the size of the "eating group" was influenced by the duration of the meal, as well as existing consumption norms (e.g., discussing interests, watching a TV programme etc.). This relationship is expressed in the previous Figure 44. The effect toward eating companions in Figure 44 speaks to the relationship amongst those socialising (familiarity). This familiarity affects both the length of the meal and consumption norms. In contrast, eating with a stranger(s) has been found to negatively affect consumption norms and meal duration through heightened self-awareness of the individual and as a consequence negatively affect consumption volume (Salvy, et al., 2007).

6.2: Summary

This chapter has outlined a discussion guided by the research aims and objectives. All findings sought as well as additional findings were discussed. The chapter explored the findings of positive mood outcomes being associated to LGL meal consumption and reason for this association being stronger in those with dementia. The findings of low internal consistency when dementia status was looked at was examined. These findings bring to light the need for the creation of mood surveys that are not affected by forms of cognitive dysfunction. The chapter presented the importance of various nutrients to the health of older adults, whilst highlighting adequacy as well as deficiencies in nutrients, giving possible justifications for these findings. Recommendations and implications for nutrient findings were mentioned. The GL of meals was then examined, with rationale for certain meals having higher or lower GLs discussed. The possible new findings establishing the relationship between nutrient density and GL was then examined.

The last section of the chapter then looked at all of the factors that should be considered when placing the results into context. Though significant to the discussion of this study, these factors appeared to have no major impact on the results obtained. Further independent investigations to better understand their impacts would be warranted.

The next chapter concludes the thesis. It offers contributions and implications for future research, strengths and limitations of the study, recommendations and ends with a concise conclusion.

Chapter 7: Contributions, Recommendations and Conclusions

7.1: Introduction

This chapter of the thesis discusses contributions to the area of behavioural nutrition, implications for future research, strengths and limitations of the study, recommendations, and finally a conclusion section guided by the study's aims and objectives as well as the research findings.

7.2: Contributions and Implications

The first contribution to knowledge as well as implications for future research, are the nutrient findings of the study. The findings highlighted generally satisfactory macronutrient results amongst the care homes studied. However, there were major micronutrient deficiencies found based on food offerings. There were significant deficiencies in vitamin D supply while others were slightly below the target values (iron and calcium for example). These micronutrients as discussed earlier are vitally important to the health outcomes of older adults. The deficient intakes found are not uncommon in this segment of the population but being present in the care facilities examined in this study could imply difficulties in the supply of micronutrients and/or poor menu planning. One source posits that properly planning of a menu aids in improving food quality and variety (nutritional guidelines are more often followed and healthier foods are more often selected) as well as in weight maintenance (Ducrot, et al., 2017). The results further suggest that prepared frozen foods could be at a micronutrient disadvantage when compared to foods prepared on site. Implying that companies providing these type of meals could also benefit from improved menu/meal planning. Further study into the nutritional implications of frozen prepared meals used in care homes is required.

Secondly, the study found (as presented in Chapter 5) that the Glycaemic Load's association with mood outcomes is more significant in those with dementia. This does not imply that GL should be viewed as a "nutritive stimulus" but could perhaps be used during the meal planning and preparation stages as one way to benefit mood outcomes particularly in those with dementia. The results in those with dementia when compared to those without dementia may also suggest a difference in the metabolism of glucose between these two groups or important differences in glycaemic response. Definitive evidence to these differences and its impact would require building on this observational study using more invasive methodologies that could accurately monitor blood glucose levels at various periods as well as the creation of mood survey techniques specifically for this population.

Thirdly, the study contributes knowledge regarding the GL of meals measured in care homes. The GL on average was very similar for different meals throughout the four care homes. This was due to the generally similarity in meal offerings among the care homes. As GL is often examined from a food perspective instead of a meal, the data from this study provides needed evidence on the examination of the glycaemic characteristics of meals (not food) in care homes. During analysis, the GL would increase significantly because of the addition of dessert and drink options as well as the use of high starch ingredients. This provides further proof of the importance of reducing carbohydrate content in foods to reduce GL. This as well as the cooking methods employed within the care homes have serious implications on the GL of meals. Better understanding and knowledge of nutrition is necessary in care homes in addition to the previously mentioned importance of menu planning. Further, findings showing the GI/GL of various meals of the day (specifically the high GI values of breakfast or the lows of supper meals) would be greatly beneficial in examining the second meal effect.

Fourthly, study also points to a correlation between the GL and a meals nutrient density suggesting a high nutrient dense meal tends to have a lower GL. However, evidence exists highlighting a relationship between high carb foods and low nutrient density, the evidence supporting the GL and nutrient density relationship is lacking.

This contribution to knowledge may have implications for the provision of low GL meals to care home residents as these could potentially improve the variety of nutrients offered and improve the deficiencies in micronutrients.

This relationship however, requires further study with the use of a Profiling Model designed to exam a collection of foods (a meal).

A fifth contribution to knowledge is the differences in mood outcomes between those with dementia and the general non-dementia population. The researcher could not find any studies examining mood outcomes that looked at dementia status. Given the projected increase in dementia cases (Ahmadi-Abhari, et al., 2017), it is important to understand the factors which could potentially affect the symptomatology of this disease (changes in behaviour). As this study examined transient moods, further investigations would require studying the impact of GL on more prolonged moods (emotions/ behaviour) of these individuals.

 A sixth contribution to knowledge is the framing of the GL-mood relationship in relation to a number of factors that should be considered to better contextualise a study such as this one. The creation of this conceptual framework (refer to figure 43) is an important contribution to knowledge. The various observations of the dining experience, portion control, utensils used and where food is prepared as well as staff training all add to the existing literature which notes the influence these characteristics can have on the amount of food consumed and the corresponding health outcomes.

This framework and all its parts could be used as the basis for future research where these considered factors might play an even more significant role.

The seventh contribution to knowledge which the study presented relate to two major characteristics which make it important in increasing the knowledge in the specific area. The use of older adults (inclusive of those with dementia) residing in care is the first of these two characteristics. The physiological and social differences present in this group (as discussed in the study rationale) in contrast to their younger counterparts make these results important in understanding how said differences could have an impact on mood outcomes. The second characteristic is the examination of a variety of mood states. Majority of the current evidence examining mood outcomes in older adults focuses on one mood state (commonly depression or aggression) instead of larger spectrum of mood outcomes as this study has done. This provides additional evidence of moods such as Anxiety, Fatigue, Vigour-Activity etc.

Finally, the eight contribution to knowledge, though not an objective of the study, relates to the internal consistency of the survey instrument employed. The internal consistency of the POMS appears to be significantly affected by the cognitive dysfunction (dementia status) of an individual. This apparent impact could have significant implications for selecting mood survey instruments in studies involving participants with dementia or perhaps lead to the development of a mood survey specifically for dementia sufferers.

7.3: Strengths and Limitations of the study

The study presented some limitations that must be mentioned. As a non-invasive observational study, no blood glucose testing was carried out. Testing blood glucose would have been the most accurate manner of assessing the impact of the GL of the meals on the blood glucose levels and consequently state definitively if the link between GL and mood existed and if so the extent of said link. Blood glucose testing as conducted in studies examined in the systematic review would have afforded evidence on the level of glucose tolerance of the different participants. This invasive method however, was not possible given the very characteristics of the study participants and the number of times blood glucose testing would be required.

Further, ethical barriers would also have had to be surpassed as the study involved a vulnerable group. Another limitation that could have improved the reliability of the study was the weighing of meal plates before and after consumption to provide the precise amounts of food eaten.

This however would not have been feasible given the number of participants, the dynamics of each research site as well as the time and resources required to carry out such a method. The method of Direct Food Photography was the best method in this case to ascertain portion sizes in each site.

In retrospect, the UK Ofcom Model perhaps may not have been the most appropriate model to use in a study such as this. While it served the purpose of identifying the nutrient profile of each food and therefore the nutrient density, determining the nutrient profile of a meal is not the intended purpose of the model. As a result, the summation of the nutrient profile number of each food component to determine the overall profile of the meal (as done in this study) may present a level of inaccuracy in some meals where the profile number of one food (e.g. a dessert) may compromise the overall

nutrient ranking of the rest of the meal's components. However, an appropriate model designed to assess constituent meals could not be found and the inaccuracies in some meals assessed were not the norm.

It could be argued, that mood should have been assessed on both survey days, before meals were eaten in addition to after the target meals were consumed. However, it must be reiterated that the study specifically looked at the impact of GL of both HGL and LGL meal types on mood after the meals are eaten (in effect the impact of GL meal consumption on mood). Hence, differences or comparisons before and after a meal would have been irrelevant to the research aims.

Further, given the population under study, not only would it have been more time consuming to assess transient mood before and after the target meals, participants would have become frustrated when answering the same survey in such a short space of time and responses could have been biased. The design used afforded the study target meals to be examined on different days. To eliminate bias however, all participants whose mood would have been affected just before lunch or dinner due to a visible or known situation (e.g. disagreement between residents, staff or relative) did not form part of the study.

An additional critique could be the lack of uniformity between the meals used within the care homes. However, one must consider that the GLs used for both the HGL and LGL targets were similar in terms of GL measurement in all care homes. The meals also present similar constituent make up (e.g. high starch foods present in HGL meals). Further, standardised meals would have required changing the foods normally consumed by residents. This intervention of having each care home use a HGL and LGL target meal of the researchers choosing would have had its own ethical challenges.

It was hence ideal to use the meals already prepared at the sites and familiar to the participants and simply identify a high and low GL meal from each home for the study.

One the other hand, the study presents several strengths that correspond to the specific aims and objectives of the thesis. Before the study was carried out, a systematic review was done to examine the existing evidence concerning the GL of meals and its impact on mood. A systematic review offers an overview of evidence and offers a more reliable conclusion than a single study (Glasziou, et al., 2004). The systematic review identified knowledge gaps that further justified the need for this study (e.g. the lack of studies in the field involving older adults). This review in addition to providing a compilation of existing evidence also assisted in finding the best methodological structure for the study.

Firstly, with respect to the study design, an observational cross-sectional study was employed. An observational study was most appropriate for this study and provided several benefits. Given the non-interventional, non-invasive nature of the study, the risks for both researcher and participants (including the most vulnerable, i.e. dementia sufferers) was significantly reduced. Observational studies, specifically in nutrition offer a more accurate "real life" reflection of the issue under study (Faraoni and Schaefer, 2016; Szajewska and Shamir, 2013). Evidence also suggests that observational studies and RCTs examining similar themes present similar effect estimates (Concato, et al., 2000). As part of the observational design, the study did not seek to change the eating patterns/habits of the research facilities. Thus, daily routine of participants was not severely affected in the study design. This aided in reducing confounding as well as the similarities in the environment where the survey was administered in each facility (in communal areas).

To strengthen the quality of the study, the STROBE-nut checklist (designed specifically for nutritional observational studies) was considered for reporting the study findings (Lachat, et al., 2016).

Secondly, though the survey instrument presents its flaws, it was used due to its strong validity and reliability. The short form version used was appropriate enough for the population being studied. Hammersley, et al. (2014) notes that an appropriate survey scale should be brief, easy to administer, present good construct validity and favour repetitive administration. All of these characteristics were fulfilled by the POMS. Further, the POMS provided further strength by allowing a larger array of moods whilst assessing these moods appropriately as transient due to its design (McNair, et al., 1971).

Thirdly, the time mood surveys were administered can be considered another strength of the study. From the systematic review conducted, it was found that most studies had no rational or explanation for the periods in which mood was assessed after food consumption.

This study however conducted the mood survey at the times when glucose metabolism would have been the most optimal within the study population.

A fourth strength of the study was the use of Nutritics software. The software perhaps presents one of the most extensive food databases specific to the United Kingdom. It affords users accurate GI and GL values (verifiable by the International GI/GL lists) and working well with the direct food photography method (DFP) thus providing the most precise portion selections are all advantages of the software which in turn strengthened the analysis and results of the study.

A fifth strength perhaps not as significant, were the ethical considerations and approvals of the study. The researcher was trained in Good Clinical Practice (GCP), informed consent for those with mental capacity issues as well as conducting mental capacity assessments. This allowed all diagnosed dementia participants to be assessed to determine if they had capacity to complete the survey as well as their willingness to participate in the research at both times the POMS was administered.

7.4: Recommendations

The study brings to the fore a number of recommendations that could provide improved health outcomes for care home residents, service benefits to care institutions, probability of specific nutritional guideline creation, as well as suggestions for future research.

Proper menu planning is vital for improving the nutritional offerings of all care homes (Ducrot, et al., 2017). This planning should incorporate the opinions and suggestions of residents where possible. Based on these opinions, homes should also consider the feasibility of having vegetarian options for each main meal (looking at the requirement of these options).

In offering an alternative option, caloric disparities should be looked at between options to ensure residents regardless of meal choice are afforded with sufficient caloric energy throughout the day. Emphasis should be placed on "nutritional variability" i.e. offering more nutrient dense foods. Such foods would assist in improving the numerous micronutrient deficiencies found within the care homes. As a result, part of this planning should examine the macronutrients being afforded (such as fibre and proteins) but also the micronutrients required to improve health outcomes in later life (of specific interest vitamin D, calcium and iron).

Although the glycaemic index (GI) and glycaemic load (GL) are not popular measurements considered in the public domain, perhaps they should be considered during the menu planning stages. Incorporating GI/GL could assist with a number of health outcomes (as previously referred to in the thesis) but also could support favourable outcomes in residents specifically those with dementia. It must be stated however, that this study is based observational data from four care homes in England and may not be generalisable enough. Further studies are required. Given the relationship shown between nutrient density and GL, offering low GL meals could also afford residents more nutrient-dense foods.

Proper menu planning should therefore require the preparation of foods correctly to maintain GL levels as well as the nutritional attributes (particularly minerals and vitamins). This would require the creation or use of cooking guidelines that ensure these attributes are maintained or improved. Food preparation on site is therefore most ideal when compared to the use of prepared frozen meals (though these meals present an advantage from a macronutrient perspective) to ensuring micronutrient amounts can be improved.

To ensure preparation of meals correctly and improving planning, training and education will become an essential component. As observed in some of the care homes, a Nutritional Manager should form part of the care staff. This person (trained in food and nutrition) should seek to ensure that all cooking staff are knowledgeable of nutritional recommendations and cooking guidelines that would improve nutritional benefits of foods.

Care staff should also have some training in food handling and nutrition particularly where food presentation and portion or serving size is being determined, as knowledge of both aspects will have an impact on the amount of food consumed.

It is therefore recommended that all homes follow the UK Care Home Framework, 2017 as well as the Dining with Dignity Guidelines, 2017 (Care UK, 2019; NHS, 2017).

Such guidelines would further improve the eating experience of residents and consequently improve food quality and consumption.

Any actions to improve the eating experience should include the use of appropriate utensils for serving and eating meals, use of natural lighting where possible, décor of dining areas, supporting socialisation during mealtime between residents, staff and visiting relatives, as well as ensuring meals appeal to the different senses.

Other aspects of recommendations from a nutritional perspective are the need for methods such as supplementation and fortification. Homes currently participating in these activities should continue the practice. However, it is important for those that do not or are not doing so sufficiently, to increase the supplementation of fibre (the use of fibre rich snacks, desserts, shakes), vitamin D (1 daily supplement of 10 micrograms as well as 30 minutes of sunshine daily) (SACN, 2016) and other micronutrients as mentioned in the discussion section.

Though care homes may not be capable of fortifying some of the foods they offer, they should seek to use certain cooking ingredients that are already fortified. Products that have been fortified with vitamin D, as well as ingredients fortified with minerals should be incorporated in food preparation. In selecting fortification and/ or supplementation methods attention should be paid on ensuring that excess nutrient intake does not occur due to the health risk associated. Any voluntary fortification of foods should therefore be in accordance with EU regulations on food fortification 1925/2006/EC (European Commission, 2019).

A governmental policy that could be considered in future after further investigation is the creation of nutritional guidelines and recommendation specific for older adults over the age of 65. Currently in the UK, general nutrient requirements and healthy eating guidelines apply to older adults.

Given the changes in the body at that stage of life and the increase requirements for some nutrients as a result, it is vital that there be specific guidelines mandated for all care institutions.

Finally, studies in behavioural nutrition should seek to develop a mood assessment survey that maintains internal consistency or that is designed specifically for older adults or those with dementia to examine transient mood more accurately. Additionally development of a nutritional profiling model for specifically assessing the nutrient profile of meals should be considered. It is hoped that future researcher will continue research into the GL and mood outcomes relationship (perhaps from a causation instead of association perspective) in those with dementia and that this research serves as a basis for other studies.

