Evaluating and improving understanding and use of current UK nutrition labels among older adults

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Intellectual Property and Publication Statements

The candidate confirms that the work submitted is her own, except where work which has formed part of jointly authored publications has been included. The contribution of the candidate and the authors to this work has been explicitly indicated below. The candidate confirms that the appropriate credit has been given within the thesis where reference has been made to the work of others. One jointly authored paper has been produced from work conducted in this thesis. This was jointly authored with the original PhD supervisors on the project: Professor Judy Donnelly, Dr Steve Jones and Professor Janet Cade. The paper is as follows:

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Work from Chapter 6 of this PhD thesis was used for this paper. The aforementioned supervisors provided guidance on study design, search strategies, study selection, quality appraisal as well as data analysis and manuscript revisions. The researcher conducted the systematic review search and wrote and revised the manuscript.

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Abstract

Background: New formats of UK nutrition labels were mandatorily introduced on-pack and for products sold online, from 2014. However, there is a lack of evidence concerning older adults' understanding and use of this information and the extent to which these may be improved with nutrition label education. With respect to older adults, this research aimed to (1) explore use of this information and potentially related consumer characteristics and (2) evaluate objective understanding of the current UK nutrition labels, before developing and evaluating a pilot education intervention targeting label understanding.

Methods: An online survey was developed to evaluate understanding of current UK nutrition labels and their use among older adults aged 50 years or older. Exploration of these adults' engagement with online nutrition information was also undertaken using "Think aloud sessions". Following a systematic review of the effect of nutrition label education on consumers' use and understanding of this information, a single-arm pre post-intervention study design was used to evaluate a pilot educational intervention among community service-users.

Results: Frequent use of nutrition labels during purchases was reported by 51% of all survey respondents (n=181) and predicted by increasing levels of personal motivation (OR 1.1, 95% CI 1.1, 1.2), nutrition knowledge (OR 1.3, 95% CI: 1.1, 1.5) as well as self-rated (OR 1.2 95% CI: 1.0, 1.5), but not objective (OR 1.1, 95% CI: 0.9, 1.3), understanding of this information. Respondents had difficulties understanding the meaning of specific elements of the current UK nutrition labels, including "Reference Intakes (RI)" terminology. Infrequent use of online nutrition information could be explained by a variety of factors related to supermarket website use and information presentation. Finally, the developed educational intervention increased levels of participants' (n = 30) objective understanding of current UK nutrition labels (quiz score out of 5 MD=1.4, 95% CI: -2.1, -0.8), as well as participants' confidence in their use of this information to make healthier food choices (using a 7-point scale, MD = 1.0, 95% CI: 0.5 to 1.6).

Conclusion: Older adults' understanding of current UK nutrition labels may be improved with nutrition label education. Implications for policy and practice are given. Further research into the impact of education on older adults' nutrition label understanding, use and dietary intakes is now warranted.

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Abbreviations

BMI	Body Mass Index
BOP	Back-of-pack nutrition label
DH	Department of Health (UK)
DHSC	Department of Health and Social Care (UK)
DV	Daily Values
EU	European Union
EC	European Commission
FOP	Front-of-pack nutrition label
FDA	Food and Drug Administration (US)
GDA	Guideline Daily Amounts
MCQ	Multiple-choice questions
NFP	Nutrition Facts Panels (US)
NHS	National Health Service
PHE	Public Health England
RI	Reference Intakes
SACN	Scientific Advisory Committee on Nutrition (UK)
SCT	Social Cognitive Theory
VLE	Virtual Learning Environment
WHO	World Health Organisation
UK	United Kingdom
US	United States of America

Chapter 1 Introduction

1.1 Overview of the research

Nutrition labels display information on the nutritional composition of food and drink products. For nutrition labels to positively impact health, consumers must use this information during food purchase decisions. A key antecedent to use of nutrition labels is consumers' understanding of this information which is known to vary with label format and decline with age. However, there is a lack of evidence concerning older adult use of UK nutrition labels including those which, since 2014, have appeared mandatorily on food products and within UK online supermarkets. Given older adults' specific nutrition requirements and potential health concerns, it is concerning that there is little available insight into these consumers' understanding of nutrition labels or the role of education in supporting their understanding and use of this information during purchase choices.

This thesis describes research which evaluated older adult consumers' understanding and use of current UK back and front-of-pack nutrition labels and potentially related personal characteristics. This included these adults' understanding of the meaning of current nutrition label terminology "Reference Intakes (RI)" (formerly Guideline Daily Amounts) and corresponding values, which is required under the current labelling legislation. This insight, together with a review of the available evidence on the effects of nutrition label education, was used to develop and pilot an educational intervention to help improve understanding and intended use of these nutrition labels in community-based older adults. In addition, older adults' engagement with mandatory online product nutrition information displayed within supermarket websites was also explored. Overall, this PhD aimed to contribute new insight on older adults' understanding and use of the current UK nutrition information to the existing knowledge base. This work also provides perspectives on the need for and potential of nutrition label education to help improve the impact of this information on older adults' food choices and dietary health.

1.2 Public health and nutrition

1.2.1 Current dietary intakes and health

Poor quality diets are affecting the health of people in the UK (Food Standards Agency, 2018; Public Health England, 2019). Population dietary intakes of energy and nutrients of public health concern such as saturated fats, free sugars and sodium are known to exceed recommended guidance (Food Standards Agency, 2018). Excess energy intakes and poor diets are associated with obesity and diet-related ill health, including non-communicable diseases such as cardiovascular disease (CVD) and cancer (GBD 2015 Risk Factors Collaborators, 2016; World Health Organization, 2003). Defined as a body mass index (BMI) over 30kg/m^2, obesity has been estimated to account for 4.4 million deaths worldwide in 2013 (GBD 2015 Risk Factors Collaborators, 2016). In addition, diet-related diseases such as CVD account for around one quarter of deaths in England and Wales and are a leading contributor to the global burden of disease (British Heart Foundation, 2018).

As shown by the Health Survey for England, the prevalence of obesity has reached the highest levels ever recorded (NHS Digital, 2017). In England, 64% of adults are overweight or obese with variations in the prevalence of obesity by age, sex and according area of residence (NHS Digital, 2017). By age, the highest levels of obesity occur in men aged 55-64yrs and women aged 65-74 yrs (Figure 1). By region, the proportion of adults who are obese or overweight is highest in Yorkshire and the Humber (70%) and lowest in London (59%) (NHS Digital, 2018). Since 2010, obesity and diet-related ill health are estimated to have cost the NHS over £10 billion (Scarborough et al., 2011). Preventable diet-related conditions are also key contributors to the widening inequalities in life expectancies between those most affluent and most deprived (Bennett et al., 2018). Improvements in UK population level energy and nutrient intakes which are in-line with dietary guidelines are therefore anticipated to result in a reduction of approximately 33,000 deaths per year (Scarborough et al., 2012).

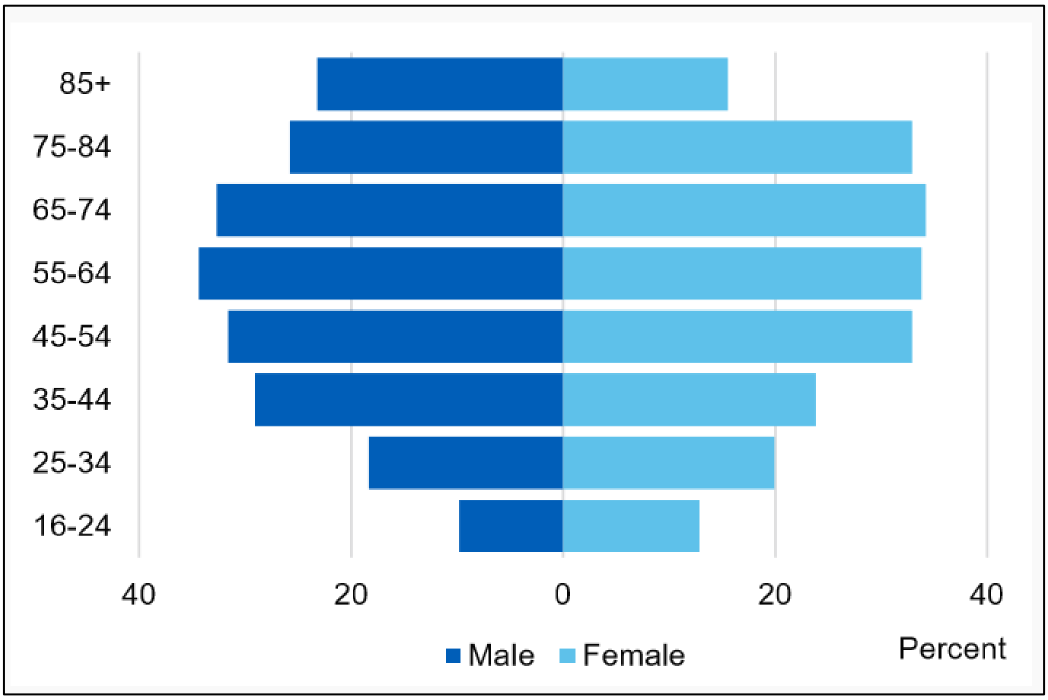


Figure 1 Obesity prevalence by age group and sex. From Statistics on Obesity, Physical Activity and Diet, England, 2018 (NHS Digital, 2018).

1.2.1 UK Public health nutrition recommendations

Public health recommendations about what constitutes a healthy diet are provided by the World Health Organisation (WHO) in their Global Strategy on Diet, Physical Activity and Health (World Health Organization, 2003). This strategy set a mandate for adopting a global mechanism for risk factor reductions and raising awareness of preventive interventions. The Strategy's dietary recommendations to promote healthier eating for populations and individuals are to:

1. Achieve energy balance and a healthy weight
2. Limit energy intake from total fats and shift fat consumption away from saturated fats to unsaturated fats (and towards the elimination of trans fatty acids)
3. Increase consumption of fruits and vegetables and legumes, whole grains and nuts
4. Limit the intake of free sugars
5. Limit salt (sodium) consumption from all sources

Accordingly, Public Health England recently summarised the UK Government's dietary recommendations for the population, which are based on assessment of the evidence base by the Scientific Committee on Nutrition (SACN) (Public Health England, 2016a). These recommendations vary by age and sex and are summarised in Table 1.

Table 1 Summary of current UK population dietary recommendations for adults aged 19yrs+ (Public Health England, 2016a).

Energy (kcal/day)*	2000kcal/day for females; 2500kcal/day for males
Protein (g/day)	45g/day for females aged 19-64 (46.5g/day for older females aged 65+); 55.5g/day for males aged 19-64 (53.5g for older males aged 65+)
Fat(g/day)*	Less than 78g/day for females; less than 97g per day for males. No more than 35% total food energy
Saturated fat*	24g/day for females; 31g/day for males. No more than 11% total food energy
Polyunsaturated fat*	14g/day for females; 18g /day for males. No more than 6.5% total food energy
Monounsaturated fat*	29g/day for females; 36g/day for males. No more than 13% total food energy
Carbohydrate (g/day)*	At least 276g/day for females; 333g per day for males At least 50% total food energy
Free sugars*	27g/day for females; 33g/day for males No more than 5% total food energy
Salt (g/day)	Less than 6g/day for females and males
Dietary fibre (g/day)	30g/day

**decreasing requirement for both older females and older males (aged 65yrs+)*

In the UK, there is an urgent need to reduce population intakes of calories and specific nutrients which are of public health concern i.e. saturated fat, salt and free sugars (Department of Health and Social Care, 2018a; Public Health England, 2018a). Policy interventions to improve dietary intakes include encouraging individuals to adopt lifestyle and behaviour changes (NHS Change4life, 2018a). Other initiatives include product reformulation by the food industry to reduce the content of energy or specific nutrients (i.e. saturated fat, free sugars) (Public Health England, 2018a, 2015a). Information about the nutrient content of food and drink products is widely provided on food labels. The provision of such nutrition label information is intended to allow meaningful comparisons between and across foods, to encourage the consumption of food with potential to improve dietary quality and to reduce the risk of chronic disease (Taylor and Wilkening, 2008).

1.2.2 The role for nutrition labels in improving public health

1.2.2.1 Overview of nutrition information on food labels

In their Global Strategy on Diet, Physical Activity and Health the WHO consider that one of the responsibilities of Governments is to provide nutrition labelling that is "*accurate, standardised and comprehensible in order that consumers can make healthy choices*" (World Health Organization, 2003, p. 7). Their report also signals the use of the Codex Alimentarius Commission (Codex) Guidelines to inform key aspects of nutrition labels. Codex provides codes of practice around food law as a principle organ of the World Health Organisation (WHO) and the Food and Agricultural Organisation (FAO) (Food and Agricultural Organization of the United Nations and World Health Organization, 1999). Codex defines food labelling as "*any written, printed or graphic matter that is present on the label, accompanies the food, or is displayed near the food, including that for the purpose of promoting its sale or disposa*l" (Codex Alimentarius Commission., 2011, p. 2). Food labelling therefore encompasses a variety of information components including ingredient listing, expiry date and storage instructions as well as nutrition information (Rayner et al., 2013). Codex states that "to ensure that nutrition labelling is effective", the purpose of providing aspects of food labelling that relate to nutrition are as follows;

"in providing the consumer with information about a food so that a wise choice of food can be made; in providing a means for conveying information of the nutrient content of a food on the label; in encouraging the use of sound nutrition principles in the formulation of foods which would benefit public health; in providing the opportunity to include supplementary nutrition information on the label" (Codex Alimentarius Commission., 2011, p. 2)

As such, nutrition labels are considered a key tool to help promote dietary guidance, industry product reformulation and to enable "wise" choices to be made by consumers.

1.2.2.2 The anticipated effect of nutrition labels on public health

The provision of nutrition information is intended to help improve dietary intakes via the expectation that consumers will use this information to choose healthier products and make “wise” choices. For example, the potential impact of mandatory labelling of products as either “high” or “low” in salt in Finland has been theoretically modelled as effective in reducing population salt consumption by “giving consumers the possibility to choose products with less salt” (Pietinen et al., 2008). The consistency and standardisation of the display of this information is therefore considered important in helping consumers to best utilise the information provided. Originally, Codex guidance recommended voluntary nutrition labelling, although the provision of this information was mandatory when a claim was declared on the product (Food and Agricultural Organization of the United Nations and World Health Organization, 1999). The Codex guidance was revised in 2012 to recommend mandatory labelling, with more than 50 countries adopting this ambition via their own legislation (Codex Alimentarius Commission., 2011; European Food Information Council, 2018). Indeed, policy makers consider that EU Regulations on harmonised food labelling contribute an “integrated preventive approach” to the “multi-causal character of the obesity epidemic” by mandating provision of nutrition information for “human health protection” in line with the Lisbon Treaty (Bolognin, 2015).

The existence and the availability of nutrition information is therefore widely included in public health strategies aimed at reducing the prevalence of obesity and improving population-level nutrient intakes in line with dietary recommendations (Bolognin, 2015; Bonsmann and Wills, 2012; European Commission, 2007; World Health Organization, 2003). The current labelling legislation in the UK states that “*knowledge of the basic principles of nutrition and appropriate nutrition information on foods would contribute significantly towards enabling the consumer to make such an informed choice*” (EC, 2011, para. 10) The associated legislation which informs nutrition labelling within the EU and UK is described in the next section.

The imposition of mandatory nutrition label information on food products is expected to increase use of this information by consumers and to modify their nutrient intakes (Variyam, 2008). Mandating nutrition labelling has also been projected to result in decreases in both obesity and disability adjusted life years

(DALYS) across Europe (Bonsmann and Wills, 2012, Sassi et al, 2011). For example, Sassi et al (2009) has modelled a 2% reduction in obesity in Europe when mandating the disclosure of nutritional characteristics of food. Based on the available evidence, these authors' theoretical models take into account anticipated changes in consumers' food consumption and industry reformulation, compared to a baseline scenario of no labelling (Sassi et al., 2009). In their model, food labelling is defined as "mandatory food labelling for food sold in stores" and assumed to deliver information about nutrient content and serving sizes. The projected effects of this intervention on decreasing obesity are moderate relative to other interventions, including restrictions to food advertising, yet comparable to those including individualised physician-dietitian counselling and fiscal measures (i.e. taxation) (Figure 2). The effects of this modelled intervention were found to fade with advancing age, whereby those aged 25 years old were predicted to experience greater levels of obesity reduction compared to those aged 65 or older.

Improvements in dietary intakes and health which are expected to emanate from the mandatory imposition of nutrition labels may be due to both consumer use of this information as well as product reformulation. It can be seen that regulation grounded on maximum limits and mandated labelling has been shown to reduce the content of trans fatty acids in foods (Hendry et al., 2015). In the UK, implementation of voluntary salt targets for foods based on their "per 100g" contents has also been considered to contribute to a reduction in population sodium intakes (Cappuccio et al., 2011; He et al., 2014). Several ongoing UK reformulation initiatives are also underway and are aimed at modifying product recipes and ingredients to reduce the content of energy or nutrients of concern (i.e. sugar, saturated fat) (Public Health England, 2015a, 2018a).

The expectation that UK consumers will use nutrition labels to help them achieve a healthy diet is currently reflected in the inclusion of this information within the recently revised "Eatwell Guide" (Public Health England, 2016b). This pictorial guidance visualises dietary recommendations for individuals as a food-based guide which shows the proportion of food "groups" which should comprise a healthy diet. Since the food groups represented in this guide are mostly single ingredient foods, a version of the current UK front-of-pack (traffic light) nutrition label is now displayed on the guide. This appears alongside suggestions to use this information to select healthier packaged foods “lower in fat, saturates, sugar and salt” (Public Health England, 2016c) (see Figure 3). This recent addition to the Eatwell Guide reflects the public health expectation that nutrition labelling plays a role in shaping consumers healthy diets, as well as the need for the provision of this information within the current food environment and rapidly changing food supply (Kasapila and Shaarani, 2016; Roodenburg et al., 2011). The impact of nutrition labels on population health therefore rests, in part, on their ability to provide information that consumers are thought to need to maintain or improve health (Koen et al., 2016; Taylor and Wilkening, 2008).