7.5: Conclusions

As the older adult population continues to increase, addressing the challenge of improving the quality of life of this important population is paramount. This study presents a number of contributions to knowledge that will have some impact on minimising the nutritional challenges of older adults.

This study concludes that the glycaemic load of meals does appear to have an association with the mood outcomes of older adults residing in care homes. Given the observational nature of the data and sample of four small care homes in England, considering the incorporation of the GL of meals into menu planning requires further investigation. The relationship between the GL of meals and mood outcome is more apparent in those with dementia when compared to those older adults without dementia. Within the care homes, micronutrient offerings from menus are deficient in both homes with externally prepared and in- house catering with vitamin D present a major deficiency. Macronutrients are offered in amounts that are more satisfactory though fibre intake needs to be improved. LGL meals appear to be more likely to be classified as high nutrient density foods perhaps because of their low carbohydrate (free sugars) and sodium content and higher amounts of proteins, fibre and micronutrients. Further research is suggested for more definitive conclusions.

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Appendices

Appendix 1: Research Approval, Ethical Approval, Sponsorship, Insurance Evidence and Ethical Training Evidence.

11 February 2016
SID Number: 1229113/2

Anglia Ruskin University

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RICH WARNER

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Dear Rich

Approval of Research Proposal

I am pleased to inform you that your Research Proposal has been approved on behalf of the Faculty of Medical Science Research Degrees Sub Committee, for the degree of Doctor of Philosophy (subject to Confirmation of Candidature).

Your attention is drawn to the following points:-

Title of Research
Assessing the impact of sugar on aggressive behaviour in persons with dementia.

Supervisory Team

1st Supervisor   2nd Supervisor
Dr Marie-Ann Ha   Dr Jennifer Lim

Faculty Director of Research Students

Faculty Directors of Research Students have overall responsibility for the progress and welfare of research degree students attached to their Faculty and are the first point of contact. The Director of Research Students for your Faculty is Dr Nigel Sansom, Tel 0845 196 3590, Email nigel.sansom@anglia.ac.uk.

Confirmation of Candidature

All research students registered to PhD direct are required to apply for Confirmation of Candidature if they wish to proceed towards a doctoral qualification (please see section 8 of the Research Degrees Regulations for further information). Your application for Confirmation of Candidature should be submitted by no later than **16 June 2017**. You should contact me nearer the time to ascertain the submission date for consideration at the Faculty Research Degrees Committee.
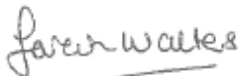
Information for Candidates

I attach some important information which you are asked to note, including a list of publications available for research degree candidates.

A copy of this letter has been sent to your Supervisory Team and Faculty Director of Research/Director of Research Students.

Yours sincerely

[signature]

Sarah Walters
Secretary, Medical Science Faculty Research Degrees Sub Committee

Cc:

1st Supervisor
Dr Marie-Ann Ha

2nd Supervisor
Dr Jennifer Lim

Director of Research
Dr Nigel Sansom

Faculty Research Administrator
Jo Corney

NHS
Health Research Authority

London - Queen Square Research Ethics Committee

HRA NRES Centre Manchester
Barlow House
3rd Floor
4 Minshull Street
Manchester
M1 3DZ

> **Please note:** This is the favourable opinion of the REC only and does not allow you to start your study at NHS sites in England until you receive HRA Approval

21 June 2017

Dr Marie-Ann Ha
Faculty of Medical Science, Health Building
Young Street
Cambridge
CB1 2LZ

Dear Dr Ha

Study title:	The impact of the glycaemic load of meals on the mood of older adults within a care home setting.
REC reference:	17/LO/0613
Protocol number:	076832
IRAS project ID:	224924

Thank you for your letter of 20th June 2017, responding to the Committee's request for further information on the above research.

The further information was considered in correspondence by a Sub-Committee of the REC at a meeting held on 13th June 2017. A list of the Sub-Committee members is attached.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to make a request to postpone publication, please contact hra.studyregistration@nhs.net outlining the reasons for your request.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Conditions of the favourable opinion

The REC favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements. Each NHS organisation must confirm through the signing of agreements and/or other documents that it has given permission for the research to proceed (except where explicitly specified otherwise).

Guidance on applying for NHS permission for research is available in the Integrated Research Application System, www.hra.nhs.uk or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of management permissions from host organisations

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database within 6 weeks of recruitment of the first participant (for medical device studies, within the timeline determined by the current registration and publication trees).

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g. when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non-clinical trials this is not currently mandatory.

If a sponsor wishes to request a deferral for study registration within the required timeframe, they should contact hra.studyregistration@nhs.net. The expectation is that all clinical trials will be registered, however, in exceptional circumstances non registration may be permissible with prior agreement from the HRA. Guidance on where to register is provided on the HRA website.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Non-NHS sites

The Committee has not yet completed any site-specific assessment (SSA) for the non-NHS research site(s) taking part in this study.   The favourable opinion does not therefore apply to any non-NHS site at present. We will write to you again as soon as an SSA application(s) has been reviewed. In the meantime no study procedures should be initiated at non-NHS sites.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Covering letter on headed paper		23 February 2017
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only)		
Letter from sponsor		17 February 2017
Letters of invitation to participant [Invite for Research Sites]	3	06 March 2017
Other [Informed Consent ALC Training Cert]		10 February 2017
Other [Good Clinical Practice (Primary Care) Training Certificate]		10 February 2017
Other [REC UFO from first application]		28 December 2016
Other [Letter regarding changes made to study]	4	13 March 2017
Other [Application Clarification]		24 March 2017
Other [Example of POM Short Form]	2	06 March 2017
Other [Response to Provisional]	2	20 June 2017
Participant consent form [Participant Consent Form]	3	06 March 2017
Participant information sheet (PIS) [PIS]	03	06 March 2017
REC Application Form [REC_Form_02062017]		02 June 2017
Research protocol or project proposal [Protocol]	04	06 March 2017
Summary CV for Chief Investigator (CI) [CV Chief Investigator Summary]	1	28 October 2016
Summary CV for student [Student CV]	1	24 October 2016
Summary CV for supervisor (student research) [Supervisor CV]	2	24 October 2016

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research

Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document *"After ethical review – guidance for researchers"* gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website:
http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/

HRA Training

We are pleased to welcome researchers and R&D staff at our training days – see details at http://www.hra.nhs.uk/hra-training/

17/LO/0613	Please quote this number on all correspondence

With the Committee's best wishes for the success of this project.

Yours sincerely

H.wood

Signed on behalf of the Chair, Dr Eamonn Walsh
Email:nrescommittee.london-queensquare@nhs.net

Enclosures:	*List of names and professions of members who were present at the meeting and those who submitted written comments*
	"After ethical review – guidance for researchers" [SL-AR2]

Copy to:	*Prof Selim Cellek*

Anglia Ruskin
University

Cambridge | Chelmsford
London | Peterborough

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Bishop Hall Lane
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17th February 2017

To whom it may concern

Study title: The impact of the glycaemic load of meals on the mood of older adults within a care home setting.

Applicant: Dr Marie-Ann Ha

Anglia Ruskin University will be acting as sponsor for the above application. In undertaking this role, the University will comply with the requirements as set out in the Research Governance Framework for Health and Social Care (2005). I will be acting as the sponsor's representative.

If you require any further information, please do not hesitate to contact me.

Yours faithfully,

Prof Selim Cellek

Director of Research

Faculty of Medical Science

Anglia Ruskin University

Tel: 0845 196 4654

Email: selim.cellek@anglia.ac.uk

UMAL

18th July 2016

Dear Sir/Madam

ANGLIA RUSKIN UNIVERSITY HIGHER EDUCATION CORPORATION

AND ALL ITS SUBSIDIARY COMPANIES

Clinical Trials Coverage

We confirm that the above Institution is a Member of U.M. Association Limited, and that the following cover is currently in place in respect Clinical Trials undertaken within the United Kingdom subject to the cover terms, conditions and exceptions.

Certificate of Entry No.	UM007/92
Period of Cover	1 August 2016 to 31 July 2017
Limit of Indemnity	£30,000,000 any one claim and in the aggregate including claims costs and expenses
Basis of Cover	Legal Liability or No Fault cover
Cover provided by	U.M. Association Limited and Excess Cover Providers led by QBE Insurance (Europe) Limited
Main Cover Exclusions	i) Trials involving subjects under 5 years of age
	ii) Trials assisting with or altering in any way the process of conception
	iii) Trials investigating or participation in methods of contraception
	iv) Trials involving genetic engineering other than for preventing and diagnosing disease
	v) Trials involving drugs or surgery or nutrients
	vi) Trials involving persons known to be pregnant
	vii) Trials involving products manufactured by the University

Yours faithfully

Susan Wilkinson

Susan Wilkinson
For U.M. Association Limited

Certificate of Achievement

This is to certify that

Rich Warner

Has completed the following SCIE e-learning module

Mental Capacity Act (MCA): e-Learning course

And has scored 86%

On 14 June 2017

scie social care
institute for excellence

Tony Hunter
Chief Executive

CERTIFICATE of ACHIEVEMENT

This is to certify that

Rich Warner

has completed the course

Informed Consent with Adults Lacking Capacity

February 10, 2017

This course is worth 1 CPD credit

CPD
The CPD Certification Service

NHS

National Institute for
Health Research

Clinical Research Network

CERTIFICATE of ACHIEVEMENT

This is to certify that

Rich Warner

has completed the course

Introduction to Good Clinical Practice eLearning (Primary Care)

February 10, 2017

Modules completed:

Introduction to Research in the NHS
Good Clinical Practice and Standards in Research
Study Set Up and Responsibilities
The Process of Informed Consent
Data Collection and Documentation
Safety Reporting

This course is worth 4 CPD credits

CPD
The CPD Certification Service

National Institute for
Health Research
Clinical Research Network

Appendix 2: Consent Form, Participant Information Sheet and Recruitment Letter

Anglia Ruskin University

PARTICIPANT INFORMATION SHEET

Centre Number: 2

Study Number: 1265

Title: The impact of glycaemic load of meals on mood in older adults in a care home setting.

Researcher: Dr Rich Warner

We would like to invite you to take part in our research study. Before you decide we would like you to understand why the research is being done and what it would involve for you. We will be happy to go through the information sheet with you and answer any questions you have. We'd suggest this should take about 10 minutes. Talk to others about the study if you wish.

Part 1 tells you the purpose of this study and what will happen to you if you take part.

Part 2 gives you more detailed information about the conduct of the study. The study will involve an analysis of the meals offered at your care facility and how some of these meals may be linked to your mood. Your participation will involve completing a short questionnaire on two separate occasions. Ask us if there is anything that is not clear.

PART 1

What is the purpose of the study?

The research is being carried out as part of the academic requirement for obtaining a PhD.

The foods we eat have different effects on our mood. Glucose, is a carbohydrate which provides the fuel the human body needs to function. The body gets this glucose by breaking down the different meals we eat. Some meals are broken down and glucose rapidly absorbed into the blood for use while other meals provide a slow and steady release of glucose. It is believed by many scientist that meals which provide a slow and steady release of glucose are better for our health. The quantity and quality of carbohydrates in a food is referred to as its glycaemic load. Some studies have been conducted which look at the relationship between a foods glycaemic load and how it affects mood. These studies were conducted primarily in children and many present inconclusive findings. We are carrying out this study in a different group of people i.e. older adults to see if meals you are eating have an impact on your mood as well as if these meals impact those with and without dementia differently. The study will also look at the meals you are being given in your care home and if they are nutritionally adequate.

The study will therefore try to answer the following question: *Does*

the glycaemic load of meals alter the mood of older adults residing in

a care home?

Why have I been invited?

As a person over the age of 60 and residing in a care home, you are being invited to take part. This study will be carried out in four different care homes involving 100 participants.

Do I have to take part?

It is up to you to decide to join the study. We will describe the study and go through this information sheet. If you agree to take part, we will then ask you to sign a consent form. You are free to withdraw at any time, without giving a reason. This would not affect the standard of care you receive at the care home.

What will happen if I decide to take part?

Your participation will involve the completion of a short questionnaire about your feelings. This questionnaire is designed to assess your mood and will be carried out on two occasions. The questionnaire will list 37 word adjectives relating to feelings and on a scale of 0 to 4 you will be asked to select a number on the scale for each word.

For example, one word may be happy. You can select 0 if you are not feeling happy at all, 1 if you feel a little happy, 2 if you feel moderately happy, 3 for feeling quite a bit happy or 4 if you are extremely happy. The questionnaire can be completed in 10 minutes. Do not worry if you have difficulty writing or seeing as the researcher will be there to carry out the questionnaire and can read it out for you and write down your answers. This questionnaire will be carried out in a three hour period after you have eaten a specific meal identified by the researcher. Before you complete the questionnaire you will be asked how you felt before you ate on a blank sheet of paper. You can respond however you wish.

The second time you complete the questionnaire will be the same. On this occasion however, the meal you ate before the questionnaire is given to you will be a different one from the first occasion. As this is a population study, your name nor personal details are required. The researcher will then look at the two completed questionnaires from both occasions and compare the changes in mood in relation to the two meals. This will help in answering the research question.

Expenses and Payment

You are not required to pay for anything in this study nor will you receive payment for participating.

What are the possible disadvantages and risks of taking part?

There are no disadvantages in participating in this study. The questionnaire is very convenient and was designed to take up 10 minutes of your time. If you are unable to complete the written questionnaire, the researcher can read each aspect of the questionnaire for you and then record your answers. There are no risks associated for you and it will not affect your regular eating habits. Your participation will not affect any insurance coverage you may have. Your safety is very important to us and this study follows all good clinical practice guidelines.

What are the possible benefits?

The study will allow us to identify if your care home is providing you with adequate nutrition. The results of the study could aid your care home in improving the nutritional value of the meals they serve and eliminate those which may be too unhealthy. The relationship between how you feel and the glycaemic load of your meals will also aid your care home in serving you better by providing meals that will favour positive moods. The study also adds to existing scientific literature on the role of the glycaemic load on mood and assists the researcher in completing the academic objective of gaining a PhD.

What happens when the research stops?

After the second questionnaire is carried out the study will finish.

You are not required to do anything else for the study at this point. If you wish, we can give you an update on the study results once all analyses are completed.

PART 2

What will happen if I don't want to carry on with the study?

This study is a voluntary one. You are free to withdraw at any time.

Your participation only requires you to complete a questionnaire on

two separate occasions. The answers on each questionnaire cannot

be linked to you as your personal details are not required. All

correctly completed questionnaires will form part of data analysis.

What if there is a problem?

If you have a concern about any aspect of this study, you should ask

to speak to the researcher who will do his best to answer your

questions at the following contact number: ██████████ If you

remain unhappy you may wish to complain formally to the Chief

Investigator Dr.Marie-Ann Ha at: **Tel: ██████████**. Additionally you

may also lodge a complaint to the Sponsor of the research Dr Selim

Cellek of Anglia Ruskin University at **Tel: ██████████.**

How will my participation be kept confidential?

The questionnaire you will complete does not require you to give any person details. This means on both occasions after you have completed the questionnaire you cannot be identified. The questionnaire data will be collected and stored at the Anglia Ruskin University, Health Building. Only the researcher and supervisors will have access to the data. The data will not be retained for future study.

What will happen to the results?

The results will be analysed from a population basis and not an individual one. All results will form part of a PhD thesis and hopefully published in a reputable journal.

Who is organising and funding the research?

The research is being carried out by a research student of the Anglia Ruskin University (Cambridge). No funding agencies are involved.

Who has reviewed the study?

In order to protect your interests. This study has been reviewed and given a *favourable opinion* by the London- Queens Square Research Ethics Committee.

Further Information and Contact Information

Researcher- Dr Rich Warner
 Email: rich.warner@pgr.anglia.ac.uk   Tel: ●●●●●●●●●●
Chief Investigator- Dr Marie-Ann Ha
Email: Marie-Ann.Ha@anglia.ac.uk   Tel: ●●●●●●●●●●

Anglia Ruskin University

Centre: 02

Study Number: 1265

CONSENT FORM

Title of Project: The impact of glycaemic load of meals on the mood of older adults within a care home setting.