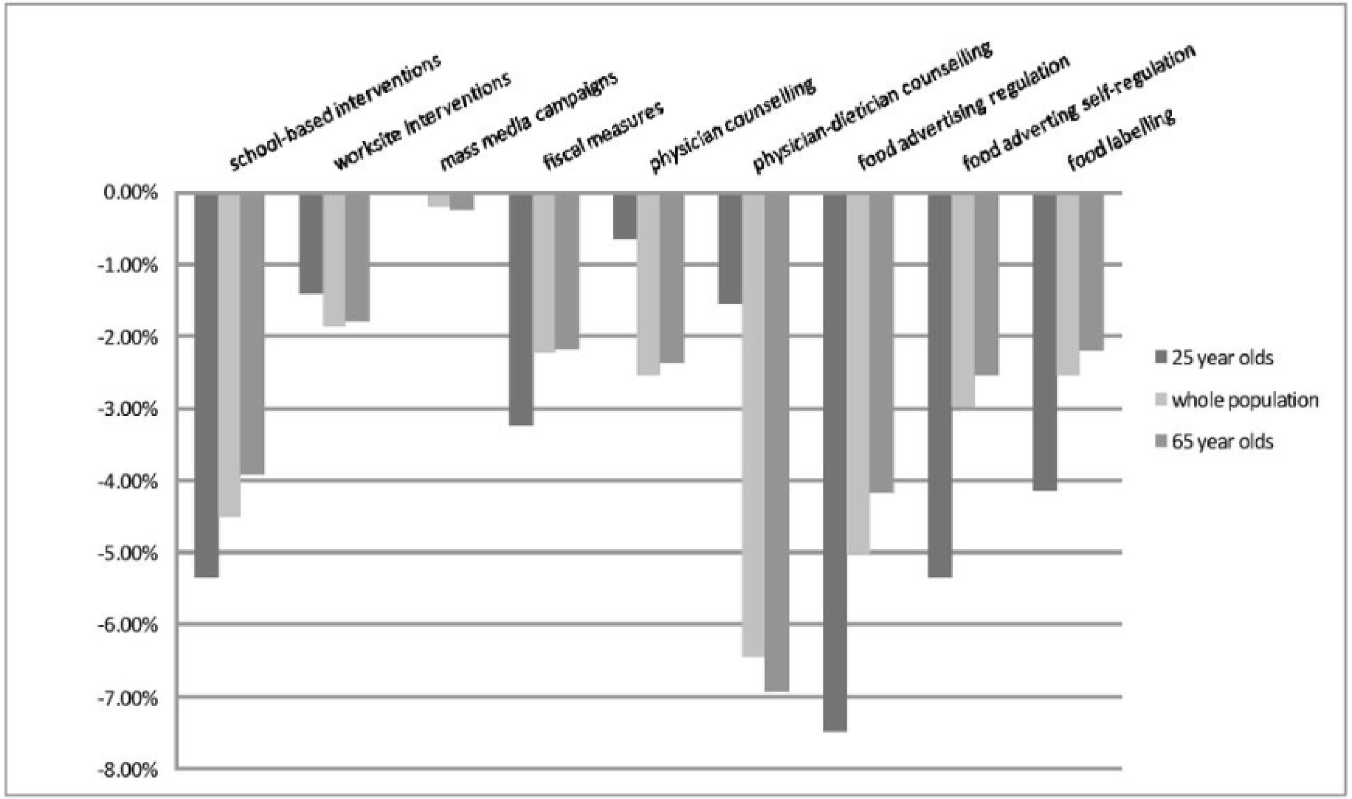


Figure 2 Modelled decrease in population obesity rates of nine intervention types, by consumer age (from Sassi et al 2009).

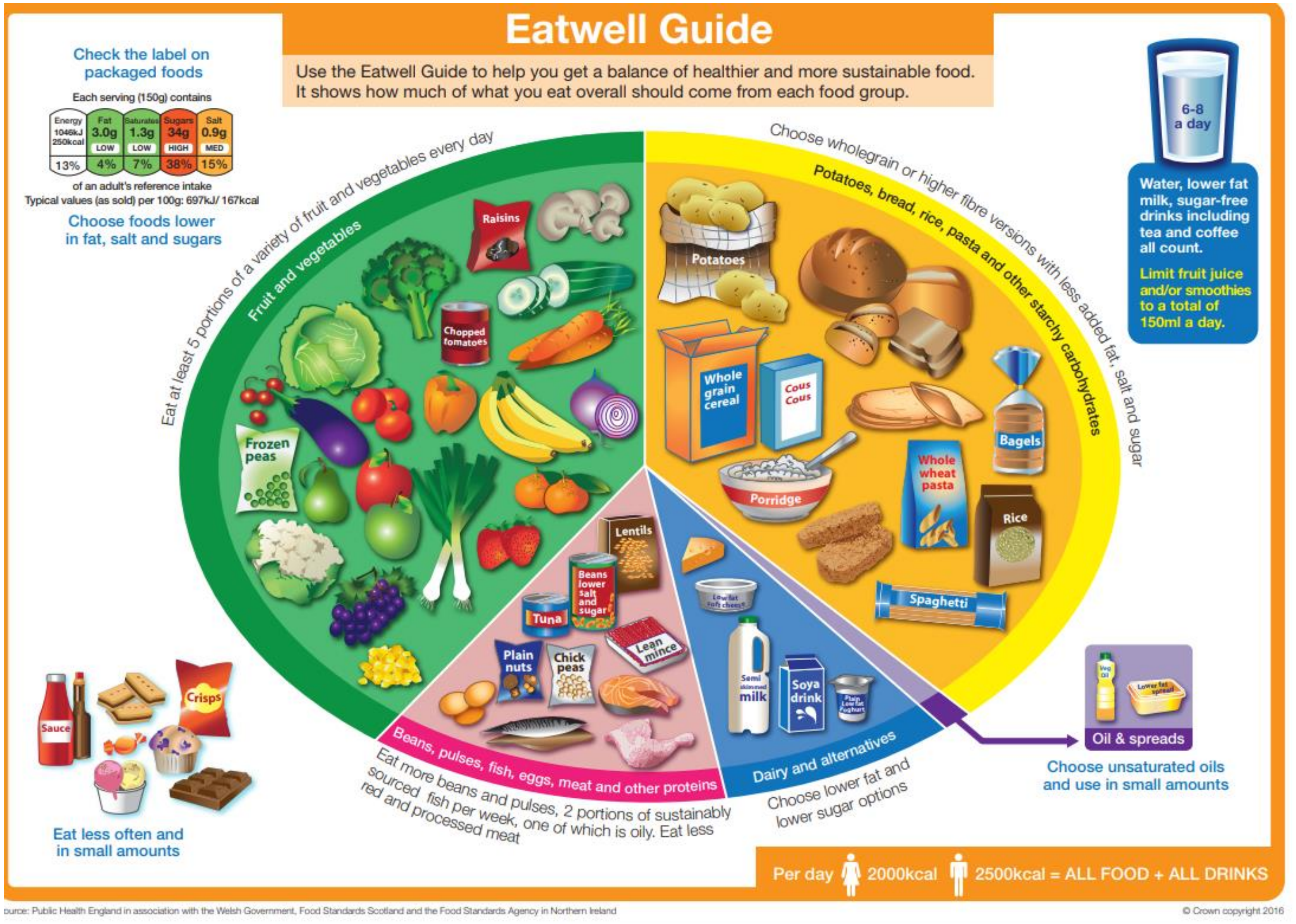


Figure 3 The UK Eatwell Guide (displaying a front-of-pack nutrition label, top left) (Public Health England, 2016c)

1.3 History and current status of UK nutrition labels

1.3.1 Overarching guidance on nutrition labelling

Food and nutrition labelling on products is also a trade and commerce policy issue. The presentation of this information therefore requires consistency with international standards (Thow et al., 2018). International Codex standards of practice on food labels informs legislative, government and voluntary policies on nutrition labelling (Codex Alimentarius Commission., 2011). Within this the following definitions are used;

- *Nutrition labelling*: a description “intended to inform the consumer of nutritional properties of a food”.
- *Nutrient declaration*: nutrition labelling which is “a standardised statement or listing of the nutrient content of a food”.
- *Supplementary nutrition information*: nutrition labelling “intended to increase the consumer's understanding of the nutritional value of their food and to assist in interpreting the nutrient declaration”.

(Source Codex Alimentarius Commission, 2011, p.2)

In the UK, nutrition labelling became compulsory on pre-packed food products from 2016, or from 2014 for products which were already declaring nutrition information. The required elements and formats of mandatory and supplementary nutrient declarations are detailed within the EU Regulation 1169/2011 on the provision of Food Information to Consumers (referred to as EU Regulation 1169/2011, hereinafter) (EC, 2011). This Regulation covers most pre-packed food and drink products with exceptions including alcohol, baby foods, nutritional supplements and non-pre-packed products. Prior to the implementation of this EU Regulation in the UK, nutrition information on food products occurred in-line with the Food Labelling Regulations (1996). Such labelling was not compulsory, unless the product declared a nutrition or health claim (Food Labelling Regulations UK, 1996).

1.3.2 Definitions: back-of-pack and front-of-pack nutrition labels

In the UK, mandatory nutrition label information should be presented in tabular form on the back, or side, of the product package (Figure 4) but may appear in any location. Such nutrition labels are also permitted to appear in linear form (i.e. non-tabular) if there is insufficient space on the label (Department of Health, 2016a). In contrast "front-of-pack" nutrition labels should repeat information displayed within the back-of-pack information and appear within the "principle field of vision". This is defined as "most likely to be seen at first glance by the consumer at the time of purchase" (Department of Health, 2016b).

1.3.3 UK back-of-pack nutrition labels

Under EU Regulation 1169/2011, the minimum mandatory requirement for back-of-pack nutrition labelling is the declaration (per 100g/ml) of energy (kJ and kcal); fat (g), of which saturates (g); carbohydrate (g), of which sugars (g); protein (g); and salt (g) (EC, 2011). A back-of-pack nutrition label showing these mandatory elements (as well as fibre, which is optional but often declared) is shown in Figure 4. The order of these nutrients differs from previous labelling requirements under the UK Food Labelling Regulations (1996) in which the declared nutrition information was expected to appear in the following format: energy, protein, carbohydrate, of which sugars, fat, of which saturates, fibre, sodium and salt equivalent (Buttriss, 2013). Another notable change under the current regulation is the mandatory declaration of "salt" (which replaces sodium). The current EU Regulation 1169/2011 also requires that any nutrients and other substances for which nutrition or health claims are made (e.g. "source of calcium") are mandatorily required to be declared in the appropriate place within the back-of-pack nutrition label (Department of Health, 2016a).

EU Regulation 1169/2011 also stipulates which specific supplementary elements of nutrition information, including amounts "per serving", can be provided voluntarily by manufacturers to appear besides the minimum mandatory information on energy and nutrients "per 100g" (Department of Health, 2016a; EC, 2011). Such supplementary information includes serving size (the consumption unit), number of servings in a pack, and nutrient content information "per serving". Supplementary information must be declared in a format compliant with the EU regulations, as shown in Figure 4. For information on "per serving" nutrition content is given for the product prepared "as sold", unless otherwise stated relating to product as consumed (i.e. prepared according to instructions). The serving size itself (i.e. a 250g serving) is determined by the manufacturer, based on expected amounts consumed, since there are no UK legal standardised serving sizes for food labelling (Kirwan et al., 2016).

In addition, supplementary information on recommended daily allowances of calories and macronutrients for the “average healthy adult” can also be declared to reflect national dietary guidance. Prior to the implementation of the EU Regulation 1169/2011 from 2014, these values were referred to as “Guideline Daily Amounts” (GDA) and were developed in collaboration with the food industry (Food and Drink Federation, 2016). Under EU Regulation 1169/2011 these are now termed “Reference Intakes” and must appear together with the abbreviation “RI” or percentage of RI (%RI) (see Figure 4). Broadly speaking, the RI values are the same as the GDA since both are based on a healthy adult (female) requiring 2000kcals per day (Buttriss, 2013) (Table 2). The notable exception to previous GDA values is the absence of the RI value for fibre, whereas the GDA for this nutrient was previously 24g/day. The wording “Reference Intake of an average adult” should appear nearby the nutrition label if RI values are included (see Figure 4).

A further change to the UK nutrition label declaration under EU Regulation 1169/2011 is the term for “recommended daily allowance” (RDA) values for vitamins and minerals (EC, 2011). These have become “Nutrient Reference Values” (NRV) although the values used remained unchanged (Buttriss, 2018; Department of Health, 2016a). Following a transition period, the deadline for compulsory nutrition labelling on almost all pre-packaged food in the UK was 14th December 2016 (Department of Health, 2016a). The exceptions to this are certain single ingredient food products, including unprocessed foods such as herbs and food additive compounds as listed in Annex V of the regulations, which are exempt from declaring nutrition information (EC, 2011). The measures relating to the transition period for existing products which were already declaring nutrition information, required that from December 13th 2014, nutrition labels in the UK needed to comply with EU Regulation 1169/2011, as described above (Buttriss, 2013; EC, 2011).

Table 2 **Guideline Daily Amounts (GDA) and Reference Intakes (RI) for an average healthy adult (adapted from Buttriss, 2013).**

	GDA	New RI for average adult
Energy	2000 kcal	8400 kJ / 2000 kcal
Fat (g)	70	70
Of which saturates (g)	20	20
Carbohydrates (g)	230	260
Of which sugars (g)	90	90
Protein (g)	45	50
Salt (g)	6	6
Fibre	24	No value

1.3.4 UK front-of-pack nutrition labels

The EU Regulation 1169/2011 also stipulates the content of the nutrition information which can appear, voluntarily, on the front-of-pack. For example, the Regulation allows front-of-pack expressions for either (1) energy alone or (2) energy plus fat, saturates, total sugars and salt (see Figure 4). Although these are not mandatory, national Governments within the EU, including the UK, can advise on locally used front-of-pack nutrition labelling schemes. Prior to the implementation of the EU Regulation 1169/2011, various front-of-pack schemes were operating across the UK food industry, including individual retailers' own schemes (Malam et al., 2009). The UK Government's own recommendation on a single front-of-pack format was issued around this time, based on earlier research work by the Food Standards Agency to investigate consumer comprehensibility of these schemes (Malam et al., 2009). This research recommended the "hybrid" front-of-pack format which consisted of both red/amber/green colour coding as well as the %GDA for specific nutrients (i.e. fat, saturates, sugars and salt) and energy provided by a serving of the product. Following this, the recommended format of the UK front-of-pack nutrition label was then revised again in line with the requirements of the EU Regulation 1169/2011 for voluntarily provided nutrition information. The UK Government first issued guidance on this in 2013 (Department of Health, 2013) which recommended use of a consistent colour-coded front-of-pack multiple traffic light voluntary scheme which used "Reference Intake (RI)" terminology compliant with EU Regulation 1169/2011 (Department of

Health, 2013; Skotarenko, 2018). The use of monochrome front-of-pack panels or single element energy-only information continued to be permitted legally (Department of Health, 2016b, 2013). This guidance has since been updated again to provide consumer communication about the use of the front-of-pack panel (Department of Health, 2016b). In line with the EU Regulation 1169/2011, both the 2013 and 2016 Department of Health guidance documents stipulate that the UK front-of-pack nutrition label should contain the following basic elements, shown in Figure 4.

- Information on the energy values in kilojoules (kJ) and kilocalories(kcal) per 100g and in a specified portion of the product
- Information on the amount of grams of fat, saturates (total) sugars and salt in grams, in a specified portion of the product
- Portion size information expressed in a way that is easily recognisable by, and meaningful to the consumer
- %RI information based on the amount of each nutrient and energy value in a portion of the food
- Colour coding of the nutrient content of the food

(Department of Health, 2016b, p. 6)

The traffic-light colour coding of each nutrient is based on a criteria set by the UK Food Standards Agencies and Department of Health which was revised prior to the 2013 guidance on front-of-pack labelling (Department of Health, 2016b, 2013). The green/amber/red colour coding criteria is based on nutrient contents per 100g of the food, with an additional specific criteria for the colour red for those products with serving sizes larger than 100g/150ml, based on proportion of "Reference Intakes" provided by a serving.

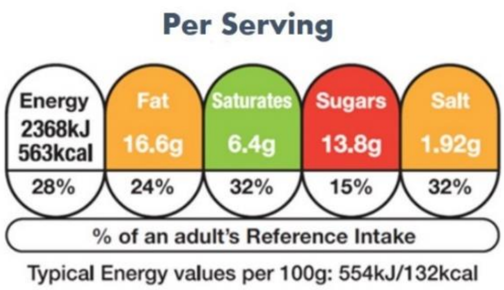
Similar to the deadlines for mandatory back-of-pack nutrition labels, products already displaying nutrition information were required to display formats compliant with EU Regulation 1169/2011 by December 2014 (Buttriss, 2013). This included the requirement to use the new terminology "Reference Intakes" on front-of-pack nutrition labels (EC, 2011). In the context of the research undertaken in this thesis, it is therefore important to note that the current UK front-of-pack nutrition labels have been present on UK products from 2013 onwards.

1.3.5 The US Nutrition Facts Panel

In the US, the 1990 Nutrition Labelling and Education Act (NLEA) required the mandatory display of Nutrition Facts Panels on food products (US Food and Drug Administration, 1995). Similar to the recent changes in the UK, before the implementation of the Act in 1994 such labelling was only required on US products which made nutrition claims (Drichoutis et al., 2005; Kasapila and Shaarani, 2016; Lalor, 2014). Given that the longevity of US Nutrition Facts Panel, much consumer research has been conducted on this specific label format. The US Nutrition Facts Panel declares information on nutrient values “per serving” (rather than “per 100g”) (Lalor, 2014) (see Figure 4). In contrast to UK labels, serving sizes declared on these labels are standardised and based on reference values which aim to reflect average consumption amounts (Food and Drug Administration, 2016; Kliemann et al., 2018). The Nutrition Facts Panel must also include “percent daily values” (%DVs) where the “daily values” are daily nutrient recommendations analogous to the EU “Reference Intakes”. The format and content of the US Nutrition Facts Panel has recently been modified under amendments to the NLEA to improve consumer comprehensibility and use of this information (Food and Drug Administration, 2016).

Nutrition				
Typical values (as consumed)	per 100g	per cooked sausage roll	%RI	your RI*
Energy	1384kJ/332kcal	485kJ/116kcal	**6%**	8400kJ/2000kcal
Fat	18.9g	6.6g	**9%**	70g
of which saturates	8g	2.8g	**14%**	20g
Carbohydrates	28.1g	9.8g		
of which sugars	1.4g	0.5g	**1%**	90g
Fibre	2.1g	0.7g		
Protein	11.2g	3.9g		
Salt	1g	0.3g	**5%**	6g

*Reference intake of an average adult (8400kJ/2000kcal) (RI).



Nutrition Facts	
8 servings per container	
Serving size	**2/3 cup (55g)**
Amount per serving	
Calories	**230**
	% Daily Value*
Total Fat 8g	**10%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**13%**
Dietary Fiber 4g	**14%**
Total Sugars 12g	
Includes 10g Added Sugars	**20%**
Protein 3g	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 235mg	6%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Figure 4 Current UK nutrition labels and US Nutrition Facts Panel.

Top: current UK back-of-pack nutrition label compliant with EU Regulation 1169/2011. Below right: current US Nutrition Facts Panel. Below left: a current UK front-of-pack nutrition label compliant with EU Regulation 1169/2011 and UK Department of Health guidance (2016b).

1.3.6 Online nutrition information

EU Regulation 1169/2011 also specifies that food sold online (i.e. within distance selling) must provide product information, including nutrition information (EC, 2011). Indeed, consumers who shop on the internet have the same need for product information with which to make informed choices as those purchasing in-store (Kasapila and Shaarani, 2011). Consequently, by 13th December 2014, nearly all food sold online was required to “make available” nutrition information “before the purchase is concluded” (Department of Health, 2016a). In practice, within the major UK supermarket websites, product nutrition information is usually displayed as a tabulated version of the physical back-of-pack nutrition label located within the product’s information webpage (see Figure 5). In addition, any voluntarily provided nutrition information, including the front-of-pack (i.e. traffic light) signposts may also be provided. Supermarket websites usually display this information besides, or as part of, the product’s photograph (see Figure 5).