Name of Researcher: Dr Rich Warner

PLEASE INITIAL THE CORRESPONDING BOX

1. I confirm that I have read and understood the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected.

3. I understand that the questionnaire I will complete is anonymous and my personal details   are not required.

4. I understand all information given will be safeguarded.

5. I have been provided with a copy of this form and the Participant Information sheet.

6. I agree to take part in this study.

....

 Name of Participant   Date   Signature

....

Name of Person taking consent   Date   Signature

RECRUITMENT LETTER

Date: 06/03/2017   Version: 03

Dear Sir/Madam

I am a PhD student studying at Anglia Ruskin University. My project is entitled," The impact of the glycaemic load of meals on the mood of older adults in a care home setting." Studies have been conducted on the glycaemic of meals and their effects on mood. These studies were conducted mainly in children and many present inconclusive findings. Older adults do not metabolise glucose as optimally as children. With ageing, energy needs decrease while micronutrient requirements remain or increase, necessitating a more nutrient-dense diet to meet nutritional needs. Inadequate nutrient intake leads to various diseases. It is therefore important to carry out scientific investigations into nutrient intake in older adults and how the glycaemic load of their meals affects their moods.

The purpose of this letter is to request your permission to use your care facility as a research site for the project. During the study, I will require access to the monthly menu. I will occasionally visit the care home to take pictures of the portion sizes of various meals from the kitchen. This will assist me in carrying out my data analyses. I will carry out analyses of the glycaemic load of each meal, nutrient density and nutritional adequacy. During my analyses, I will be able to identify the meal with the highest glycaemic load and lowest glycaemic load. These two meals will be the subject of a mood survey called the Profile of Mood States- Short Form.

The mood survey is a validated questionnaire that simply asks respondents how they are feeling. It contains 37 mood adjectives and a corresponding scale of 0-4 (0- not at all to 4- extremely). This survey takes 10 minutes on average to complete. Participants will complete this survey on two separate occasions, 3 hours after the highest glycaemic load meal is eaten and after the lowest glycaemic load meal is eaten. Participants will also be asked to write, on a blank sheet of paper how they felt before eating both meals. Those persons who cannot write or have difficulty communicating will be accommodated. The study will involve adults residing in your care facility over the age of 60 without dementia and with dementia (early to middle stages). All good clinical practice guidelines were followed in designing this study.

The London- Queens Square Research Ethics Committee has already given the requisite ethical approval. Your institution will not be used in a negative way during this study and it is hoped that the research will benefit your facility by improving the nutrient content of meals you currently offer your residents. Additionally, consent will be sought from the potential participant and or next of kin where appropriate.

My first supervisor is Dr Marie-Ann Ha. Please do not hesitate to contact either myself or her regarding any questions you may have. Attached is a research protocol that will give more detail on the study.

Regards,

Rich Warner M.D. MSc PH

PhD Student

Anglia Ruskin University

Dr Marie-Ann Ha	Rich Warner
Senior Lecturer/ Faculty of Medical Science	PhD Student
Anglia Ruskin University	Anglia Ruskin University
East Road	East Road
Cambridge CB1 1PT	Cambridge CB1 1PT

The Profile of Mood States- Short Form

Instructions: Below is a list of words that describe feelings people have. Please read each one carefully. Then circle the answer which best describes HOW YOU FEEL RIGHT NOW. Make sure you answer every question.

Feeling	Not at all	A little	Moderately	Quite a Bit	Extremely
Tense	0	1	2	3	4
Lively	0	1	2	3	4
Sad	0	1	2	3	4
Grouchy	0	1	2	3	4
Bewildered	0	1	2	3	4
Hopeless	0	1	2	3	4
On edge	0	1	2	3	4
Forgetful	0	1	2	3	4
Annoyed	0	1	2	3	4
Fatigued	0	1	2	3	4
Helpless	0	1	2	3	4
Vigorous	0	1	2	3	4
Uncertain about things	0	1	2	3	4
Uneasy	0	1	2	3	4
Bitter	0	1	2	3	4
Anxious	0	1	2	3	4
Unable to concentrate	0	1	2	3	4
Angry	0	1	2	3	4
Full of Pep	0	1	2	3	4

Furious	0	1	2	3	4
Confused	0	1	2	3	4
Cheerful	0	1	2	3	4
Bushed	0	1	2	3	4
Resentful	0	1	2	3	4
Weary	0	1	2	3	4
Miserable	0	1	2	3	4
Peeved	0	1	2	3	4
Restless	0	1	2	3	4
Energetic	0	1	2	3	4
Exhausted	0	1	2	3	4
Blue	0	1	2	3	4
Worthless	0	1	2	3	4
Worn Out	0	1	2	3	4
Discouraged	0	1	2	3	4
Nervous	0	1	2	3	4
Active	0	1	2	3	4
Unhappy	0	1	2	3	4

The Activation-Deactivation Adjective Check List (AD ACL)

Instructions: Each of the words on the following page describes feelings or mood. Please use the rating scale next to each word to describe your feelings at this moment.

VV: definitely feel
V: feel slightly
?: cannot decide
No: definitely do not feel

EXAMPLES

Relaxed **VV** V ? No   If you circle the double check (VV) it means that you *definitely* feel relaxed *at the moment*.

Relaxed VV **V** ? No   If you circle the single check (V) it means that you feel slightly relaxed *at the moment*.

Relaxed VV V **?** No   If you circled the question mark (?) it means that the word does not apply or you cannot decide if you feel relaxed *at the moment*.

Relaxed VV V ? **No**   If you circled the NO it means that you are *definitely not relaxed at the moment*.

Work rapidly, but please mark all the words. Your first reaction is best. This should take only a minute or two.

Checklist

Active	VV	V	?	No
Placid	VV	V	?	No
Sleepy	VV	V	?	No
Jittery	VV	V	?	No
Energetic	VV	V	?	No
Intense	VV	V	?	No
Calm	VV	V	?	No
Tired	VV	V	?	No
Vigorous	VV	V	?	No
At-rest	VV	V	?	No
Drowsy	VV	V	?	No
Fearful	VV	V	?	No
Lively	VV	V	?	No
Still	VV	V	?	No
Wide-awake	VV	V	?	No
Clutched up	VV	V	?	No
Quiet	VV	V	?	No
Full pf pep	VV	V	?	No
Tense	VV	V	?	No
Wakeful	VV	V	?	No

Center for Epidemiologic Studies Depression Scale (CES-D)

Instructions: Below is a list of some of the ways you may have felt or behaved.
Please indicate how often you have felt this way during the past week by checking the
appropriate space.

During the past week	Rarely or none of the time (less than 1 day)	Some or a little of the time (1–2 days)	Occasionally or a moderate amount of the time (3–4 days)	Most or all of the time (5–7 days)
1. I was bothered by things that usually don't bother me.				
2. I did not feel like eating; my appetite was poor.				
3. I felt that I could not shake off the blues even with help from my family or friends.				
4. I felt that I was just as good as other people.				
5. I had trouble keeping my mind on what I was doing.				
6. I felt depressed.				

During the past week	Rarely or none of the time (less than 1 day)	Some or a little of the time (1–2 days)	Occasionally or a moderate amount of the time (3–4 days)	Most or all of the time (5–7 days)
7. I felt that everything I did was an effort.				
8. I felt hopeful about the future.				
9. I thought my life had been a failure.				
10. I felt fearful.				
11. My sleep was restless.				
12. I was happy.				
13. I talked less than usual.				
14. I felt lonely.				
15. People were unfriendly.				

During the past week	Rarely or none of the time (less than 1 day)	Some or a little of the time (1–2 days)	Occasionally or a moderate amount of the time (3–4 days)	Most or all of the time (5–7 days)
16. I enjoyed life.				
17. I had crying spells.				
18. I felt sad.				
19. I felt that people disliked me.				
20. I could not get "going."				
Total Score:				

Table Layout at during breakfast.

Empty plate and cup used in Research site 1.

Examples of breakfast servings.

Example of Lunch serving.

Example of Lunch serving (Pureed)

Servings of foods offered at dinner in Research Site 1.

Direct Food Photography Images from Research Site 2.

Empty Blue-wash plate 10 inch (main courses)

Empty Blue-wash plate 6.5 inch (breakfast meals, toast, dessert, sandwiches)

Example of table setup and a served lunch meal.

Examples of breakfast servings above (Porridge on the left and a special cooked breakfast on the right).

Examples of lunch servings (left- Beef bourguignon meal, right- Vegetable pancake).

Examples of lunch servings (left-chicken korma and right- fish and chips meal).

Left- Salmon with vegetable dinner option and right- Pea soup.

Examples of served desserts used at lunch and dinner (left-ice cream and right strawberry mousse).

Direct Food Photography images from Research Site 3.

Cutlery on trolley in research site three.

Example of Dinner servings (Lamb mince (one plate), Cornish pasty and vegetables).

Example of Dinner serving (pureed version).

Example of dessert serving at dinner (banana and custard).

Examples of lunch servings (note the difference in lunch in site three compared to other research sites).

Example of a serving for dessert at lunch (chocolate gateau).

Example of empty main course plate used in site 4.

Example of empty bowl used mainly for breakfast and for desserts.

Example of cups used (Cups contain milkshakes for afternoon snack).

Example of a dinner serving (fish and chips).

 Example of dessert serving (sponge with whipped cream).

Appendix 5: Terms and Concepts

Important terms and concepts

- *Glycaemic index-* "GI is a relative measure of the capillary blood glucose response induced by a specific ingredient, food or meal, as compared with the response induced by the same amount (usually 50g) of available carbohydrate from a reference source, such as pure glucose or an alternative source (such as white bread) against which it has been calibrated" (Brouns *et al.*, 2005).

- *Glycaemic load-* "The GL is the product of a specific food's GI and its carbohydrate content, therefore taking into account both the quality of the carbohydrate food/meal/ingredient and the quantity of carbohydrate in the food/meal/ingredient consumed" (Brouns *et al.*, 2005).

- *Second Meal effect-* The glycaemic response to the same food or meal that may be influenced by the time, composition and GI of a previous meal. This response is often a prolonged one that can improve the glucose tolerance of the individual at the second meal (Ardvidson-Lenner, 2004).

- *Care Home -* Institutions comprised of both a physical environment and a social environment that influences the behaviours of the collective of individuals within it including the organisational context in which the provision of care takes place (Goffman 1961; Willcocks et al. 1987; Peace et al. 1997; Killett et al. 2013).

- *Older Adult-* For the purposes of this study, an older adult or elderly person is defined as persons 65 (60) years or above (John S. Hayes, Rasheed A. Balogun, Jamison Chang and Emaad M. Abdel-Rahman (2012, 159).

- *Nutrient Profiling*- "The science of classifying or ranking foods according to their nutritional composition for reasons related to preventing disease and promoting health. Nutrient profiling can be used for various applications, including marketing of foods to children, health and nutrition claims, product labelling logos or symbols, information and education, provision of food to public institutions, and the use of economic tools to orient food consumption" (WHO, 2010).

- *Nutrient density* - A form of nutrient profiling used to rank foods by their nutritional composition in order to promote human health (WHO, 2010). Foods, which therefore supply more nutrients than calories, are referred to as *nutrient dense* (Drewnowski and Fulgoni, 2008).

- *Dementia* – "A syndrome in which there is deterioration in memory, thinking, behaviour and the ability to perform everyday activities" (WHO, 2017).

Glycaemic calculation example results for meals in each care home.

Care Home 1

Breakfast Options

Breakfast	GI	GL
WeBix+Milk(semi)	67.62	19.68
Cflakes+Milk(semi)	62.88	15.34
RiceCrip+Milk(semi)	69.72	17.32
SpecialK+Milk(semi)	60.25	14.04
Muesli+Milk(semi)	56.33	13.4
BFlakes+Milk(semi)	63.2	11.94
Prdge+Milk(semi)	42.4	4.11
WB Toast+Mmlade	66.75	21.76
WB Toast+Jam	71.39	23.27
WB+Mmlade	67.25	23.74
WB+Jam	71.75	24.61
WB+honey	68.87	24.31
WB Toast+honey	68.49	22.32
BB+Mmlade	65.33	19.4
BB+Jam	69.97	20.78
BB+honey	67.07	19.92
BB Toast+honey	65.56	16.78
BB Toast+Jam	68.96	17.65
BB Toast+Mmlade	63.52	16.26

Breakfast combo with drink offering

Breakfast	GI	GL
Rcrisp,Mk,BB,Mmlade,tea/coffee	66.45	36.9
Rcrisp,Mk,BB,Mmlade,orange juice	64.47	44.19

Afternoon Tea Snack

Snack	GI	GL
Tea and biscuits (2)	59.22	9.59

Alternative Food Offerings

Food	GI	GL
Yoghurt	36	5.9
Ice Cream	61	4.5
Grapefruit	48	3.7
Tuna Sandwich	72	6.7
Ham Sandwich	72	6.6
CheesePK Sandwich	72	7.3

Alternative Supper Combo Sandwich Meals

Alt Sup Combo	GI	GL
Tuna,Ham,Cheese Pkle, OJ	65.54	26.35

Lunch Main with orange juice drink option

Week Day	GI	GL
Monday Week 1	60.28	40.99
Tuesday Week 1	52.78	20.47
Wednesday Week 1	60	37.88
Thursday Week 1	60.17	42.05
Friday Week 1	63.82	51.32
Saturday Week 1	58.62	34.76
Sunday Week 1	58.9	30.35
Monday Week 2	62.16	37.11
Tuesday Week 2	57.08	41.05
Wednesday Week 2	63.03	20.67
Thursday Week 2	63.85	33.69
Friday Week 2	54.71	36.42
Saturday Week 2	48.07	31.86
Sunday Week 2	59.69	35.24
Monday Week 3	56.76	44.84
Tuesday Week 3	51.73	30.06
Wednesday Week 3	58.64	37.35
Thursday Week 3	60.42	25.1
Friday Week 3	54.56	48.19
Saturday Week 3	62.55	35.86
Sunday Week 3	60.25	33.94
Monday Week 4	66.08	71.37
Tuesdy Week 4	59.99	34.12
Wednesday Week 4	63.59	46.36

Weekday		
Thursday Week 4	**64.74**	**43.77**
Friday Week 4	**56.46**	**43.49**
Saturday Week 4	**63.29**	**38.79**
Sunday Week 4	**62.29**	**44.24**

Lunch Option 2 with orange juice drink option

Weekday	GI	GL
Monday Week 1	**59.12**	**42.14**
Tuesday Week 1	**54.69**	**17.12**
Wednesday Week 1	**50.67**	**50.08**
Thursday Week 1	**61.44**	**48.58**
Friday Week 1	**60.92**	**34.9**
Saturday Week 1	**63.18**	**26.09**
Sunday Week1	**55.46**	**32.89**
Monday Week 2	**63.9**	**55.91**
Tuesday Week 2	**59.46**	**37.05**
Wednesday Week 2	**63.03**	**20.67**
Thursday Week 2	**60.17**	**39.69**
Friday Week 2	**62.31**	**48.75**
Saturday Week 2	**49.31**	**32.38**
Sunday Week 2	**55.97**	**37.43**
Monday Week 3	**56.81**	**38.06**
Tuesday Week 3	**54.4**	**26.06**
Wednesday Week 3	**58.84**	**30.38**
Thursday Week 3	**51.29**	**33.82**

Friday Week 3	**55.78**	**41.9**
Saturday Week 3	**61.85**	**39.28**
Sunday Week 3	**61.36**	**39.35**
Monday Week 4	**60.24**	**56.85**
Tuesday Week 4	**60.5**	**35.59**
Wednesday Week 4	**60.47**	**40.09**
Thursday Week 4	**53.92**	**26.03**
Friday Week 4	**63.73**	**65.07**
Saturday Week 4	**62.77**	**28.43**
Sunday Week 4	**51.83**	**60.98**

Supper Meal offering with orange juice drink option

Weekday	**GI**	**GL**
Monday Week 1	**50.61**	**36.89**
Tuesday Week 1	**43.22**	**20.17**
Wednesday Week 1	**61.8**	**58.03**
Thursday Week 1	**57.67**	**29.94**
Friday Week 1	**49.42**	**18.79**
Saturday Week 1	**47.31**	**18.71**
Sunday Week 1	**60.37**	**51.67**
Monday Week 2	**46.59**	**28.43**
Tuesday Week 2	**46.96**	**17.46**
Wednesday Week 2	**48.48**	**16.15**
Thursday Week 2	**58.92**	**32.76**
Friday Week 2	**52.42**	**25.45**

Saturday Week 2	**46.82**	**36.74**
Sunday Week 2	**51.67**	**41.85**
Monday Week 3	**46.24**	**19.74**
Tuesday Week 3	**54.29**	**28.67**
Wednesday Week 3	**63.73**	**39.45**
Thursday Week 3	**52.38**	**28.18**
Friday Week 3	**47.2**	**29.19**
Saturday Week 3	**51.14**	**22.39**
Sunday Week 3	**54.41**	**42.9**
Monday Week 4	**50.14**	**17.89**
Tuesday Week 4	**62.56**	**28.59**
Wednesday Week 4	**57.1**	**28.41**
Thursday Week 4	**61.38**	**30.94**
Friday Week 4	**53.56**	**40.33**
Saturday Week 4	**53.39**	**44.3**
Sunday Week 4	**52.2**	**45.26**

Care Home 2

Alternative food options

Alternative Foods	**GI**	**GL**
Yoghurt	**36**	**5.9**
Ice Cream	**61**	**4.5**
Grapefruit	**48**	**3.7**
Tuna Sandwich	**72**	**6.7**
Ham Sandwich	**72**	**6.6**
CheesePK Sandwich	**72**	**7.3**

Jacket Potato	**69**	**27.4**
Jacket Potato and Beans	**62.75**	**26.35**
Salad	**71**	**0.7**

Alternative food combo

Alternative Combo	**GI**	**GL**
Jacket,beans,salad	**63.48**	**30.47**
Combo with OJ	**61.52**	**38.14**

Afternoon Tea Snack

Snack	**GI**	**GL**
Tea and biscuits (2)	**59.22**	**9.59**

Main Lunch Meal option with orange juice option

Weekday Lunch Meal+OJ	**GI**	**GL**
Monday Week 1 mash+OJ	**57.81**	**39.88**
Monday Week 1 rice+OJ	**56.77**	**38.6**
Monday Week 1 mash+dessert 2+OJ	**58.03**	**36.55**
Monday Week 1 rice+dessert 2+OJ	**56.9**	**36.41**
Tuesday Week 1+OJ	**57.46**	**54.01**
Tuesday Week 1+desset 2+OJ	**58.09**	**55.76**
Wednesday Week 1+OJ	**59.3**	**59.89**
Wednesday Week 1+dessert 2+OJ	**68.02**	**57.81**
Thursday Week 1+OJ	**63.49**	**63.49**
Thursday Week 1+dessert 2+OJ	**64.56**	**62.62**

Friday Week 1+OJ	**65.18**	**56.05**
Friday Week 1+dessert 2+OJ	**66.9**	**64.89**
Saturday Week 1+OJ	**63.5**	**50.8**
Saturday Week1 + dessert 2+OJ	**64.93**	**51.29**
Sunday Week 1 +OJ	**63.81**	**31.26**
Sunday Week 1 + dessert 2+OJ	**56.33**	**23.09**
Monday Week 2 +OJ	**65.87**	**71.13**
Monday Week 2 +dessert 2+OJ	**62.67**	**53.26**
Tuesday Week 2 +OJ	**56.69**	**62.92**
Tuesday Week 2+ dessert 2+OJ	**58.86**	**52.38**
Wednesday Week 2+OJ	**68.17**	**68.17**
Wednesday Week 2+dessert2+OJ	**66.44**	**52.48**
Thursday Week 2+OJ	**60.24**	**73.49**
Thursday Week 2+dessert2+OJ	**59.75**	**62.73**
Friday Week 2+OJ	**59.81**	**65.19**
Friday Week 2+dessert 2+OJ	**54.68**	**49.75**
Saturday Week 2+OJ	**62.51**	**64.38**
Saturday Week 2+dessert 2+OJ	**56.81**	**46.58**
Sunday Week 2 +OJ	**59.25**	**33.18**
Sunday Week 2 +dessert 2+OJ	**61.4**	**33.77**
Monday Week 3 +OJ	**59.82**	**49.05**
Monday Week 3+dessert 2+OJ	**58.49**	**58.49**
Tuesday Week 3+ OJ	**63.32**	**55.08**
Tuesday Week +dessert2+ OJ	**60.04**	**44.42**
Wednesday Week 3 +OJ	**68.18**	**89.31**
Wednesday Week 3+ dessert 2+OJ	**63.16**	**78.95**

Thursday Week 3 +OJ	**54.82**	**33.98**
Thursday Week 3 +dessert 2+ OJ	**52.13**	**32.84**
Friday Week 3+OJ	**59.98**	**43.18**
Friday Week 3+ dessert 2 +OJ	**57.53**	**36.24**
Saturday Week 3 +OJ	**64.38**	**75.96**
Saturday Week 3 +dessert 2 +OJ	**65.54**	**70.12**
Sunday Week 3 +OJ	**64.86**	**40.21**
Sunday Week 3+ dessert 2 +OJ	**65.57**	**33.44**

Lunch Meal Option 2 with orange juice

Weekday Option 2 + OJ	**GI**	**GL**
Monday Week 1 mash+OJ	**58.29**	**41.96**
Monday Week 1 rice+OJ	**59.19**	**43.2**
Monday Week 1 mash+dessert 2+OJ	**58.99**	**40.11**
Monday Week 1 rice+dessert 2+OJ	**57.91**	**39.95**
Tuesday Week 1+OJ	**59.82**	**51.44**
Tuesday Week 1+dessert 2+OJ	**60.4**	**53.15**
Wednesday Week 1+OJ	**68.57**	**69.94**
Wednesday Week 1+dessert 2+OJ	**68.68**	**68.68**
Thursday Week 1+OJ	**57.94**	**64.89**
Thursday Week 1+dessert 2+OJ	**58.83**	**64.12**
Friday Week 1+OJ	**63.8**	**42.74**
Friday Week 1+dessert 2+OJ	**66.15**	**51.59**
Saturday Week 1+OJ	**64.86**	**70.69**
Saturday Week 1+dessert 2+OJ	**65.92**	**71.19**

Sunday Week 1 +OJ	**65.28**	**39.16**
Sunday Week 1 +dessert 2+OJ	**59.47**	**30.92**
Monday Week 2+ OJ	**66.92**	**74.28**
Monday Week 2+dessert 2+OJ	**54.07**	**57.13**
Tuesday Week 2+OJ	**52.79**	**55.95**
Tuesday Week 2+dessert 2+OJ	**55.88**	**52.52**
Wednesday Week 2+OJ	**65.28**	**69.84**
Wednesday Week 2+dessert 2+OJ	**62.78**	**53.99**
Thursday Week 2+OJ	**55.03**	**78.14**
Thursday Week 2+dessert 2+OJ	**53.91**	**67.38**
Friday Week 2+OJ	**63.51**	**74.94**
Friday Week 2+dessert 2+OJ	**58.72**	**58.72**
Saturday Week 2+OJ	**51.42**	**52.96**
Saturday Week 2+dessert 2+OJ	**43.47**	**35.64**
Sunday Week 2 +OJ	**60.55**	**30.88**
Sunday Week 2+dessert 2+OJ	**62.89**	**31.44**
Monday Week 3+ OJ	**57.29**	**40.1**
Monday Week 3 +dessert 2+ OJ	**56.24**	**49.49**
Tuesday Week3 +OJ	**63.44**	**39.96**
Tuesday Week 3+dessert2+OJ	**58.47**	**29.23**
Wednesday Week 3 +OJ	**68.05**	**91.18**
Wednesday Week 3 +dessert 2+ OJ	**63.22**	**80.92**
Thursday Week 3 +OJ	**60.49**	**47.18**
Thursday Week 3 +dessert 2 +OJ	**58.38**	**46.12**
Friday Week 3 +OJ	**64.73**	**41.42**
Friday Week 3+ dessert 2+ OJ	**62.71**	**34.49**

Saturday Week 3 +OJ	**66.23**	**74.17**
Saturday Week 3 +dessert 2+OJ	**67.86**	**68.53**
Sunday Week 3 +OJ	**64.33**	**32.8**
Sunday Week 3 +dessert 2+ OJ	**65.13**	**26.05**

Supper Meal with orange juice option

Weekday Supper Meal+OJ	**GI**	**GL**
Monday Week 1+OJ	**51.38**	**41.1**
Monday Week 1+dessert2+OJ	**48.29**	**31.38**
Tuesday Week 1+OJ	**59.4**	**49.3**
Tuesday Week 1+dessert2+OJ	**66.38**	**42.48**
Wednesday Week 1+OJ	**48.07**	**38.45**
Wednesday Week 1+dessert2+OJ	**52.31**	**21.44**
Thursday Week 1+OJ	**51.84**	**35.76**
Thursday Week 1+dessert2+OJ	**58.6**	**25.78**
Friday Week 1+ OJ	**50**	**66.5**
Friday Week 1+dessert2+OJ	**52.47**	**45.64**
Saturday Week 1+OJ	**58.15**	**30.81**
Saturday Week 1+dessert2+OJ	**56.75**	**15.32**
Sunday Week 1+OJ	**61.71**	**54.3**
Sunday Week 1+dessert2+OJ	**60.87**	**35.3**
Monday Week 2+OJ	**50.46**	**41.37**
Monday Week 2+dessert2+OJ	**46.3**	**28.7**
Tuesday Week 2+OJ	**64.69**	**44.63**
Tuesday Week 2+dessert2+OJ	**65.18**	**31.12**

Wednesday Week 2+OJ	**48.92**	**28.86**
Wednesday Week 2+dessert2+OJ	**53.45**	**19.24**
Thursday Week 2+OJ	**61.19**	**48.95**
Thursday Week2+dessert2+OJ	**62.3**	**34.88**
Friday Week 2+OJ	**50.32**	**35.22**
Friday Week 2+dessert2+OJ	**54.5**	**22.89**
Saturday Week 2+ OJ	**57.43**	**34.45**
Saturday Week 2+dessert 2+OJ	**54.97**	**17.59**
Sunday Week 2+OJ	**63.19**	**51.81**
Sunday Week 2+dessert 2+OJ	**63.03**	**31.51**
Monday Week 3 +OJ	**58.26**	**52.43**
Monday Week 3+ dessert2+OJ	**59.92**	**40.14**
Tuesday Week 3+OJ	**51.76**	**39.85**
Tuesday Week 3+dessert 2+OJ	**65.18**	**31.28**
Wednesday Week 3 +OJ	**64.02**	**45.45**
Wednesday Week 3+dessert2+OJ	**63.76**	**49.73**
Thursday Week 3 +OJ	**52.58**	**44.69**
Thursday Week 3+dessert 2 +OJ	**49.7**	**30.31**
Friday Week 3 +OJ	**57.62**	**39.18**
Friday Week 3+dessert 2+ OJ	**52.84**	**19.55**
Saturday Week 3 +OJ	**49.35**	**27.14**
Saturday Week 3 +dessert 2+OJ	**54.97**	**17.59**
Sunday Week 3 + OJ	**59.54**	**32.15**
Sunday Week 3 +dessert 2+OJ	**54.34**	**5.43**

Care Home 4

Main Lunch Meal with OJ (orange juice)

Weekday Lunch Meal +OJ	GI	GL
Monday Week 1+OJ	53.31	47.44
Monday Week 1+OJ+dessert 2	65.59	43.94
Tuesday Week 1 +OJ	62.6	66.35
Tuesday Week 1+OJ+dessert 2	61.73	79.01
Wednesday Week 1 + OJ	56.86	31.84
Wednesday Week1+OJ+dessert 2	63.6	21.62
Thursday Week 1 +OJ	53.37	58.7
Thursday Week 1 +OJ+dessert 2	59.38	73.03
Friday Week 1 +OJ	59.88	61.07
Friday Week 1+OJ+dessert 2	54.52	62.15
Saturday Week1 +OJ	52.87	28.54
Saturday Week 1 +OJ+dessert 2	47.91	15.33
Sunday Week 1 + OJ	57.14	48.56
Sunday Week 1 +OJ+dessert 2	63.53	69.88
Monday Week 2 +OJ	58.79	64.66
Monday Week 2+OJ+dessert 2	58.51	77.23
Tuesday Week 2+OJ	55.64	43.39
Tuesday Week 2+dessert2+OJ	56.55	40.15
Wednesday Week 2+OJ	64.32	50.16
Wednesday Week 2+dessert2+OJ	57.03	51.89
Thursday Week 2+OJ	51	51
Thursday Week2+dessert2+OJ	58.63	62.73

Friday Week 2+OJ	**55.55**	**58.88**
Friday Week 2+dessert2+OJ	**61.15**	**40.35**
Saturday Week 2+ OJ	**54.78**	**54.78**
Saturday Week 2+dessert 2+OJ	**67.15**	**49.01**
Sunday Week 2+OJ	**59.84**	**44.28**
Sunday Week 2+dessert 2+OJ	**61.04**	**57.37**
Monday Week 3 +OJ	**57.67**	**57.09**
Monday Week 3+ dessert2+OJ	**52.35**	**58.63**
Tuesday Week 3+OJ	**54.26**	**60.77**
Tuesday Week 3+dessert 2+OJ	**61.08**	**72.68**
Wednesday Week 3 +OJ	**64.15**	**48.75**
Wednesday Week 3+dessert2+OJ	**65.13**	**25.4**
Thursday Week 3 +OJ	**60.63**	**49.11**
Thursday Week 3+dessert 2 +OJ	**68.04**	**60.22**
Friday Week 3 +OJ	**60.38**	**64.6**
Friday Week 3+dessert 2+ OJ	**59.47**	**63.27**
Saturday Week 3 +OJ	**54.6**	**60.06**
Saturday Week 3 +dessert 2+OJ	**74.46**	**60.54**
Sunday Week 3 + OJ	**67.12**	**40.94**
Sunday Week 3 +dessert 2+OJ	**61.03**	**39.66**
Monday Week 4 +OJ	**61.35**	**46.01**
Monday Week 4+ dessert2+OJ	**60.46**	**58.64**
Tuesday Week 4+OJ	**58.45**	**65.46**
Tuesday Week 4+dessert 2+OJ	**67.05**	**39.55**
Wednesday Week 4 +OJ	**61.73**	**41.97**
Wednesday Week 4+dessert2+OJ	**66.65**	**43.32**

Thursday Week 4 +OJ	**58.28**	**44.29**
Thursday Week 4+dessert 2 +OJ	**58.11**	**57.52**
Friday Week 4 +OJ	**54.64**	**65.89**
Friday Week 4+dessert 2+ OJ	**56.89**	**52.33**
Saturday Week 4 +OJ	**60.09**	**46.87**
Saturday Week 4+dessert 2+OJ	**59.52**	**60.11**
Sunday Week 4 + OJ	**66.38**	**43.81**
Sunday Week 4 +dessert 2+OJ	**57.89**	**45.73**

Lunch Meal Option 2 with OJ

Weekday Lunch Opt 2+OJ	**GI**	**GL**
Monday Week 1+OJ	**53.52**	**44.42**
Monday Week 1+OJ+dessert 2	**67.31**	**41.05**
Tuesday Week 1 +OJ	**67.59**	**57.45**
Tuesday Week 1+OJ+dessert 2	**65.66**	**70.25**
Wednesday Week 1 + OJ	**56.09**	**32.53**
Wednesday Week1+OJ+dessert 2	**62.13**	**22.36**
Thursday Week 1 +OJ	**53.4**	**58.2**
Thursday Week 1 +OJ+dessert 2	**59.45**	**72.52**
Friday Week 1 +OJ	**55.3**	**58.06**
Friday Week 1+OJ+dessert 2	**50.58**	**59.17**
Saturday Week1 +OJ	**61.07**	**51.9**
Saturday Week 1 +OJ+dessert 2	**60.57**	**38.15**
Sunday Week 1 + OJ	**57.14**	**48.56**
Sunday Week 1 +OJ+dessert 2	**63.53**	**69.88**