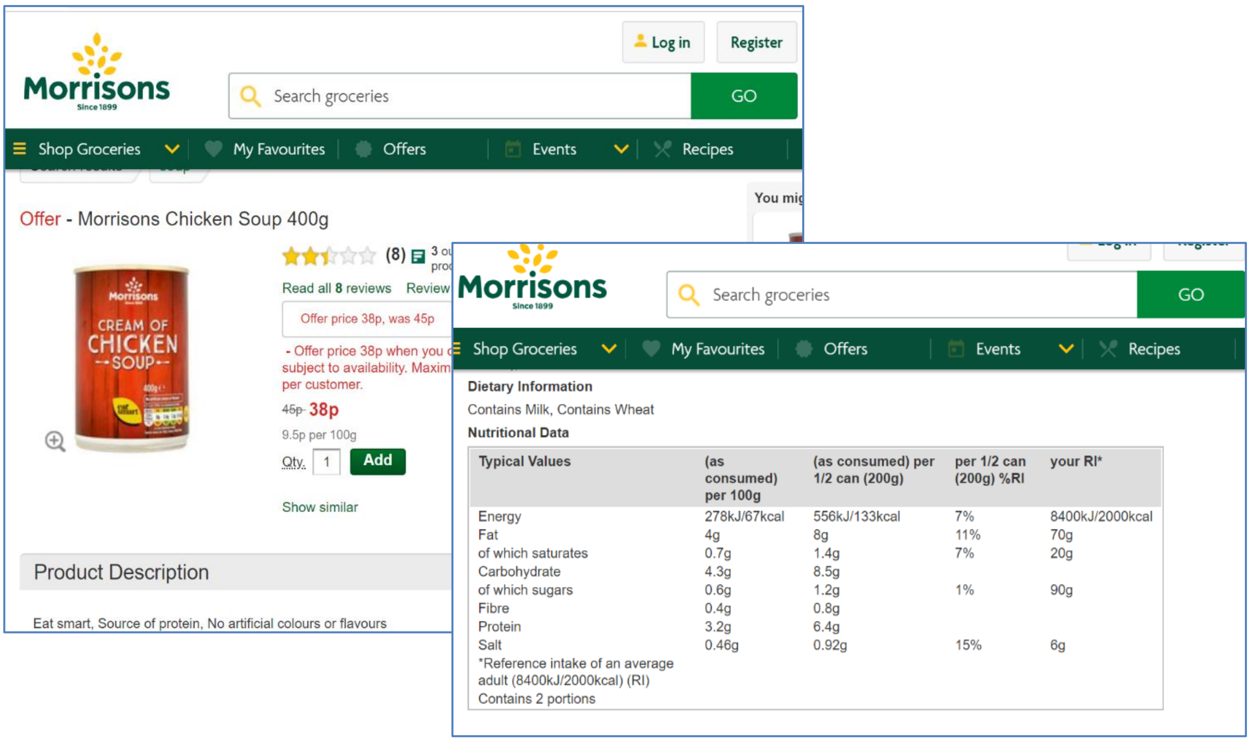


Figure 5 Online product nutrition information as displayed within a UK supermarket website.

Left (back): Product information webpage within a UK supermarket website. Right (front): Product nutrition information displayed at the bottom of the product information webpage (i.e. scrolled down).

1.3.7 Prevalence of nutrition labelling

In an audit of the prevalence of nutrition labels on products sold in 28 European countries conducted in 2008/09, back-of-pack nutrition information was found to be consistently more widespread than front-of-pack nutrition labels in all countries. The UK showed the highest penetration of both back and front-of-pack nutrition labelling which covered between 82-92% of products, depending on category, including ready meals (Storcksdieck genannt Bonsmann et al., 2010). Reflecting the voluntary provision of this information, front-of-pack labelling in Europe has been applied inconsistently across products of various food categories (Van Camp et al., 2012). However, these previous audits were conducted prior to the 2014 deadline for much of the mandatory imposition of UK back-of-pack nutrition labels and the aligned UK voluntary front-of-pack labelling scheme. Accordingly, the current prevalence of both label types is likely to be higher across the UK and Europe, given the requirements of the three year (2014 – 2016) transition period for the implementation of the EU Regulation 1169/2011.

Since the implementation of this Regulation, advocacy and public health initiatives have also driven an increase in the voluntary provision of front-of-pack nutrition labels across the UK (Hoggan, 2018; World Cancer Research Fund International, 2019). Various forms of front-of-pack nutrition labelling have been implemented in other countries (World Cancer Research Fund International, 2019). For example, in France the government has recently formally adopted the NUTRI-SCORE front-of-pack nutrition label which has been evaluated as the "most widely understood and well-perceived label" format by consumers (Buttriss, 2018; Julia and Hercberg, 2017). The existing visual differences in front-of-pack label schemes and their impact on consumer use and understanding has also been widely reviewed (Hersey et al., 2013; van der Bend and Lissner, 2019). Efforts to secure a mandatory or harmonised global nutrition label currently persist (Kasapila and Shaarani, 2016; Roodenburg et al., 2011; Thow et al., 2019).

Given that back-of-pack nutrition labels were mandatory from 2014 for products already displaying this information, it is likely that this information is currently more prevalent than front-of-pack nutrition labels in the UK. In addition, back-of-pack information was also found to be the type most likely to be declared online in a study of UK supermarket websites conducted in July 2015 (Stones, 2016).

Overall, mandatory, back-of-pack nutrition labels are considered to be the most common type of nutrition information currently available to consumers in the UK (Buttriss, 2018). There appear to be no specific or imminent changes required to the prevalence or format of either back, or front, of pack nutrition labels following the likely UK exit from the EU (BREXIT). This is evident within the recently proposed legislative modifications to food label information in-line with preparation for a “no deal” exit scenario, which is focussed on ingredients, allergens and country of origin information (Department for Environment, Food and Rural Affairs, 2019).

1.3.8 Practical use of nutrition labels by consumers

According to Magnusson (2010), the use of nutrition label information by consumers can be considered as part of their “personal responsibility” to ensure they consume a healthy diet (Magnusson, 2010). Information relating to the content of energy and nutrients which is displayed on nutrition labels can be used by consumers in a variety of ways to choose and eat foods which are more healthy, relative to other options (Taylor and Wilkening, 2008). The provision of recommended daily amounts of nutrients and energy (i.e. Reference Intakes) on back and front-of-pack nutrition labels can also help facilitate the use of nutrient content information within the context of the consumer’s daily diet (Department of Health, 2016b). For these reasons, practical use of nutrition labels by consumers when choosing foods is often advised by healthcare professionals (Koen et al., 2016). For example, dietitians or nurses may promote the use of nutrition labels with their patients as part of advice about food choices designed to prevent and manage diet-related conditions including diabetes, cardiovascular disease and obesity (Deville-Almond and Halliwell, 2014; World Health Organization, 2003). Specifically, advice to use nutrition labels may occur within recommendations to individuals to reduce their consumption of saturated fats and salt as part of the lifestyle changes which support the primary prevention of cardiovascular disease (National Institute for Health Care Excellence (NICE), 2014).

Practical use of nutrition labels by consumers can be considered to involve either of the two following general tasks: (1) evaluating nutrient levels to determine healthiness of products, including during comparisons and (2) to track nutrients within the context of daily targets. For the first, consumers may compare products’ nutritional composition based on like-for-like amounts (i.e. “per 100g” information) or “high” / “low” thresholds of nutrient content (Guthrie et al., 1995; NHS, 2014). For the second, “per serving” nutrient values, or %RI information, can be used to track daily intakes and to provide consumers with information to attain specific daily energy or nutrient intakes (Department of Health, 2016b; NHS, 2014; Taylor and Wilkening, 2008). In their earlier review of consumers’ use of nutrition labels, Cowburn and Stockley (2005) listed the common tasks consumers undertake with nutrition information on food labels. These were: identifying the amount of a specific nutrient a product contains; assessing what counts as a “low” or “high” amount of the nutrient; deciding the overall healthiness of a product; comparing the specific nutrient content of a product with one or more similar products; calculating the amount of nutrient eaten in a serving; assessing the product in the context of a meal choice or daily intake (Cowburn and Stockley, 2005). Overall, it can be seen that nutrition labelling can be considered to help “general” consumers make informed and healthier food choices in line with “general dietary recommendations” (Taylor and Wilkening, 2008).

1.4 Consumer use of nutrition labels

1.4.1 Aims of the literature review

The initial motivation for this research originated from the legislative changes to UK nutrition labels which have been described above. In addition, this research also sought to provide meaningful research outputs to help address current health and equality challenges in UK society. The overarching motivation for the current thesis was therefore to investigate factors which can help to optimise the effect of nutrition labels on consumers' food product purchase choices and health. As such, the literature concerning consumer use of nutrition labels, including online nutrition information, was first reviewed to inform this project's research aims. The literature concerning consumers' use of nutrition labels is wide and has already been reviewed internationally several times in the last two decades (Campos et al., 2011; Cowburn and Stockley, 2005; Drichoutis et al., 2005; Drichoutis and Nayga, 2006; Graham et al., 2012; Grunert et al., 2010a; Grunert and Wills, 2007; Hersey et al., 2012; Hieke and Taylor, 2012; Vyth et al., 2012; Kerr et al., 2015; Miller and Cassady, 2015) (see Table 3). The present review set out to identify key themes and issues related to consumers' use of UK and other country's nutrition labels. The literature review also aimed to identify a conceptual framework of consumer use of nutrition labels with which to inform the present research from a theoretical perspective. This insight and corresponding literature gaps are summarised here to demonstrate how the specific research questions posed by this PhD project were generated.

In line with this initial stage of the PhD project, research literature published up to 2015 was summarised here. Studies which emerged during the course of this PhD research are then discussed in relation to the findings of Chapters 4, 5, 6 and 7 and within the overall discussion in Chapter 8.