Monday Week 2 +OJ	**63.31**	**56.34**
Monday Week 2+OJ+dessert 2	**62.15**	**68.98**
Tuesday Week 2+OJ	**52.14**	**51.09**
Tuesday Week 2+dessert2+OJ	**52.63**	**47.89**
Wednesday Week 2+OJ	**65.42**	**53.64**
Wednesday Week 2+dessert2+OJ	**58.35**	**55.43**
Thursday Week 2+OJ	**50.83**	**47.27**
Thursday Week2+dessert2+OJ	**59.05**	**59.05**
Friday Week 2+OJ	**55.09**	**55.09**
Friday Week 2+dessert2+OJ	**60.56**	**36.33**
Saturday Week 2+ OJ	**50.6**	**44.02**
Saturday Week 2+dessert 2+OJ	**63.73**	**38.23**
Sunday Week 2+OJ	**59.84**	**44.28**
Sunday Week 2+dessert 2+OJ	**61.04**	**57.37**
Monday Week 3 +OJ	**61.96**	**45.23**
Monday Week 3+ dessert2+OJ	**54.51**	**46.87**
Tuesday Week 3+OJ	**54.01**	**59.95**
Tuesday Week 3+dessert 2+OJ	**60.76**	**71.69**
Wednesday Week 3 +OJ	**64.34**	**50.82**
Wednesday Week 3+dessert2+OJ	**65.42**	**27.47**
Thursday Week 3 +OJ	**57.07**	**59.92**
Thursday Week 3+dessert 2 +OJ	**57.07**	**79.32**
Friday Week 3 +OJ	**62.33**	**62.33**
Friday Week 3+dessert 2+ OJ	**57.12**	**65.66**
Saturday Week 3 +OJ	**54.75**	**60.08**
Saturday Week 3 +dessert 2+OJ	**60.87**	**75.47**

Sunday Week 3 + OJ	**67.12**	**40.94**
Sunday Week 3 +dessert 2+OJ	**61.03**	**39.66**
Monday Week 4 +OJ	**59.68**	**48.94**
Monday Week 4+ dessert2+OJ	**59.13**	**61.49**
Tuesday Week 4+OJ	**54.52**	**53.42**
Tuesday Week 4+dessert 2+OJ	**64.85**	**27.88**
Wednesday Week 4 +OJ	**61.83**	**42.66**
Wednesday Week 4+dessert2+OJ	**65.66**	**43.33**
Thursday Week 4 +OJ	**57.94**	**50.4**
Thursday Week 4+dessert 2 +OJ	**57.83**	**63.61**
Friday Week 4 +OJ	**57.73**	**73.89**
Friday Week 4+dessert 2+ OJ	**60.85**	**60.24**
Saturday Week 4 +OJ	**57.81**	**51.45**
Saturday Week 4+dessert 2+OJ	**57.72**	**64.64**
Sunday Week 4 + OJ	**66.38**	**43.81**
Sunday Week 4 +dessert 2+OJ	**57.89**	**45.73**

Main Supper Meal with OJ

Weekday Supper Meal+OJ	**GI**	**GL**
Monday Week 1 +OJ	**58.94**	**27.7**
Tuesday Week 1 +OJ	**54.73**	**28.45**
Wednesday week 1+OJ	**45.77**	**16.93**
Thursday Week 1+OJ	**57.02**	**27.36**
Friday Week 1+OJ	**60.93**	**38.99**
Saturday Week 1+OJ	**46.72**	**18.22**

Sunday Week1+OJ	**65.29**	**19.58**
Monday week 2+OJ	**61.21**	**23.87**
Tuesday Week 2+OJ	**50.94**	**32.09**
Wednesday Week 2+OJ	**62.11**	**25.46**
Thursday Week 2+OJ	**61.68**	**35.77**
Friday Week 2+OJ	**53.48**	**23.53**
Saturday Week 2+OJ	**59.07**	**30.12**
Sunday Week 2+OJ	**58.25**	**32.62**
Monday Week 3+OJ	**58.58**	**36.31**
Tuesday Week 3+OJ	**59.17**	**31.36**
Wednesday Week 3+OJ	**49.43**	**22.73**
Thursday Week 3+OJ	**49.86**	**32.4**
Friday Week 3+OJ	**55.94**	**40.83**
Saturday Week 3+OJ	**55.6**	**25.02**
Sunday Week 3+OJ	**48.76**	**23.89**
Monday Week 4+OJ	**62.04**	**29.16**
Tuesday Week 4+OJ	**57.42**	**21.81**
Wednesday Week 4+OJ	**56.9**	**32.24**
Thursday Week 4+OJ	**56.45**	**38.95**
Friday Week 4+OJ	**56**	**16.8**
Saturday Week 4+OJ	**54.83**	**44.96**
Sunday Week 4+OJ	**46.83**	**16.85**

Appendix 7A: Examples of Nutrient Profile of Foods

Foods	Nutrient Profile Number
wholemeal toast	-2
cream	12
cheesecake	13
sweet and sour pork	-7
custard (skim milk) (1)	1
garlic bread	3
horseradish sauce	12
Yorkshire pudding (Skim milk)	-2
canned pears	-5
tartare sauce	16
stew rhubarb	-3
fruit flan	2
courgette	-7
sage and onion stuffing	7
roast parsnips	-8
leek and potato bake	6
chicken nugget	3

sweet and sour sauce	8
noodles (egg)	-4
bacon rashers	20
broad beans	-8
Spinach	-3
mint sauce	10
French onion soup	1
Strawberries	-5
quorn chilli	-4
fried plaice	0
Moussaka	-2
Parsley	-4
potato salad	2
red cabbage	-7
gala pie/pork	18
Crackling	16
tuna pasta bake	0
beef root stew, meat, dumpling	2
Manchester, custard tart	11
stuffed tomatoes	-1
Meringue	15
butternut squash soup	2
petit pois	-6
Grape	-2
mince meat	0

Appendix 7B: Example of Nutrient Profile of meals and GL

Home week meal	GL	Nutrient profile
Monday Week 1 L OJ Home1	40.99	-16
Tuesday Week 1	20.47	-6
Wednesday Week 1	37.88	-3
Thursday Week 1	42.05	-1
Friday Week 1	51.32	-7
Saturday Week 1	34.76	-9
Sunday Week 1	30.35	-14
Monday Week 2	37.11	-1
Tuesday Week 2	41.05	-18
Wednesday Week 2	20.67	29
Thursday Week 2	33.69	-1
Friday Week 2	36.42	4
Saturday Week 2	31.86	-4
Sunday Week 2	35.24	2

Monday Week 3	44.84	7
Tuesday Week 3	30.06	-7
Wednesday Week 3	37.35	-10
Thursday Week 3	25.1	13
Friday Week 3	48.19	15
Saturday Week 3	35.86	38
Sunday Week 3	33.94	-10
Monday Week 4	71.37	1
Tuesdy Week 4	34.12	-16
Wednesday Week 4	46.36	0
Thursday Week 4	43.77	10
Friday Week 4	43.49	21
Saturday Week 4	38.79	-8
Sunday Week 4	44.24	-3
Monday Week 1 L OJ Alt	42.14	6
Tuesday Week 1	17.12	-8
Wednesday Week 1	50.08	-2
Thursday Week 1	48.58	-11
Friday Week 1	34.9	-1
Saturday Week 1	26.09	0
Sunday Week1	32.89	-11
Monday Week 2	55.91	-24
Tuesday Week 2	37.05	-11
Wednesday Week 2	20.67	11
Thursday Week 2	39.69	-3
Friday Week 2	48.75	-14
Saturday Week 2	32.38	22
Sunday Week 2	37.43	-17
Monday Week 3	38.06	1
Tuesday Week 3	26.06	-3
Wednesday Week 3	30.38	-28
Thursday Week 3	33.82	3
Friday Week 3	41.9	0
Saturday Week 3	39.28	0
Sunday Week 3	39.35	-24
Monday Week 4	56.85	-2
Tuesday Week 4	35.59	-6
Wednesday Week 4	40.09	-2
Thursday Week 4	26.03	24
Friday Week 4	65.07	9
Saturday Week 4	28.43	15
Sunday Week 4	60.98	-18
Monday Week 1 Supper with OJ	36.89	20

Tuesday Week 1	**20.17**	**18**
Wednesday Week 1	**58.03**	**37**
Thursday Week 1	**29.94**	**1**
Friday Week 1	**18.79**	**8**
Saturday Week 1	**18.71**	**9**
Sunday Week 1	**51.67**	**37**
Monday Week 2	**28.43**	**-7**
Tuesday Week 2	**17.46**	**26**
Wednesday Week 2	**16.15**	**1**
Thursday Week 2	**32.76**	**24**
Friday Week 2	**25.45**	**7**
Saturday Week 2	**36.74**	**41**
Sunday Week 2	**41.85**	**27**
Monday Week 3	**19.74**	**8**
Tuesday Week 3	**28.67**	**34**
Wednesday Week 3	**39.45**	**30**
Thursday Week 3	**28.18**	**29**
Friday Week 3	**29.19**	**4**
Saturday Week 3	**22.39**	**5**
Sunday Week 3	**42.9**	**17**
Monday Week 4	**17.89**	**64**
Tuesday Week 4	**28.59**	**13**
Wednesday Week 4	**28.41**	**9**
Thursday Week 4	**30.94**	**7**
Friday Week 4	**40.33**	**29**
Saturday Week 4	**44.3**	**8**
Sunday Week 4	**45.26**	**14**
Monday Week 1 mash+OJ Home 2	**39.88**	**-15**
Monday Week 1 rice+OJ	**38.6**	**-16**
Monday Week 1 mash+dessert 2+OJ	**36.55**	**-20**
Monday Week 1 rice+dessert 2+OJ	**36.41**	**-21**
Tuesday Week 1+OJ	**54.01**	**-23**
Tuesday Week 1+desset 2+OJ	**55.76**	**-28**
Wednesday Week 1+OJ	**59.89**	**4**
Wednesday Week 1+dessert 2+OJ	**57.81**	**14**
Thursday Week 1+OJ	**63.49**	**-4**
Thursday Week 1+dessert 2+OJ	**62.62**	**-8**
Friday Week 1+OJ	**56.05**	**1**
Friday Week 1+dessert 2+OJ	**64.89**	**14**
Saturday Week 1+OJ	**50.8**	**17**
Saturday Week1 + dessert 2+OJ	**51.29**	**10**
Sunday Week 1 +OJ	**31.26**	**9**
Sunday Week 1 + dessert 2+OJ	**23.09**	**2**

Monday Week 2 +OJ	71.13	6
Monday Week 2 +dessert 2+OJ	53.26	-23
Tuesday Week 2 +OJ	62.92	23
Tuesday Week 2+ dessert 2+OJ	52.38	-2
Wednesday Week 2+OJ	68.17	-3
Wednesday Week 2+dessert2+OJ	52.48	-10
Thursday Week 2+OJ	73.49	46
Thursday Week 2+dessert2+OJ	62.73	46
Friday Week 2+OJ	65.19	4
Friday Week 2+dessert 2+OJ	49.75	15
Saturday Week 2+OJ	64.38	-1
Saturday Week 2+dessert 2+OJ	46.58	-24
Sunday Week 2 +OJ	33.18	7
Sunday Week 2 +dessert 2+OJ	33.77	2
Monday Week 3 +OJ	49.05	16
Monday Week 3+dessert 2+OJ	58.49	26
Tuesday Week 3+ OJ	55.08	-9
Tuesday Week +dessert2+ OJ	44.42	-16
Wednesday Week 3 +OJ	89.31	13
Wednesday Week 3+ dessert 2+OJ	78.95	41
Thursday Week 3 +OJ	33.98	17
Thursday Week 3 +dessert 2+ OJ	32.84	15
Friday Week 3+OJ	43.18	0
Friday Week 3+ dessert 2 +OJ	36.24	-10
Saturday Week 3 +OJ	75.96	2
Saturday Week 3 +dessert 2 +OJ	70.12	1
Sunday Week 3 +OJ	40.21	19
Sunday Week 3+ dessert 2 +OJ	33.44	35
Monday Week 1 mash+OJ	41.96	-20
Monday Week 1 rice+OJ	43.2	-21
Monday Week 1 mash+dessert 2+OJ	40.11	-25
Monday Week 1 rice+dessert 2+OJ	39.95	-26
Tuesday Week 1+OJ	51.44	-16
Tuesday Week 1+dessert 2+OJ	53.15	-21
Wednesday Week 1+OJ	69.94	18
Wednesday Week 1+dessert 2+OJ	68.68	28
Thursday Week 1+OJ	64.89	-15
Thursday Week 1+dessert 2+OJ	64.12	-19
Friday Week 1+OJ	42.74	0
Friday Week 1+dessert 2+OJ	51.59	13
Saturday Week 1+OJ	70.69	5
Saturday Week 1+dessert 2+OJ	71.19	-2
Sunday Week 1 +OJ	39.16	36

Sunday Week 1 +dessert 2+OJ	30.92	29
Monday Week 2+ OJ	74.28	-15
Monday Week 2+dessert 2+OJ	57.13	-44
Tuesday Week 2+OJ	55.95	1
Tuesday Week 2+dessert 2+OJ	52.52	-24
Wednesday Week 2+OJ	69.84	-20
Wednesday Week 2+dessert 2+OJ	53.99	-27
Thursday Week 2+OJ	78.14	51
Thursday Week 2+dessert 2+OJ	67.38	51
Friday Week 2+OJ	74.94	2
Friday Week 2+dessert 2+OJ	58.72	13
Saturday Week 2+OJ	52.96	-4
Saturday Week 2+dessert 2+OJ	35.64	-27
Sunday Week 2 +OJ	30.88	5
Sunday Week 2+dessert 2+OJ	31.44	0
Monday Week 3+ OJ	40.1	16
Monday Week 3 +dessert 2+ OJ	49.49	26
Tuesday Week3 +OJ	39.96	17
Tuesday Week 3+dessert2+OJ	29.23	10
Wednesday Week 3 +OJ	91.18	10
Wednesday Week 3 +dessert 2+ OJ	80.92	38
Thursday Week 3 +OJ	47.18	-16
Thursday Week 3 +dessert 2 +OJ	46.12	-18
Friday Week 3 +OJ	41.42	18
Friday Week 3+ dessert 2+ OJ	34.49	8
Saturday Week 3 +OJ	74.17	0
Saturday Week 3 +dessert 2+OJ	68.53	-1
Sunday Week 3 +OJ	32.8	32
Sunday Week 3 +dessert 2+ OJ	26.05	48
Monday Week 1+OJ	41.1	7
Monday Week 1+dessert2+OJ	31.38	15
Tuesday Week 1+OJ	49.3	10
Tuesday Week 1+dessert2+OJ	42.48	21
Wednesday Week 1+OJ	38.45	26
Wednesday Week 1+dessert2+OJ	21.44	22
Thursday Week 1+OJ	35.76	13
Thursday Week 1+dessert2+OJ	25.78	17
Friday Week 1+ OJ	66.5	27
Friday Week 1+dessert2+OJ	45.64	14
Saturday Week 1+OJ	30.81	12
Saturday Week 1+dessert2+OJ	15.32	7
Sunday Week 1+OJ	54.3	6
Sunday Week 1+dessert2+OJ	35.3	12

Monday Week 2+OJ	**41.37**	**-15**
Monday Week 2+dessert2+OJ	**28.7**	**-9**
Tuesday Week 2+OJ	**44.63**	**5**
Tuesday Week 2+dessert2+OJ	**31.12**	**11**
Wednesday Week 2+OJ	**28.86**	**28**
Wednesday Week 2+dessert2+OJ	**19.24**	**24**
Thursday Week 2+OJ	**48.95**	**11**
Thursday Week2+dessert2+OJ	**34.88**	**19**
Friday Week 2+OJ	**35.22**	**40**
Friday Week 2+dessert2+OJ	**22.89**	**12**
Saturday Week 2+ OJ	**34.45**	**10**
Saturday Week 2+dessert 2+OJ	**17.59**	**7**
Sunday Week 2+OJ	**51.81**	**16**
Sunday Week 2+dessert 2+OJ	**31.51**	**22**
Monday Week 3 +OJ	**52.43**	**14**
Monday Week 3+ dessert2+OJ	**40.14**	**11**
Tuesday Week 3+OJ	**39.85**	**41**
Tuesday Week 3+dessert 2+OJ	**31.28**	**22**
Wednesday Week 3 +OJ	**45.45**	**-2**
Wednesday Week 3+dessert2+OJ	**49.73**	**1**
Thursday Week 3 +OJ	**44.69**	**11**
Thursday Week 3+dessert 2 +OJ	**30.31**	**6**
Friday Week 3 +OJ	**39.18**	**23**
Friday Week 3+dessert 2+ OJ	**19.55**	**19**
Saturday Week 3 +OJ	**27.14**	**6**
Saturday Week 3 +dessert 2+OJ	**17.59**	**2**
Sunday Week 3 + OJ	**32.15**	**4**
Sunday Week 3 +dessert 2+OJ	**5.43**	**10**
Monday Week 1 +OJ L Home 3	**49.81**	**2**
Tuesday Week 1 +OJ	**27.87**	**16**
Wednesday week 1+OJ	**18.8**	**37**
Thursday Week 1+OJ	**54.09**	**42**
Friday Week 1+OJ	**35.12**	**31**
Saturday Week 1+OJ	**28.43**	**28**
Sunday Week1+OJ	**13.13**	**1**
Monday week 2+OJ	**52.18**	**16**
Tuesday Week 2+OJ	**35.35**	**12**
Wednesday Week 2+OJ	**43.54**	**40**
Thursday Week 2+OJ	**53.12**	**37**
Friday Week 2+OJ	**31.06**	**12**
Saturday Week 2+OJ	**23.05**	**7**
Sunday Week 2+OJ	**27.72**	**11**
Monday Week 3+OJ	**30.22**	**16**