1.4.2 Overview of the literature on consumers' use of nutrition labels

Review evidence from studies undertaken worldwide (i.e. including the US, Europe, UK, Australia, New Zealand, Thailand and Canada) is summarised in Table 3. In general, consumer use of nutrition labels is considered to be moderately high whereby at least 50% of consumers report using this information (Campos et al., 2011). Consumer types who are more likely to report looking at labels are females and those with higher levels of education (Campos et al., 2011; Cowburn and Stockley, 2005; Grunert and Wills, 2007; Hieke and Taylor, 2012). Consumers are more likely to view this information when they purchase a food product for the first time or if they possess health reasons or motivations for doing so (Campos et al., 2011; Cowburn and Stockley, 2005; Grunert and Wills, 2007; Hieke and Taylor, 2012). The attention paid to nutrition labels by consumers also appears to be related to the format and location of this information on product packaging (Bialkova and van Trijp, 2010), including in combination with their health-related motivations (Aschemann-Witzel et al., 2013; Grunert et al., 2012; Turner et al., 2014; Visschers et al., 2010). Consumer types who are least likely to use this information vary, but repeatedly include adolescents, older adults and those with lower income, educational attainment or health literacy (Cowburn and Stockley, 2055; Campos et al., 2011; Cha et al., 2014; Grunert et al., 2010a; Kerr et al., 2015; Malam et al., 2009).

Evidence on consumer use of nutrition labels originates from cross-sectional surveys or experimental (i.e. web-based) studies, in which self-reported measures of label "use" are used (Grunert and Wills, 2007; Campos et al., 2011; Hersey et al., 2012; Vyth et al., 2012). Limitations with and differences between these types of study designs may explain differences in study findings (Hieke and Taylor, 2012; Grunert and Wills, 2007). For example, self-reported data on label use may over estimate actual label use, compared to observed behaviours (Gruner and Wills., 2007). One area where findings differ concerns use of labels by older aged consumers. Older age has been associated with both increased and reduced use (Campos et al., 2011) and increasing interest in (Grunert and Wills, 2007) this information, compared to younger consumers. Evidence also suggests that as age increases so does the likelihood of using this information for specific reasons or perceived health benefits (Campos et al., 2011; Drichoutis and Nayga, 2006; Grunert and Wills, 2007; Ollberding et al., 2010; Su et al., 2015). Whilst these findings are mostly based on self-reported data on these adults' label use, the variety of specific measures used to evaluate consumer's use of labels (i.e. when shopping for specific products types, or when first time a product is purchased) may also help explain some of the differences in results. Furthermore, review evidence notes that individual research studies concern different types of (countries) nutrition labels (and logos) according to regional labelling regulations which may contribute to variations in the overall picture on how well consumers use and understand labels (Hersey et al., 2012; Vyth et al., 2012, Campost et al., 2011, Grunert and Wills, 2007., Cowburn and Stockley, 2005) (Table 3).

Table 3 Relevant reviews on consumer use of nutrition labels

Reference	Stated aim of the review	Review type	Number of studies	Publication dates	Definition of nutrition labelling (BOP: Back-of-pack, FOP: Front-of-pack)	Geographic origins of included studies
Cowburn and Stockley (2005)	Explore published/unpublished research into consumer understanding and use of nutrition labelling	Systematic review	103	Up to 2002	BOP, summary nutrition logos	Global
Grunert and Wills (2007)	To review literature conducted 2003-2008 in the EU 15 countries on home consumer perceive, understand, like and use nutrition information on food labels	Systematic review	58	2003 - 2008	BOP, FOP, Summary nutrition logos, nutrition and Health Claims	European Union
Drichoutis et al (2006)	A review of research studies and issues regarding the determinants of consumers' use of nutritional labels, mandatory labelling, preferred label formats and the effect of nutrition label use on purchase and dietary behaviour.	Not described	Not stated	Two decades prior to 2006	BOP	Global
Campos et al (2011)	Prevalence of consumer use and understanding of nutrition labelling and the impact of nutrition labels on consumer dietary habits	Systematic review	120	Up to 2010	BOP, FOP, Summary nutrition logos, nutrition and Health Claims	Global
Hieke and Taylor (2012)	What helps consumers to understand nutrition labelling information and has the regulation of nutrition labelling helped consumers be better informed and changed behaviour?	Systematic review	47	Up to 2011	BOP, FOP, Summary nutrition logos, nutrition and Health Claims	Global
Hersey et al (2012)	Consider "consumers' responses" to Front of pack nutrition labels (shelf and labels) to inform the development of a US federal standard scheme	Systematic review	38	1990 -2010	FOP, Shelf labelling schemes	Europe, Asia, Australia, Americas, New Zealand
Kerr et al (2015)	To review the observational and laboratory evidence which has examined impact of nutrition labels on dietary behaviour	Review	Not stated	Not stated	BOP, FOP, labels at point of purchase	Global
Vyth et al (2012)	Review the methodological quality of current Front of pack labelling research	Structured review	31	1990- Feb 2011	FOP, Summary nutrition/health logo	Global

Frequent use of nutrition labels has been linked with healthier diets in both theoretical and observational (survey) studies (Barreiro-Hurlé et al., 2010; Campos et al., 2011; Variyam, 2008) as indicated by a systematic review of 120 studies (Campos et al., 2011). For example, increases in use of US Nutrition Facts Panels have also been associated with improved nutrient intakes (i.e. saturated fat, sodium, sugars) in a nationally representative consumer survey of 10,000 adults aged 18 - 85yrs (Ollberding et al., 2010). Nutrition label use among young adult undergraduates is also linked with positive attitudes to health and better dietary quality (Cooke and Papadaki, 2014; Graham and Laska, 2012). Survey evidence among 800 Spanish consumers (mean age 45yrs) suggests that those consumers with higher levels of nutrition knowledge, educational attainment and frequent use of nutrition labels have greater "intentions to follow a healthy diet" (Barreiro-Hurlé et al., 2010).

Examination of the potential impact on consumers choices of providing labels includes a recent meta-analysis of nine experimental and real-life studies assessed the impact on food choices of both mandatory and various front-of-pack nutrition labels (Cecchini and Warin, 2015). This meta-analysis suggests that the provision of this information could result in more people selecting healthier food products and a decrease in calorie choice/intakes by 3.5%, although none of the included individual studies reported significant results. In addition, this study did not examine which types of consumers may be most likely to use, or be most influenced by, these nutrition labels.

In contrast to these potential effects on dietary intakes and food choices, research does not consistently show that nutrition labels influence consumers' purchase choices. For example, global review evidence has reported a lack of impact of nutrition labelling or point-of-purchase product health information on actual purchase behaviours (van 't Riet, 2013). Similarly, review evidence on the real-world effectiveness of nutrition labels and point-of-purchase information, including claims, on food behaviours also remains contentious (Volkova and Ni Mhurchu, 2015). However, these reviews both encompass global evidence and the authors note the changes and differences between country's label declarations, over time, that may impact on the overall effects of the labels examined in these studies. These findings may also be explained by the variations (voluntary) nutrition label implementation across individual studies. For example, Sacks et al (2009) reported no discernible effect on the relative healthiness of consumer purchases following a UK intervention to display traffic lights in selected product categories in-store in one UK retailer (Sacks et al., 2009) In addition, another study has also shown a lack of effect on sales of an intervention displaying “traffic light” nutrition information on selected products (and specific categories) within an “online” supermarket (Sacks et al., 2011). Alternatively, there is some evidence that traffic light nutrition labels may increase consumer awareness of healthy choices at the point-of-purchase (Sonnenberg et al., 2013; Thorndike et al., 2014). Overall, the evidence suggests that there is still potential to improve the efficacy of nutrition labels and online nutrition information on food choices and purchases (Drichoutis and Nayga, 2006; Gregori et al., 2014; Hieke and Taylor, 2012; Sacks et al., 2009).

Barriers which may prevent use of nutrition labels by consumers have therefore been a focus of research attention. Such barriers are known to include a lack of attention and motivation to use nutrition labels. Indeed, work with focus groups points to a general lack of everyday use of this information other than for motivated consumers and health-driven purchase choices (Deakin, 2011; Health Canada, 2010). In addition, levels of consumers’ understanding of this information have also been widely researched as potential barrier to label use (Bialkova and van Trijp, 2010; Cowburn and Stockley, 2005; Gregori et al., 2014; Hieke and Taylor, 2012; Levy et al., 1996; McLean and Hoek, 2014; Mhurchu and Gorton, 2007; Sacks et al., 2009; van ’t Riet, 2013). To date, this research has encompassed various types of back and front-of-pack nutrition labels, mainly with a view to improving label use via the implementation of more comprehensive label formats and designs (Roberto and Khandpur, 2014).

1.4.3 Consumer understanding of back-of-pack nutrition labels

Consumer understanding of nutrition labels has been defined by Grunert and Wills (2007) as “the ability to understand the meaning of the information”. These researchers have also categorised understanding of nutrition labels into two parts: (1) subjective understanding of what consumers perceive they have understood and; (2) objective understanding as whether the meaning consumer has understood is the same as that intended (Grunert and Wills, 2007). Both objective and subjective understanding of nutrition labels feature in the conceptual framework of consumer use of this information, as shown in Figure 6, described later. Within the context of how consumers could use nutrition labels to shape healthy dietary choices (via product evaluation and food choice or purchase decisions), use of this information is considered to first require consumer understanding and interpretation of the declared nutrient and dietary reference values (Grunert et al., 2010b; Grunert and Wills, 2007).

Consumers with lower levels of objective understanding of back-of-pack nutrition labels such as US Nutrition Facts Panels, include older adults or those with lower levels of educational attainment, income, nutrition knowledge, or health literacy (Campos et al., 2011; Cha et al., 2014; Hieke and Taylor, 2012; Sharif et al., 2014). Given the requirement to obtain, then process and interpret numerical nutrition label information, it is also unsurprising that those with lower levels of literacy or numeracy should possess poorer understanding of this information, compared to those with higher levels (Rothman et al., 2006; Viswanathan et al., 2009). Furthermore, adequate health and nutrition literacy are also thought to be required to understand nutrition labels and to promote improvement in nutrition-related health outcomes (Carbone and Zoellner, 2012; Cha et al., 2014; Mackert et al., 2013; Velardo, 2015; Zoellner et al., 2011). These concepts have been defined as “the degree to which people have the capacity to obtain, process, and understand basic information about health (and nutrition)” (Velardo, 2015; Zoellner et al., 2009).

In general, older age has been consistently shown to negatively affect levels of understanding of nutrition labels (Block and Peracchio, 2006; Ducrot et al., 2015; Grunert et al., 2010b; Hieke and Taylor, 2012; Levy and Fein, 1998; Macon et al., 2004; Malam et al., 2009; Miller and Cassady, 2012; Sinclair et al., 2013). Among 2,846 surveyed older Americans (aged 51 years and older) reported use of nutrition labels increased between ages 51-81 years whilst assessed understanding decreased, although label use was related to improvements in intakes in specific nutrients, including fat (Macon et al., 2004). Overall, research concerning consumer understanding suggests there is likely to be a disadvantage for some consumer types who are expected to use this information to make healthy food choices, including older adults who are also expected to use this information to make healthy choices.

Research into consumer understanding of nutrition labels has also focussed on the common difficulties experienced by consumers when using nutrition labels

(Campos et al., 2011; Cowburn and Stockley, 2005). For example, it has been found that consumers may have difficulties with use of the quantitative information presented on labels, including "percent daily values (%DV)", serving sizes or other forms of reference information on the label, including "technical terms" (Campos et al., 2011; Grunert and Wills, 2007). In addition, tasks which were found to be poorly performed by consumers include interpretation of nutrition label information, determination of energy per serving and comparing products (Campos et al., 2011; Cowburn and Stockley, 2005). However, it should be critically noted that most studies which evaluate consumer understanding of back-of-pack nutrition labels originate from the US, which declares a different nutrition label to the UK (see Figure 4). At present, no research yet exists on consumer understanding of the current UK mandatory nutrition labels and their elements.

To date, research has focussed on providing evidence underpinning recommendations for specific changes to nutrition label format which are intended to improve the "comprehensibility" of this information and the potential downstream effects on consumers' health (Roberto and Khandpur, 2014). These include the addition of interpretative aids like "recommended reference values" to help in product comparisons and in "putting products in the context of a healthy diet" (Cowburn and Stockley, 2005). Consequently, compared with "traditional" (i.e. back-of-pack) nutrition labels, interpretational (i.e. colour coded) front-of-pack nutrition labels are now considered more effective at supporting consumer understanding and use of this information (Campos et al., 2011; Gorton et al., 2009) and may help remove some of the barriers to label use across consumer types (Campos et al., 2011; Ducrot et al., 2015; Gorton et al., 2009; Gregori et al., 2014; Jones and Richardson, 2007; Viswanathan et al., 2009).

1.4.4 Front-of-pack nutrition labels and comprehensibility

Consumers' use and understanding of front-of-pack labels which may display graphics or adjectives, including traffic lights, has been extensively researched in the UK, EU, Australia and US. According to Gorton et al (2008) this type of label "*should be more accessible for those who currently find labels difficult to use or understand*" (Gorton et al., 2009, p. 1364). Research has also evaluated the "comprehensibility" of various versions of front-of-pack nutrition labels to identify those which may be helpful for consumers who do not possess adequate nutrition knowledge to use the existing information properly (Ducrot et al., 2015; Hersey et al., 2013; Magnusson, 2010). For example, Ducrot et al (2015) reported that characteristics such as age and (self-rated) nutrition knowledge could be seen to impact on the objective understanding of various front-of-pack nutrition labels among 15,000 EU respondents. For example, those respondents aged 30-50, 50-65, or 65yrs+ scored lower on their objective understanding of these labelling schemes, compared to those aged 18-30. However, the biggest influence on objective understanding was label format, which favoured the 5-colour (NUTRI-SCORE) label type (Ducrot et al., 2015). Indeed, lack of consistency in the presentation and format of front-of-pack nutrition labels in the UK has been reported to cause consumers difficulties in use and interpretation of this information (Draper et al., 2013).

Another key influence on use of (front-of-pack) nutrition labels appears to be consumers' perceptions of how "easy" labels are to understand, or alternatively, how well consumers believe they can understand front-of-pack nutrition labels (i.e. subjective understanding) (Feunekes et al., 2008; Grunert et al., 2010a, 2010b; Malam et al., 2009; Méjean et al., 2013a). For example, consumer's actual comprehension of eight different formats of UK front-of-pack nutrition labels did not appear to vary conclusively in objective tests (Malam et al., 2009). However, subsequent qualitative research indicated "colour coded GDA formats" were "viewed best" in terms of perceived understanding (Gracia et al., 2007; Grunert and Wills, 2007; Malam et al., 2009). On this basis, specific improvements to the design of front-of-pack nutrition labels have been proposed to facilitate consumers' label interpretation and their food choices (Roberto and Khandpur, 2014, Visschers et al., 2010 (Mejean et al., 2013b; Méjean et al., 2013a). This includes those recommendations which informed the current UK front-of-pack nutrition label format guidance (Department of Health, 2016b; Malam et al., 2009).

Two studies have compared UK consumers' objective understanding of various front-of-pack nutrition labelling schemes, declared prior to 2010. These found that levels of such understanding were generally high yet varied according to consumers' age, level of educational attainment (Malam et al., 2009) and general nutrition knowledge (Grunert et al., 2010b). Age was related to understanding of "GDA" and Traffic light labels, with younger consumers (18-34yrs) giving more correct answers than older adults (55yrs+) during ready meal comparison tasks. However, it should also be noted that there is currently no evaluation of consumers', including older adults', understanding of the current UK voluntary front-of-pack nutrition label which was launched in 2013 by the Department of Health, to comply with the EU Regulation 1169/2011.

1.4.5 Characteristics associated with use and understanding of nutrition labels

To increase the effect of nutrition labels on food choice and health, initiatives to increase consumers' motivation to use this information have been called for (Lachat and Tseng, 2013; van 't Riet, 2013). This is because labels can only be effective at shaping food choices if consumer use them as intended. Experimental evidence shows that when participants are given "health motivation" goals (e.g. to buy for another person who prefers healthful foods) they spend longer viewing front-of-pack nutrition labels (Turner et al., 2014). Such participants are also more likely to seek out nutrition labels displayed in difficult to seek package locations compared with participants more concerned with taste (Visschers et al., 2010).

However, the use of nutrition labels in populations with diagnosed health conditions has been inconsistently associated with improved dietary intakes (Lewis et al., 2009; Post et al., 2010). One possible, yet not fully evaluated, explanation for this may be variations in whether these consumers have been "advised" to use nutrition labels by health care professionals, which may increase with age (Drichoutis et al., 2005). For example, among US patients with chronic disease, the odds of reading food labels were increased by 50% when advised to do so by a doctor or health professional to help to manage body weight, compared to those without this advice (Post et al., 2010). Indeed, consumers' "enduring motivation" to process nutrition information has also been a key characteristic linked with regular engagement and use of nutrition labels (Drichoutis and Nayga, 2006; Hieke and Taylor, 2012; Moorman, 1990). Moorman (1990) defines this type of motivation as reflective of the personal relevance of and involvement with nutrition information and has linked this characteristic with greater levels of information acquisition and processing (Moorman, 1990). The role of such "personal involvement" with nutrition labels has also been associated with increased label use or calorie estimation in restaurant or experimental settings with US young adult participants (Celsi and

Olson, 1988; Chandon and Wansink, 2007; Moorman, 1990). However, despite an increasing likelihood of possible nutrition-related health conditions, older adults' enduring motivation to utilise nutrition labels does not appear to have been evaluated in the literature. This includes if they have been advised to use this information by healthcare professionals.

Besides motivation, a second major pre-requisite for use of nutrition labels appears to be consumers' levels of nutrition knowledge (Barreiro-Hurlé et al., 2010; Drichoutis et al., 2005; Grunert and Wills, 2007; Miller and Cassady, 2015; van der Merwe et al., 2013). Such knowledge is generally defined as: "knowledge of concepts and processes related to nutrition and health including diet and health, disease, food sources of nutrients, dietary guidelines and recommendations" (Miller and Cassady, 2015). Nutrition knowledge is thought to facilitate the use of nutrition labels, in part, via understanding of this information (Drichoutis et al., 2005; Ducrot et al., 2015; Grunert et al., 2010b; Méjean et al., 2013b; Miller et al., 2010; Miller and Cassady, 2012). For example, increased levels of nutrition knowledge were found to be supportive of consumers' understanding of various front-of-pack nutrition labels (Ducrot et al., 2015; Grunert et al., 2010b; Méjean et al., 2013). The possession of basic nutrition knowledge may also be a pre-condition of correct identification of information on a nutrition label (Lachat and Tseng, 2013; van der Merwe et al., 2013).

However, a major criticism of the research in this area is an "excessive" use of undergraduate-aged consumers, with a lack of insight into the role of this characteristic in over 55yrs (Hike and Taylor, 2012; Miller and Cassady, 2015; Miller and Cassady, 2012). Indeed, whilst survey data from 330 Greek adults suggest that their increasing nutrition knowledge supports frequent use of nutrition labels with increasing age, only 37 adult respondents were aged 57yrs or older (Drichoutis et al., 2005). In addition, the evaluation of label use and nutrition knowledge seems to employ both self-reported and objective measures and may concern non-specific reference to both "food labels" or "nutrition labels" (Hieke and Taylor, 2012; Miller and Cassady, 2015; Vyth et al., 2012). This issues therefore limit the external validity of the results and confound the more important picture of assessing "how well" (not just how often) consumers use nutrition information on labels (Miller and Cassady, 2012).