Tuesday Week 3+OJ	41.77	43
Wednesday Week 3+OJ	18.96	7
Thursday Week 3+OJ	22.08	22
Friday Week 3+OJ	26.38	8
Saturday Week 3+OJ	28.24	17
Sunday Week 3+OJ	20.47	2
Monday Week 4+OJ	39.45	25
Tuesday Week 4+OJ	16.59	-4
Wednesday Week 4+OJ	51	35
Thursday Week 4+OJ	39.31	15
Friday Week 4+OJ	46.82	15
Saturday Week 4+OJ	16.86	14
Sunday Week 4+OJ	25.86	21
Monday Week 1 + OJ Opt 2 Lunch	46.95	1
Tuesday Week 1 +OJ	40.4	11
Wednesday Week 1 +OJ	38.89	26
Thursday Week 1 +OJ	51.45	24
Friday Week 1 +OJ	30.66	29
Saturday Week 1+OJ	32.97	15
Sunday Week 1+OJ	32.06	18
Monday Week 2 +OJ	38.57	27
Tuesday Week 2+OJ	37.83	29
Wednesday Week 2+OJ	44.97	29
Thursday Week 2+OJ	38.47	27
Friday Week 2+OJ	46	24
Saturday Week 2+OJ	29.79	15
Sunday Week 2+OJ	47.68	28
Monday Week 3+OJ	36.32	27
Tuesday Week 3+OJ	56.15	53
Wednesday Week 3+OJ	31.27	24
Thursday Week 3+OJ	37.6	26
Friday Week 3+OJ	39.48	21
Saturday Week 3+OJ	27.87	9
Sunday Week 3+OJ	39.48	21
Monday Week 4+OJ	33.3	15
Tuesday Week 4+OJ	29.57	9
Wednesday Week 4+OJ	35.81	25
Thursday Week 4+OJ	33.12	13
Friday Week 4+OJ	46.95	21
Saturday Week 4+OJ	30.07	16
Sunday Week 4+OJ	35.26	14
Monday Week 1+OJ Supper	52.07	-18
Monday Week 1+OJ+dessert 2	43.8	-31

Tuesday Week 1 +OJ	32.4	8
Tuesday Week 1+OJ+dessert 2	12.05	-11
Wednesday Week 1 + OJ	43.58	-21
Wednesday Week1+OJ+dessert 2	40.62	-15
Thursday Week 1 +OJ	71.11	-2
Thursday Week 1 +OJ+dessert 2	28.45	-7
Friday Week 1 +OJ	66.71	4
Friday Week 1+OJ+dessert 2	47.9	-6
Saturday Week1 +OJ	49.84	12
Saturday Week 1 +OJ+dessert 2	47.92	-8
Sunday Week 1 + OJ	50.61	0
Sunday Week 1 +OJ+dessert 2	32.79	-3
Monday Week 2 +OJ	94.54	-25
Monday Week 2+OJ+dessert 2	78.69	-27
Tuesday Week 2+OJ	53.43	1
Tuesday Week 2+dessert2+OJ	35.59	-8
Wednesday Week 2+OJ	52.5	5
Wednesday Week 2+dessert2+OJ	52.74	-1
Thursday Week 2+OJ	43.55	-14
Thursday Week2+dessert2+OJ	39.02	-9
Friday Week 2+OJ	55.69	5
Friday Week 2+dessert2+OJ	46.88	-3
Saturday Week 2+ OJ	51.25	27
Saturday Week 2+dessert 2 +OJ	43.05	6
Sunday Week 2+OJ	41.94	9
Sunday Week 2+dessert 2 +OJ	23.08	-8
Monday Week 3 +OJ	84.07	5
Monday Week 3+ dessert2+OJ	42.18	0
Tuesday Week 3+OJ	40.41	-12
Tuesday Week 3+dessert 2 +OJ	37.61	-17
Wednesday Week 3 +OJ	61.56	4
Wednesday Week 3+dessert2+OJ	40.65	2
Thursday Week 3 +OJ	39.18	-12
Thursday Week 3+dessert 2 +OJ	27.75	-14
Friday Week 3 +OJ	58.8	5
Friday Week 3+dessert 2+ OJ	46.88	-3
Saturday Week 3 +OJ	36.35	-3
Saturday Week 3 +dessert 2+OJ	39.15	-16
Sunday Week 3 + OJ	28.17	-3
Sunday Week 3 +dessert 2+OJ	34.45	-8
Monday Week 4 +OJ	57.17	-11
Monday Week 4+ dessert2+OJ	35.84	-16
Tuesday Week 4+OJ	35	25

Tuesday Week 4+dessert 2+OJ	**35.61**	**-4**
Wednesday Week 4 +OJ	**58.14**	**-26**
Wednesday Week 4+dessert2+OJ	**38.71**	**-26**
Thursday Week 4 +OJ	**66.37**	**6**
Thursday Week 4+dessert 2 +OJ	**43.67**	**-6**
Friday Week 4 +OJ	**38.13**	**-18**
Friday Week 4+dessert 2+ OJ	**37.88**	**-4**
Saturday Week 4 +OJ	**42.48**	**15**
Saturday Week 4+dessert 2+OJ	**20.98**	**-7**
Sunday Week 4 + OJ	**30.76**	**4**
Sunday Week 4 +dessert 2+OJ	**22.54**	**-8**
Monday Week 1+OJ Supper Opt 2	**40.06**	**10**
Monday Week 1+OJ+dessert2	**31.67**	**-3**
Tuesday Week 1+OJ	**35**	**12**
Tuesday Week 1+OJ+dessert2	**14.46**	**-7**
Wednesday Week 1+OJ	**24.66**	**-3**
Wednesday Week 1+OJ+dessert 2	**21.68**	**3**
Thursday Week 1 +OJ	**71.68**	**9**
Thursday Week 1 +OJ+dessert 2	**29.71**	**4**
Friday Week 1 +OJ	**36.93**	**13**
Friday Week 1+OJ+dessert 2	**17.83**	**3**
Saturday Week 1 +OJ	**44.53**	**9**
Saturday Week 1 +OJ+dessert 2	**42.75**	**-11**
Sunday Week 1 +OJ	**51.79**	**3**
Sunday Week 1+ OJ+dessert 2	**32.64**	**0**
Monday Week 2+OJ	**51.8**	**13**
Monday Week 2 +OJ+dessert 2	**36.04**	**11**
Tuesday Week 2+OJ	**45.18**	**10**
Tuesday Week 2 + OJ+dessert 2	**27.39**	**1**
Wednesday Week 2+OJ	**24.22**	**29**
Wednesday Week 2+OJ+dessert 2	**17.81**	**23**
Thursday Week 2+OJ	**46.9**	**6**
Thursday Week 2+OJ+dessert 2	**42.37**	**11**
Friday Week 2+OJ	**34.15**	**17**
Friday Week 2+OJ+dessert 2	**26.37**	**9**
Saturday Week 2+OJ	**45.82**	**13**
Saturday Week 2+OJ+dessert 2	**33.83**	**-8**
Sunday Week 2+OJ	**33.67**	**30**
Sunday Week 2+OJ+dessert 2	**15.03**	**13**
Monday Week 3 +OJ	**84.47**	**17**
Monday Week 3+ dessert2+OJ	**42.52**	**12**
Tuesday Week 3+OJ	**37.29**	**11**
Tuesday Week 3+dessert 2+OJ	**35.06**	**6**

Wednesday Week 3 +OJ	33.15	6
Wednesday Week 3+dessert2+OJ	11.74	4
Thursday Week 3 +OJ	34.64	-4
Thursday Week 3+dessert 2 +OJ	23.15	-6
Friday Week 3 +OJ	23.18	15
Friday Week 3+dessert 2+ OJ	11.68	7
Saturday Week 3 +OJ	23.63	17
Saturday Week 3 +dessert 2+OJ	19.66	4
Sunday Week 3 + OJ	36.32	13
Sunday Week 3 +dessert 2+OJ	42.49	8
Monday Week 4 +OJ	23.6	24
Monday Week 4+ dessert2+OJ	13.4	17
Tuesday Week 4+OJ	60.69	22
Tuesday Week 4+dessert 2+OJ	61.16	-7
Wednesday Week 4 +OJ	36.97	2
Wednesday Week 4+dessert2+OJ	17.59	2
Thursday Week 4 +OJ	42.73	16
Thursday Week 4+dessert 2 +OJ	20.26	4
Friday Week 4 +OJ	11.84	-5
Friday Week 4+dessert 2+ OJ	11.68	3
Saturday Week 4 +OJ	34.83	12
Saturday Week 4 +dessert 2+OJ	13.08	-10
Sunday Week 4+ OJ	27.44	15
Sunday Week 4+dessert 2+OJ	19.24	3
Monday Week 1+OJ L Home 4	47.44	-7
Monday Week 1+OJ+dessert 2	43.94	-25
Tuesday Week 1 +OJ	66.35	-3
Tuesday Week 1+OJ+dessert 2	79.01	-9
Wednesday Week 1 + OJ	31.84	7
Wednesday Week1+OJ+dessert 2	21.62	-25
Thursday Week 1 +OJ	58.7	3
Thursday Week 1 +OJ+dessert 2	73.03	-13
Friday Week 1 +OJ	61.07	-18
Friday Week 1+OJ+dessert 2	62.15	-8
Saturday Week1 +OJ	28.54	-5
Saturday Week 1 +OJ+dessert 2	15.33	-16
Sunday Week 1 + OJ	48.56	-3
Sunday Week 1 +OJ+dessert 2	69.88	-13
Monday Week 2 +OJ	64.66	-2
Monday Week 2+OJ+dessert 2	77.23	9
Tuesday Week 2+OJ	43.39	-7
Tuesday Week 2+dessert2+OJ	40.15	-21
Wednesday Week 2+OJ	50.16	-6

Wednesday Week 2+dessert2+OJ	51.89	0
Thursday Week 2+OJ	51	-8
Thursday Week2+dessert2+OJ	62.73	-24
Friday Week 2+OJ	58.88	-5
Friday Week 2+dessert2+OJ	40.35	-28
Saturday Week 2+ OJ	54.78	-5
Saturday Week 2+dessert 2+OJ	49.01	-20
Sunday Week 2+OJ	44.28	1
Sunday Week 2+dessert 2+OJ	57.37	-8
Monday Week 3 +OJ	57.09	-15
Monday Week 3+ dessert2+OJ	58.63	-9
Tuesday Week 3+OJ	60.77	11
Tuesday Week 3+dessert 2+OJ	72.68	-14
Wednesday Week 3 +OJ	48.75	4
Wednesday Week 3+dessert2+OJ	25.4	-19
Thursday Week 3 +OJ	49.11	-8
Thursday Week 3+dessert 2 +OJ	60.22	-11
Friday Week 3 +OJ	64.6	-3
Friday Week 3+dessert 2+ OJ	63.27	-18
Saturday Week 3 +OJ	60.06	6
Saturday Week 3 +dessert 2+OJ	60.54	-13
Sunday Week 3 + OJ	40.94	-9
Sunday Week 3 +dessert 2+OJ	39.66	-10
Monday Week 4 +OJ	46.01	27
Monday Week 4+ dessert2+OJ	58.64	28
Tuesday Week 4+OJ	65.46	14
Tuesday Week 4+dessert 2+OJ	39.55	-18
Wednesday Week 4 +OJ	41.97	8
Wednesday Week 4+dessert2+OJ	43.32	-1
Thursday Week 4 +OJ	44.29	-10
Thursday Week 4+dessert 2 +OJ	57.52	-16
Friday Week 4 +OJ	65.89	-4
Friday Week 4+dessert 2+ OJ	52.33	-17
Saturday Week 4 +OJ	46.87	8
Saturday Week 4+dessert 2+OJ	60.11	-6
Sunday Week 4 + OJ	43.81	-3
Sunday Week 4 +dessert 2+OJ	45.73	3
Monday Week 1+OJ Opt 2 L F	44.42	-18
Monday Week 1+OJ+dessert 2	41.05	-36
Tuesday Week 1 +OJ	57.45	-8
Tuesday Week 1+OJ+dessert 2	70.25	-14
Wednesday Week 1 + OJ	32.53	4
Wednesday Week1+OJ+dessert 2	22.36	-28

Thursday Week 1 +OJ	58.2	-2
Thursday Week 1 +OJ+dessert 2	72.52	-18
Friday Week 1 +OJ	58.06	-19
Friday Week 1+OJ+dessert 2	59.17	-9
Saturday Week1 +OJ	51.9	-8
Saturday Week 1 +OJ+dessert 2	38.15	-19
Sunday Week 1 + OJ	48.56	-1
Sunday Week 1 +OJ+dessert 2	69.88	-11
Monday Week 2 +OJ	56.34	-16
Monday Week 2+OJ+dessert 2	68.98	-5
Tuesday Week 2+OJ	51.09	-16
Tuesday Week 2+dessert2+OJ	47.89	-30
Wednesday Week 2+OJ	53.64	-4
Wednesday Week 2+dessert2+OJ	55.43	2
Thursday Week 2+OJ	47.27	12
Thursday Week2+dessert2+OJ	59.05	-4
Friday Week 2+OJ	55.09	-10
Friday Week 2+dessert2+OJ	36.33	-33
Saturday Week 2+ OJ	44.02	-8
Saturday Week 2+dessert 2+OJ	38.23	-23
Sunday Week 2+OJ	44.28	4
Sunday Week 2+dessert 2+OJ	57.37	-5
Monday Week 3 +OJ	45.23	-18
Monday Week 3+ dessert2+OJ	46.87	-12
Tuesday Week 3+OJ	59.95	9
Tuesday Week 3+dessert 2+OJ	71.69	-16
Wednesday Week 3 +OJ	50.82	5
Wednesday Week 3+dessert2+OJ	27.47	-18
Thursday Week 3 +OJ	59.92	-13
Thursday Week 3+dessert 2 +OJ	79.32	-16
Friday Week 3 +OJ	62.33	-7
Friday Week 3+dessert 2+ OJ	65.66	-22
Saturday Week 3 +OJ	60.08	5
Saturday Week 3 +dessert 2+OJ	75.47	-14
Sunday Week 3 + OJ	40.94	-7
Sunday Week 3 +dessert 2+OJ	39.66	-8
Monday Week 4 +OJ	48.94	4
Monday Week 4+ dessert2+OJ	61.49	5
Tuesday Week 4+OJ	53.42	27
Tuesday Week 4+dessert 2+OJ	27.88	-5
Wednesday Week 4 +OJ	42.66	6
Wednesday Week 4+dessert2+OJ	43.33	-3
Thursday Week 4 +OJ	50.4	-15

Thursday Week 4+dessert 2 +OJ	63.61	-21
Friday Week 4 +OJ	73.89	-3
Friday Week 4+dessert 2+ OJ	60.24	-16
Saturday Week 4 +OJ	51.45	7
Saturday Week 4+dessert 2+OJ	64.64	-7
Sunday Week 4 + OJ	43.81	-6
Sunday Week 4 +dessert 2+OJ	45.73	0
Monday Week 1 +OJ Sup F	27.7	-5
Tuesday Week 1 +OJ	28.45	2
Wednesday week 1+OJ	16.93	-9
Thursday Week 1+OJ	27.36	3
Friday Week 1+OJ	38.99	-20
Saturday Week 1+OJ	18.22	-4
Sunday Week1+OJ	19.58	-15
Monday week 2+OJ	23.87	7
Tuesday Week 2+OJ	32.09	-8
Wednesday Week 2+OJ	25.46	-11
Thursday Week 2+OJ	35.77	-5
Friday Week 2+OJ	23.53	-12
Saturday Week 2+OJ	30.12	9
Sunday Week 2+OJ	32.62	-19
Monday Week 3+OJ	36.31	-11
Tuesday Week 3+OJ	31.36	-5
Wednesday Week 3+OJ	22.73	-10
Thursday Week 3+OJ	32.4	-4
Friday Week 3+OJ	40.83	0
Saturday Week 3+OJ	25.02	-4
Sunday Week 3+OJ	23.89	-7
Monday Week 4+OJ	29.16	-3
Tuesday Week 4+OJ	21.81	1
Wednesday Week 4+OJ	32.24	-6
Thursday Week 4+OJ	38.95	13
Friday Week 4+OJ	16.8	-4
Saturday Week 4+OJ	44.96	-14
Sunday Week 4+OJ	16.85	-8

Appendix 8: UK Ofcom Model Calculation Example and Further Guidance

Answers

a. Should I use NSP or AOAC fibre values to calculate a nutrient profile score?

The nutrient profiling model was developed using UK recommendations for NSP fibre intake, as measured using the Englyst method. The nutrient profiling score should therefore be calculated using the NSP fibre value, where this is known. Where the NSP value is not known, AOAC fibre values can be used.

Scoring system

Points	NSP(g)	AOAC(g)
0	≤ 0.7	≤ 0.9
1	> 0.7	> 0.9
2	> 1.4	> 1.9
3	> 2.1	> 2.8
4	> 2.8	> 3.7
5	> 3.5	> 4.7

b. How do I calculate a nutrient profile score for a product consumed in quantities less than 100 grams (g)?

The nutrient profile score is always calculated per 100g, irrespective of the amount of product which is consumed (see worked example 1). Amounts of nutrients must be multiplied up to the amount in the product per 100g.

c. How do I calculate a nutrient profile score for breakfast cereals?

The nutrient profile score for breakfast cereals should be calculated on 100g of the product as sold, on a dry weight basis.

d. How do I calculate a nutrient profile score for a product which is measured by volume, e.g. ice-cream, which is usually measured in millilitres (ml's)?

Nutrient profile scores are calculated per 100g of product. If available information is per 100ml's, this should be converted to per 100g using the appropriate specific gravity (density) of the product (see worked example 2).

e. Should I calculate nutrient profile scores for products as sold or as consumed?

Nutrient profile scores should usually be calculated for a product as sold. In cases where a product needs to be reconstituted before it is eaten, for example custard powder, the nutrient profile score should be calculated based on 100g of the product as reconstituted according to the manufacturers instructions.

f. How do I calculate a nutrient profile score for drinks which need to be reconstituted (e.g. squash, milkshake powder or syrup, hot chocolate powder, cocoa powder, malted milk powder)?

The nutrient profile score should be calculated based on 100g of the drink as reconstituted according to the manufacturers instructions (see worked example 3).

g. How do I calculate a nutrient profile score for powdered or ready-made soups?

Soups are classified as food for the purposes of the model.

If the soup is powdered, it should be reconstituted according to the manufacturer's instructions and the nutrient profile score calculated on the nutritional composition of 100g of made-up soup (see worked example 4).

If the soup is ready made, the score should be calculated based on the nutritional composition of 100g of the ready made soup.

h. How do I calculate a nutrient profile score for dried pasta, noodles or dried rice products?

The nutrient profile score for dried pasta, noodles, dried rice and other foods which require reconstitution prior to consumption should be calculated on the basis of the nutritional composition per 100g of the reconstituted product according to the manufacturer's instructions (see worked example 4).

i. How do I calculate a nutrient profile score for milk?

Nutrient profiling scores for whole, semi-skimmed and skimmed milk should be determined on the basis of the composition values provided within McCance and Widdowson's, The Composition of Foods 2002, Sixth Summary Edition, which take account of seasonal and geographical variability in nutritional components of milk, and represent a variety of processing treatments (pasteurised, sterilised and UHT milk varieties).

In the case of whole milk, the value for *whole milk average* should be used.

In the case of semi-skimmed milk, the value for *semi-skimmed milk average* should be used.

In the case of skimmed milk, the value for *skimmed milk average* should be used.

In the case of standardised whole milk, which has a slightly lower fat content than whole milk, where McCance and Widdowson does not give values, the whole milk average should be used adjusted for fat content.

This section works through how to calculate nutrient profiling scores in various scenarios and for different types of products.

Worked example 1: Calculating a score for a product sold in a portion size <100g

Product: Fruit fromage frais, 50g pot.
  Contains fruit puree (8%).

- Product sold in 50g servings, however <u>NP score worked out using amounts per 100g.</u>

	Per 50g pot	Per 100g	Score
Energy (kJ)	230	459	1
Saturated fat (g/100g)	0.9	1.8	1
Total sugar (g/100g)	6.7	13.4	2
Sodium (mg/100g)	<0.1	<0.1	0
Total A points	-	-	**4**
Fruit, veg, nuts (%)	8%	8%	0
AOAC fibre (g/100g)	0.3	0.6	0
Protein (g/100g)	3.5	6.5	4
Total C points	-	-	**4**
SCORE: A-C	-	-	**0**

This product scores 0 and so would not be subject to advertising restrictions.

Worked example 2: Calculating a score for a product where nutrient information is provided in mls rather than grams

Product: Vanilla ice-cream.

Products sold in mls should be converted to per 100g using the appropriate specific gravity (density) of the product.

- Multiply nutrition information per 100ml by 0.55* to give nutrition information in grams.
- Calculate score using per 100g information.

	Nutrition information per **100ml** ice-cream	Nutrition information per **100g** ice-cream**	Score
Energy (kJ)	1347	741	2
Saturated fat (g/100g)	11.1	6.1	6
Total sugar (g/100g)	34.0	18.7	4
Sodium (mg/100g)	109.1	60	0
Total A points	-	-	**12**
Fruit, veg, nuts (%)	0	0	0
NSP fibre (g/100g)	0	0	0
Protein (g/100g)	6.5	3.6	0***
Total C points	-	-	**0**
SCORE: A-C	-	-	**12**

* Specific gravity of ice-cream = 0.55, taken from: 'Food Portion Sizes' Third Ed
** Nutrition information from vanilla dairy ice-cream, McCance & Widdowson's The Composition of Foods, 6th Summary Ed.
*** Product not eligible to score points for protein as it scores a total of 12 'A' points

This ice-cream scores 12 and so would be subject to advertising restrictions.

Worked example 3: Calculating a score for a drink that requires reconstitution before consumption

Product: Powdered milkshake (instructions for reconstitution provided on pack are 15g of powder and 200mls of semi-skimmed milk).

- A – use nutrition info for powder for 15g of product
- B – calculate weight (g) of 200ml of semi skimmed milk
- C – add together nutrient info for 15g powder and 206.8g milk together
- D – scale down from 221g (15g + 206.8g) to per 100g by dividing by 2.218

	A	B	C	D	
	15g milkshake powder	200ml x 0.034* = 206.8g semi skimmed milk	15g powder + 206.8g milk	15g powder + 206.8g milk scaled down to 100g	Score
Energy (kJ)	247	417	664	299	0
Saturated fat (g/100g)	0	2.3	2.3	1.0	0
Total sugar (g/100g)	14.7	5	19.7	8.9	1
Sodium (mg/100g)	0	91	91	41	0
Total A points	-	-	-	-	**1**
Fruit, veg, nuts (%)	0	0	0	0	0
AOAC fibre (g/100g)	0	0	0	0.5	0
Protein (g/100g)	0	7	7	3.2	1
Total C points	-	-	-	-	**1**
SCORE: A-C	-	-	-	-	**0**

* Specific gravity of semi-skimmed milk = 0.034, taken from: 'Food Portion Sizes' Third Ed

This milkshake scores 0 and so would not be subject to advertising restrictions.

Worked example 4: Calculating a score for a food that requires reconstitution before consumption

Product: Cup soup, tomato flavour (instructions for reconstitution provided on pack are 25g of soup powder and 230ml of water).

- Use nutrition info for 25g of product
- No calculation for weight of water needed (1ml = 1g)
- Add together 25g soup powder and 230g water
- Scale down nutrition info from 255g (25g + 230g) to per 100g by diving it by 2.55

	Per 25g soup powder and 230ml water*	Nutrition information scaled down to 100g	Score
Energy (kJ)	395	155	0
Saturated fat (g/100g)	0.9	0.4	0
Total sugar (g/100g)	9.2	3.6	0
Sodium (mg/100g)	1200	471	5
Total A points	-	-	**5**
Fruit, veg, nuts (%)	0	0	0
AOAC fibre (g/100g)	0.5	0.2	0
Protein (g/100g)	0.8	0.3	0
Total C points	-	-	**0**
SCORE: A-C	-	-	**5**

* 1ml of water is equivalent to 1g hence no density calculation required

This cup soup scores 5 and so would be subject to advertising restrictions.

Worked example 5: Calculating a score for a product containing dried fruit

Product: Fruit and nut cereal bars.
            Contains dried fruit (30g/100g).

Using fruit, vegetables and nuts calculation (page 4) this product contains 46 % fruit, veg and nuts:

$$\frac{(Weight\ of\ f,v\&n) + (2 \times weight\ of\ dried\ f,v\&n^*)}{(weight\ of\ f,v\&n) + (2 \times weight\ of\ dried\ f,v\&n) + (weight\ of\ other\ ingredie} \times 100$$

- Weight of f,v&n = 0
- Weight of dried f,v&n = 30
- Weight of other ingredients 70
- Calcultation: 60 (2 x 30) ÷ 130 (60 + 70) x 100 = 46%

	Per 40g bar	Per 100g	Score
Energy (kJ)	602	1504	4
Saturated fat (g/100g)	0.6	1.4	1
Total sugar (g/100g)	14.3	35.7	7
Sodium (mg/100g)	0	0	0
Total A points	-	-	**12**
Fruit, veg, nuts (%)	46%	46%	1
AOAC fibre (g/100g)	1.9	4.8	5
Protein (g/100g)	1.7	4.3	0*
Total C points	-	-	**6**
SCORE: A-C	-	-	**6**

* Product not eligible to score points for protein as it scores a total of 12 'A' points

This cereal bar scores 6 and so would be subject to advertising restrictions.

Appendix 9: Example Nutrient Analysis. Care Home 1 First Options

NUTRIENT	AVG. INTAKE	TARGET	LIMITS				
				LOWER LIMIT	ACTUAL INTAKE	YOUR TARGET	UPPER LIMIT
- ENERGY -							
Energy(Kcal)	1459kcal	2025kcal					
Energy(Kj)	6135kJ	8473kJ					
- MACRONUTRIENTS -							
Carbohydrate	194g	253g					
Protein	57g	60g					
Fat	50g		<79g				
Water	962g			N/A			
› water from drinks	271g			N/A			
Alcohol	0.1g		<14.5g				
- CARBOHYDRATE -							
Starch	93g			N/A			
Oligosaccharide	0.39g			N/A			
Fibre	14.5g	30g					
Sugars	101g			N/A			
! Free Sugars	64g		<25.3g				
- LIPID COMPONENTS -							
Saturated Fat	18.8g		<24.8g				
› monounsaturated fat	16.9g	29.3g					
Polyunsaturated fat	8g		>6.5g <22.5g				
› omega3(n-3)	0.55g		>0.45g				
› omega6(n-6)	3g		>2.3g				
Trans-fatty acids	0.79g		<4.5g				
Cholesterol	233mg			N/A			
- MINERALS & TRACE ELEMENTS -							
Sodium	1540mg	1600mg	>575mg <2400mg				
Potassium	2212mg	3500mg	>2000mg				
Chloride	2481mg	2500mg					
Calcium	599mg	700mg	>400mg				
Phosphorus	885mg	550mg					
! Magnesium	174mg	300mg	>190mg				
Iron	7.6mg	8.7mg	>4.7mg				
Zinc	6.5mg	9.5mg	>5.5mg				

Copper	2.1mg	1.2mg				
Manganese	2.1mg		>1.4mg			
! Selenium	33.3ug	75ug	>40ug			
Iodine	88ug	140ug	>70ug			
- VITAMINS -						
Vitamin A (ret eq)	2994ug	700ug	>300ug			
Vitamin D	1.6ug	10ug				
Vitamin E	5.9mg		>4mg			
Vitamin K $_1$	53ug	80ug				
Thiamin (B$_1$)	1mg	0.9mg	>0.23mg			
Riboflavin (B$_2$)	1.5mg	1.3mg	>0.8mg			
Niacin total (B$_3$)	23.3mg	13.4mg	>8.9mg			
Pantothenic Acid (B$_5$)	4.2mg	3-7mg				
Vitamin B $_6$	1mg	0.85mg	>0.62mg			
Folates (B$_9$) Total	171ug	200ug	>100ug			
Vitamin B $_{12}$	11.8ug	1.5ug	>1ug			
Biotin (B$_7$)	16.6ug	10-200ug				
Vitamin C	59mg	40mg	>10mg			
- OTHER -						
GL	119			N/A		
Caffeine	0.3mg			N/A		

Figures from UK: SACN 2017 / COMA guidelines for male 75-110 years old

Macronutrient Analysis

	CARBOHYDRATE	SUGARS	PROTEIN	FAT	SATFAT	ALCOHOL
Intake	194.3g	101g	56.8g	50.4g	18.8g	0.1g
g/kg body-weight	2.4	1.3	0.7	0.6	0.2	0
Kilocal	777	404	227	454	169	1
Kilocal %	53.3%	27.7%	15.6%	31.1%	11.6%	0%

53.3% Carbs
15.6% Protein
31.1% Fat

DAYS 1
52.7%
14.6%
32.7%
0%

DAYS 2
53.8%
14.8%
31%
0.5%

DAYS 3
46.1%
16.5%
37.5%
0%

DAYS 4
57.2%
16.4%
26.4%
0%

DAYS 5
60.2%
13.3%
26.6%
0%

DAYS 6
55.6%
13.6%
30.8%
0%

DAYS 7
52.8%
18.6%
28.6%
0%
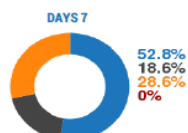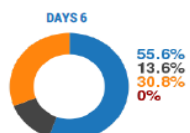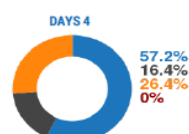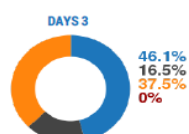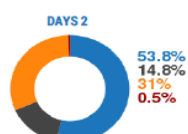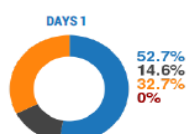
Appendix 10: Example Menu from a Care Home

Texture Modified Diet, Diabetic Diet, Vegetarian, and Gluten Free menu all available on request

WK 1	Mon	Tues	Weds	Thurs	Fri	Sat	Sun Main
Breakfast	Orange Juice Toast and Preserves Cereals and Porridge Tea, Coffee Boiled Eggs	Orange Juice Toast and Preserves Cereals and Porridge Tea, Coffee Bacon Roll	Orange Juice Toast and Preserves Cereals and Porridge Tea, Coffee Pancake	Orange Juice Toast and Preserves Cereals and Porridge Tea, Coffee Scrambled Egg	Orange Juice Toast and Preserves Cereals and Porridge Tea, Coffee Sausage Cob	Orange Juice Toast and Preserves Cereals and Porridge Tea, Coffee Tomatoes on Toast	Orange Juice Toast and Preserves Cereals and Porridge Tea, Coffee Kippers
Lunch	Corned Beef Hash Baked Beans Assorted Sandwiches Fruit Scones	Fish Finger Sandwiches Assorted Sandwiches Fresh Fruit Salad and Evaporated Milk	Bacon and Egg Assorted Sandwiches Jam and Lemon Tarts	Cheesy Crumpets Assorted Sandwiches Iced Carrot Cake	Jacket Potato and Cheese Assorted Sandwiches Chocolate Éclairs	Bacon Butty Assorted Sandwiches Crème Caramel	Salmon Salad Assorted Sandwiches Trifle
Dinner	Shepherd Pie Diced Potato Cauliflower and Green Beans	Sausages and Onions Creamed Potatoes Cabbage and Carrots	Chicken and Mushroom Pie Boiled Potatoes Garden Peas and Broccoli	Braised Steak Chips Cauliflower/Swede	Battered Fish Chips Mushy Peas	Faggots in Gravy Creamed Potatoes Mixed Vegetables	Roast Pork Roast and Creamed Potatoes Vegetables
Dinner Option Two	Macaroni Cheese	Vegetable Hot Pot	Quorn Sausage and Yorkshire Pudding	Vegetable Pie	Spanish Omelette	Vegetable Curry	Quorn Roast
Dessert	Apple Pie and Custard	Raspberry and Coconut Sponge with Custard	Baked Apple and Custard	Rice Pudding and Jam	Ginger Sponge and Custard	Jam Roly Poly	Peach Crumble and Custard
Dessert 2	Banana Custard	Yoghurts	Angel Delight	Ice Cream	Peaches and Cream	Fresh Fruit Salad	Sorbet

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Appendix 11: List of all Food Substitutions (Substitution focused on Macronutrient content)

Food missing from software data	Substitute used
Lemon mousse	generic fruit mousse
Beef and root stew	Stewed beef with vegetables
Gala Pie	Pork Pie with boiled egg
Fondant Potatoes	Roast Potatoes
Cottage Pie	Shepherd's Pie
Cod Goujons	Fish Fingers (Cod)
Lemon Sponge	Fruit Sponge generic
Apple Turnover	Apple Pie
Broccoli Soup	Broccoli and Stilton Soup
Peach Fool	Fruit Fool generic
Baked Fish Gratin	Cod Gratin
Strawberry Gateau	Fruit Gateau
Lamb Stew with Dumplings	Beef Stew with Dumplings
Blue Berry Cheesecake	Fruit Cheesecake
Pork and Leek Casserole	Pork Sausage and Veg Casserole
Mushroom Risotto	Risotto + Cooked Mushrooms
Chocolate Orange Pots	Chocolate Pots
Plum Sponge	Fruit Sponge generic
Apricot Slices	Fresh Apricots
Sausage Meat Plait	Sausage Roll
Ginger Bread Squares	Ginger cake
Quorn Sausage	Vegetarian Sausage generic
Vegetable Hot Pot	Vegetable Casserole
Peach Crumble	Fruit Crumble generic
Gooseberry Crumble	Fruit Crumble generic
Lemon Flan	Fruit Flan generic
Strawberry Pot	Strawberry Mousse
Red Lentil Soup	Lentil Soup
Pineapple Sponge	Fruit Sponge generic
Mashed Root Vegetables	Carrot and Parsnip Mashed
Cherry Pie	Fruit Pie generic
Lamb and mint pie	Beef Pie
Colcannon Mash	Mash cooked with cabbage
Dauphinoise Potatoes	Creamy Garlic Potatoes
Cooked Apricots	Stewed Apricots no sugar
West Country Cheddar Mash	Creamy garlic with cheese mash
Eton Mess	*Home ingredients: meringue, cream and strawberry
	*Based on home recipe and serving.

Appendix 12: Recommended Portion Sizes for Adults (summarised)

FINDING YOUR BALANCE ACROSS THE DAY

The image below shows how many portions to aim for from each food group each day for a healthy, balanced diet.

5+ PORTIONS

3-4 PORTIONS

2-3 PORTIONS

2-3 PORTIONS

SMALL AMOUNTS

FRUIT AND VEGETABLES
A variety of different types each day
5+

STARCHY CARBOHYDRATES
Potatoes, bread, rice, pasta and others
3-4

PROTEIN FOODS
Beans, pulses, fish, eggs, meat and others
2-3

DAIRY AND ALTERNATIVES
Milk, cheese, yogurt and alternatives
2-3

UNSATURATED OILS AND SPREADS
SMALL AMOUNTS

BRITISH
Nutrition
FOUNDATION

HANDY PORTION SIZES!

Your hands are perfect for measuring the right portion size for you – this guide gives examples of portion sizes for different food and drinks for adults. You can find portion sizes for more foods on the BNF website.

Group	Food	1 Portion	Weight
	Fresh fruit	About one handful or more	80g
	Vegetables	About 3 serving spoons or more	80g
	Fruit juice	1 small glass	150ml
	Dried rice or pasta	About 2 handfuls	65-75g
	Cooked pasta or rice	About the amount that would fit in two hands cupped together	180g
	Flaked breakfast cereals	About 3 handfuls	40g
	Dried porridge oats	About 1 and a half handfuls	40g
	Baked potato	About the size of your fist	220g
	Plain popcorn	About 3 handfuls	20g
	Grilled chicken breast	About half the size of your hand	120g
	Cooked fish fillet (e.g. salmon or cod)	About half the size of your hand	100-140g
	Cooked steak	About half the size of your hand	130g
	Cooked beans, chickpeas or lentils	About 6 tablespoons	120g
	Canned tuna in water	One can (about 160g net weight)	120g
	Houmous	About 2 tablespoons or about ¼ standard pot	55g
	Nuts and seeds	The amount you can fit in your palm	20g
	Low fat yogurt	About 4 tablespoons or one individual pot	120g
	Cheddar cheese	About the size of two thumbs together	30g
	Milk or plant-based alternative	One medium glass	200ml
	Unsaturated oils or spread	One teaspoon	3-5g

These portion sizes have been based on averages and may be different to what you see in stores and on pack. They have been developed based on a 2000kcal per day diet. Individual needs vary and you may need larger or smaller portions. As hand size varies you can use your hands as a measure of a suitable portion size for you. Note that where we have used 'tablespoon' this refers to a 10ml spoon that would be used to eat soup or pudding, rather than a larger serving spoon.

Appendix 13: Current Micronutrient DR Values for the EU and UK

Category	Nutrient	Target population	Age	Gender	AI	AR	PRIs	RI	UL
Minerals	Calcium	Adults	≥ 25 years	Both genders	NA	750 mg/day	950 mg/day	NA	2500 mg/day
Minerals	Copper	Adults	≥ 18 years	Male	1.6 mg/day	NA	NA	NA	5 mg/day
Minerals	Copper	Adults	≥ 18 years	Female	1.3 mg/day	NA	NA	NA	5 mg/day
Minerals	Fluoride	Adults	≥ 18 years	Male	3.4 mg/day	NA	NA	NA	7 mg/day
Minerals	Fluoride	Adults	≥ 18 years	Female	2.9 mg/day	NA	NA	NA	7 mg/day
Minerals	Iodine	Adults	≥ 18 years	Both genders	150 µg/day	NA	NA	NA	600 µg/day
Minerals	Iron	Postmenopausal women	≥ 40 years	Female	NA	6 mg/day	11 mg/day	NA	ND
Minerals	Iron	Adults	≥ 18 years	Male	NA	6 mg/day	11 mg/day	NA	ND
Minerals	Magnesium	Adults	≥ 18 years	Male	350 mg/day	NA	NA	NA	250 mg/day
Minerals	Magnesium	Adults	≥ 18 years	Female	300 mg/day	NA	NA	NA	250 mg/day
Minerals	Manganese	Adults	≥ 18 years	Both genders	3 mg/day	NA	NA	NA	ND
Minerals	Molybdenum	Adults	≥ 18 years	Both genders	65 µg/day	NA	NA	NA	0.6 mg/day
Minerals	Phosphorus	Adults	≥ 18 years	Both genders	550 mg/day	NA	NA	NA	ND
Minerals	Potassium	Adults	≥ 18 years	Both genders	3500 mg/day	NA	NA	NA	ND
Minerals	Selenium	Adults	≥ 18 years	Both genders	70 µg/day	NA	NA	NA	300 µg/day
Minerals	Zinc	Adults (LPI 300 mg/day)	≥ 18 years	Male	NA	7.5 mg/day	9.4 mg/day	NA	25 mg/day
Minerals	Zinc	Adults (LPI 600 mg/day)	≥ 18 years	Male	NA	9.3 mg/day	11.7 mg/day	NA	25 mg/day
Minerals	Zinc	Adults (LPI 900 mg/day)	≥ 18 years	Male	NA	11 mg/day	14 mg/day	NA	25 mg/day
Minerals	Zinc	Adults (LPI 1200 mg/day)	≥ 18 years	Male	NA	12.7 mg/day	16.3 mg/day	NA	25 mg/day
Minerals	Zinc	Adults (LPI 300 mg/day)	≥ 18 years	Female	NA	6.2 mg/day	7.5 mg/day	NA	25 mg/day
Minerals	Zinc	Adults (LPI 600 mg/day)	≥ 18 years	Female	NA	7.6 mg/day	9.3 mg/day	NA	25 mg/day
Minerals	Zinc	Adults (LPI 900 mg/day)	≥ 18 years	Female	NA	8.9 mg/day	11 mg/day	NA	25 mg/day
Minerals	Zinc	Adults (LPI 1200 mg/day)	≥ 18 years	Female	NA	10.2 mg/day	12.7 mg/day	NA	25 mg/day
Vitamins	Biotin	Adults	≥ 18 years	Both genders	40 µg/day	NA	NA	NA	ND
Vitamins	Choline	Adults	≥ 18 years	Both genders	400 mg/day	NA	NA	NA	NA
Vitamins	Cobalamin (vitamin B12)	Adults	≥ 18 years	Both genders	4 µg/day	NA	NA	NA	ND
Vitamins	Folate	Adults	≥ 18 years	Both genders	NA	250 µg DFE/day	330 µg DFE/day	NA	1 mg/day
Vitamins	Niacin	Adults	≥ 18 years	Both genders	NA	1.3 mg NE/MJ	1.6 mg NE/MJ	NA	900 mg/day nicotinamide
Vitamins	Niacin	Adults	≥ 18 years	Both genders	NA	1.3 mg NE/MJ	1.6 mg NE/MJ	NA	10 mg/day nicotinic acid
Vitamins	Pantothenic acid	Adults	≥ 18 years	Both genders	5 mg/day	NA	NA	NA	ND
Vitamins	Riboflavin	Adults	≥ 18 years	Both genders	NA	1.3 mg	1.6 mg	NA	ND
Vitamins	Thiamin	Adults	≥ 18 years	Both genders	NA	0.072 mg/MJ	0.1 mg/MJ	NA	ND
Vitamins	Vitamin A	Adults	≥ 18 years	Male	NA	570 µg RE/day	750 µg RE/day	NA	3000 µg RE/day
Vitamins	Vitamin A	Adults	≥ 18 years	Female	NA	490 µg RE/day	650 µg RE/day	NA	3000 µg RE/day
Vitamins	Vitamin B6	Adults	≥ 18 years	Male	NA	1.5 mg/day	1.7 mg/day	NA	25 mg/day
Vitamins	Vitamin B6	Adults	≥ 18 years	Female	NA	1.3 mg/day	1.6 mg/day	NA	25 mg/day
Vitamins	Vitamin C	Adults	≥ 18 years	Male	NA	90 mg/day	110 mg/day	NA	ND
Vitamins	Vitamin C	Adults	≥ 18 years	Female	NA	80 mg/day	95 mg/day	NA	ND
Vitamins	Vitamin D	Adults	≥ 18 years	Both genders	15 µg/day	NA	NA	NA	100 µg/day
Vitamins	Vitamin E as α-tocopherol	Adults	≥ 18 years	Male	13 mg/day	NA	NA	NA	300 mg/day
Vitamins	Vitamin E as α-tocopherol	Adults	≥ 18 years	Female	11 mg/day	NA	NA	NA	300 mg/day
Vitamins	Vitamin K as phylloquinone	Adults	≥ 18 years	Both genders	70 µg/day	NA	NA	NA	ND

Nutrition Requirements

Reference Nutrient Intakes for Vitamins

BRITISH Nutrition FOUNDATION

Age	Thiamin	Riboflavin	Niacin	Vitamin B6 +	Vitamin B12	Folate	Vitamin C	Vitamin A	Vitamin D
	mg/d	mg/d	mg/d	mg/d	µg/d	µg/d	mg/d	µg/d	µg/d
0-3 months	0.2	0.4	3	0.2	0.3	50	25	350	8.5-10***
4-6 months	0.2	0.4	3	0.2	0.3	50	25	350	8.5-10***
7-9 months	0.2	0.4	4	0.3	0.4	50	25	350	8.5-10***
10-12 months	0.3	0.4	5	0.4	0.4	50	25	350	8.5-10***
1-3 years	0.5	0.6	8	0.7	0.5	70	30	400	10
4-6 years	0.7	0.8	11	0.9	0.8	100	30	400	10
7-10 years	0.7	1.0	12	1.0	1.0	150	30	500	10
Males									
11-14 years	0.9	1.2	15	1.2	1.2	200	35	600	10
15-18 years	1.1	1.3	18	1.5	1.5	200	40	700	10
19-50 years	1.0	1.3	17	1.4	1.5	200	40	700	10
50+ years	0.9	1.3	16	1.4	1.5	200	40	700	10
Females									
11-14 years	0.7	1.1	12	1.0	1.2	200	35	600	10
15-18 years	0.8	1.1	14	1.2	1.5	200	40	600	10
19-50 years	0.8	1.1	13	1.2	1.5	200	40	600	10
50+ years	0.8	1.1	12	1.2	1.5	200	40	600	10
Pregnancy	+ 0.1**	+ 0.3	*	*	*	+ 100	+ 10**	+ 100	10
Lactation:									
0-4 months	+ 0.2	+ 0.5	+ 2	*	+ 0.5	+ 60	+ 30	+ 350	10
4+ months	+ 0.2	+ 0.5	+ 2	*	+ 0.5	+ 60	+ 30	+ 350	10

+ Based on protein providing 14.7% of EAR for energy   *No increase   **For last trimester only   *** Safe intake. For more information on vitamin D recommendations, visit our webpage https://www.nutrition.org.uk/healthyliving/basics/vitamind.html

Sources: Department of Health, Dietary Reference Values for Food Energy and Nutrients for the United Kingdom, HMSO, 1991. SACN Vitamin D and Health, 2016.

Nutrition Requirements

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Reference Nutrient Intakes for Minerals

Age	Calcium	Phosphorus[1]	Magnesium	Sodium	Potassium	Chloride[4]	Iron	Zinc	Copper	Selenium	Iodine
	mg/d	mg/d	mg/d	mg/d[2]	mg/d[3]	mg/d	mg/d	mg/d	mg/d	µg/d	µg/d
0-3 months	525	400	55	210	800	320	1.7	4.0	0.2	10	50
4-6 months	525	400	60	280	850	400	4.3	4.0	0.3	13	60
7-9 months	525	400	75	320	700	500	7.8	5.0	0.3	10	60
10-12 months	525	400	80	350	700	500	7.8	5.0	0.3	10	60
1-3 years	350	270	85	500	800	800	6.9	5.0	0.4	15	70
4-6 years	450	350	120	700	1100	1100	6.1	6.5	0.6	20	100
7-10 years	550	450	200	1200	2000	1800	8.7	7.0	0.7	30	110
Males											
11-14 years	1000	775	280	1600	3100	2500	11.3	9.0	0.8	45	130
15-18 years	1000	775	300	1600	3500	2500	11.3	9.5	1.0	70	140
19-50 years	700	550	300	1600	3500	2500	8.7	9.5	1.2	75	140
50+ years	700	550	300	1600	3500	2500	8.7	9.5	1.2	75	140
Females											
11-14 years	800	625	280	1600	3100	2500	14.8[5]	9.0	0.8	45	130
15-18 years	800	625	300	1600	3500	2500	14.8[5]	7.0	1.0	60	140
19-50 years	700	550	270	1600	3500	2500	14.8[5]	7.0	1.2	60	140
50+ years	700	550	270	1600	3500	2500	8.7	7.0	1.2	60	140
Pregnancy	*	*	*	*	*	*	*	*	*	*	*
Lactation:											
0-4 months	+ 550	+ 440	+ 50	*	*	*	*	+ 6.0	+ 0.3	+ 15	*
4+ months	+ 550	+ 440	+ 50	*	*	*	*	+ 2.5	+ 0.3	+ 15	*

mg/d – milligram per day. A milligram is one thousandth of a gram

µg/d – microgram per day. A microgram is a millionth of a gram

[1]Phosphorous RNI is set equal to calcium in molar terms; [2]1mmol sodium = 23 mg; [3]1 mmol potassium= 39 mg; [4]Corresponds to sodium 1 mmol= 35.5 mg; [5]Insufficient for women with high menstrual losses where the most practical way of meeting iron requirements is to take iron supplements

Sources: Department of Health, Dietary Reference Values for Food Energy and Nutrients for the United Kingdom, HMSO, 1991. SACN Vitamin D and Health, 2016.