Nutrition knowledge is also an integral part of consumers' health literacy (Spronk et al., 2014) and is thought to shape health behaviours including food choice (Dickson-Spillmann and Siegrist, 2011; Geaney et al., 2015; Miller and Cassady, 2015; Spronk et al., 2014; Worsley, 2002). The accumulation of nutrition knowledge over the life span was found to be predictive of comprehension of textual nutrition information in US older adults (Miller et al., 2010). Whilst the interactions between nutrition knowledge, nutrition label use and understanding may help to design "effective educational programmes" (Miller and Cassady, 2015), there appears to be lack of insight into how this characteristic may support use or consumer understanding of the current UK nutrition labels, including those displayed mandatorily on the back-of-pack.

1.4.6 The impact of the US Nutrition Labelling and Education Act on consumer use of Nutrition Facts Panels

The overall effect of the US legislation which mandated Nutrition Facts Panels on consumers' search and use of this information has produced some mixed findings. There is no evidence of an increase in consumer search for this information following the 1994 implementation of the Nutrition Labelling and Education Act (NLEA) (Drichoutis and Nayga, 2006). However, the implementation of these labels appears to have positively impacted on the search activities of highly motivated and less knowledgeable consumers, who were reported to have therefore benefited from this legislation more than other consumer groups (Balasubramanian and Cole, 2002). Attention to negative nutrients (fat, sodium) also appeared greater than that paid to positive nutrient attributes (calcium and vitamins). One of the reasons for this may be that the implementation of mandatory US Nutrition Facts Panels could have positivity affected consumers' understanding this information and their accurate of assessment of nutrition values (Burton and Andrews, 1996; Drichoutis and Nayga, 2006) as well as their general awareness and understanding (Burton and Biswas, 1993).

However, the available US evidence suggests there were no significant changes in the overall nutrition quality of purchased food products, or consumers' purchase preferences following the implementation of the NLEA which has resulted in calls for more consumer education on this topic (Drichoutis and Nayga, 2006). Furthermore, evidence comparing consumer behaviours before and after the implementation of this US legislation has also found that food label users had a lower fat diet than non-users and projected a potential decrease of BMI at population level (Variyam and Cawley, 2006). Following the recent mandatory implementation of the current UK nutrition labels, research into consumer use and understanding of this information, including in specific consumer groups, is therefore warranted.

1.4.7 Research undertaken with UK nutrition labels

Described above, research concerning UK nutrition labels has been undertaken using those back and front-of-pack labels declared in-line with the previous Food Labelling Regulations (1996). This research has used a variety of approaches and methodologies to explore consumer use and engagement with this information. For example, Higginson et al (2002) has explored "how" consumers used back-of-pack nutrition labels using verbal data to show that fat and energy (calories) contents were accessed most frequently by consumers, including values for "per 100g" and "per serving" (Higginson et al., 2002a, 2002b). Using in-store intercept interviews, Grunert et al (2010b) showed fat, sugar, calorie and salt information were frequently recalled by participants, in line with the nutrients which appear on supermarkets' front-of-pack nutrition labels.

One other important consideration when assessing consumer use of nutrition labels is the access to the available of this information, on products etc. Although mandatory labelling is intended to improve this, research conducted in the UK has also provided some insight into previous levels of availability and use of front-of-pack nutrition labels previously displayed, prior to 2010. For example, front-of-pack nutrition labels on ready-meal products were viewed more often than back-of-pack labels when available within this product category (Grunert et al., 2010b). However, back-of-pack nutrition information was necessarily viewed more where front-of-pack labels were not available, for example in yoghurts. This study also found that consumers' actual frequency of viewing of both front and back-of-pack nutrition labels appeared to correspond to the type of label which was available at that time (Grunert et al., 2010b). Given that the current UK nutrition labels also appear within mandatory back-of-pack and voluntary front-of-pack locations, there is a need to encompass both labels types in future UK research with consumers.

Whilst this literature review has clearly revealed that no published research yet exists which encompasses the current formats of UK back or front-of-pack nutrition labels, researchers have highlighted that label format changes required under the EU Regulation 1169/2011 may potentially affect consumer understanding and use of this information (Graham et al., 2012; Lalor, 2014). For example, in a review of eye tracking research concerning consumers' detailed use of elements of nutrition label information, Graham et al (2012) emphasises that consumers pay attention to nutrients located at the top of the ordered list (Graham et al., 2012). These authors noted the potential implications of these findings given the (at that time, forthcoming) changes to the order of displayed nutrients presented on the back-of-pack nutrition label under the EU Regulation 1169/2011. In addition to the other format and terminology changes to UK nutrition labels which appear in line with this legislation, there is a need to evaluate the potential impact of these on UK consumers' use and understanding of nutrition labels.

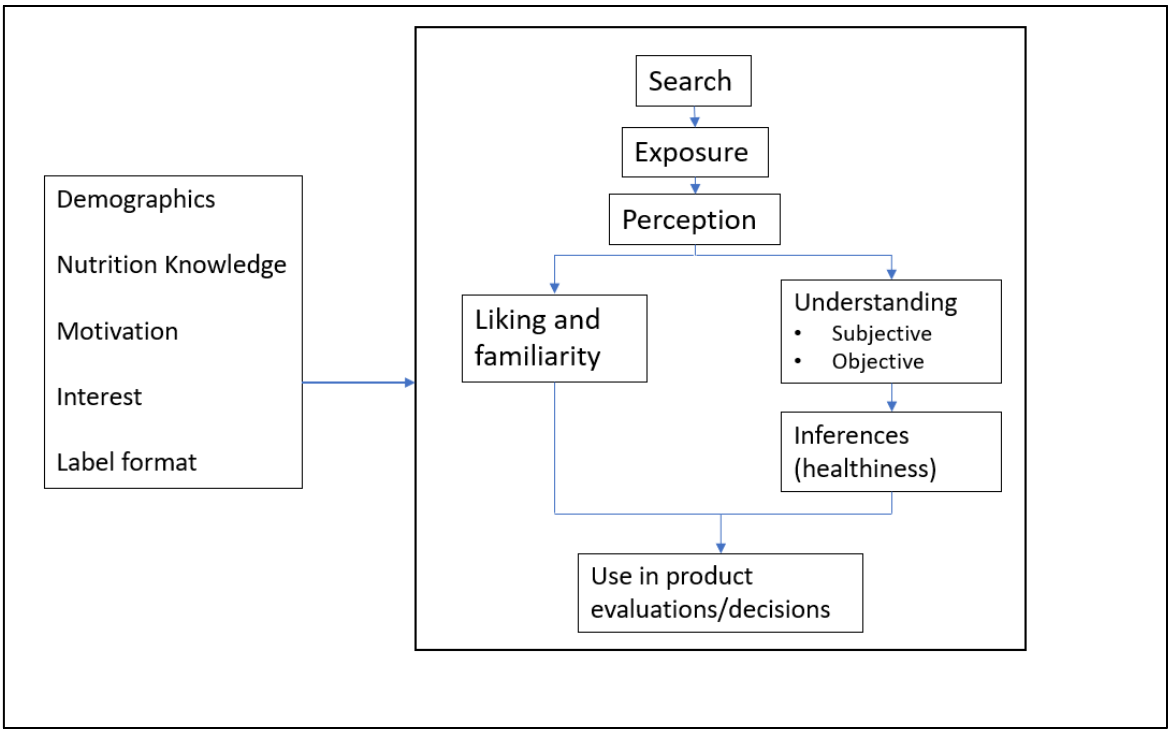
Also, of note under the current legislation is the recent provision of nutrition information in UK online supermarkets. In contrast to the body of research focussed on nutrition labels provided on product packaging, the use of online product information in UK supermarket websites, including nutrition, appears to have been assessed in only one study (Benn et al., 2015). These researchers used eye tracking to measure consumer viewing of online product information amongst 40 participants aged 18-34yrs whilst conducting weekly shops. Findings show that nutrition information, along with other aspects of food labelling, was poorly viewed and that viewing was unrelated to participant's stated dietary restrictions (i.e. vegetarian, allergies, religious principles).

1.4.8 Theoretical framework

The theoretical framework of consumer use of nutrition labels provided by Grunert et al (2007) has been adapted for use in this thesis with reference to similar frameworks proposed by Drichoutis et al (2005) and Grunert et al (2010b) (Figure 6). This framework aims to describe consumer characteristics and other influences which are considered to determine use and information processing of nutrition labels during product evaluations (Grunert and Wills, 2007).

As shown in Figure 6, consumers must first be exposed to nutrition labels. Such exposure may be increased by the presence of nutrition label information on-pack as mandatorily declared under labelling legislation. The likelihood of exposure may also increase with consumers “search” for this information, which may also be determined by other consumer characteristics, including their nutrition knowledge, motivations and interests. In this respect, motivation to engage with labels is an important influence (Drichoutis et al., 2005; Drichoutis and Nayga, 2006). Such exposure leads to effects on subsequent behaviour only when information is perceived by the consumer. Perception of this information leads to understanding which is the meaning the consumer attaches to what is perceived. Understanding may also be influenced by a consumer’s pre-existing nutrition knowledge. Subjective or objective, understanding is thought to result in “inferences” about the healthiness of the product. In addition, liking and familiarity with the particular type, or format, of nutrition label may also impact on use of this information. These influences are integrated with other product-related information (e.g. taste, marketing), to enable consumer to evaluate and make a decision about the product (Drichoutis et al., 2005; Grunert et al., 2010b; Grunert and Wills, 2007).

Figure 6 Conceptual framework of influences on consumer use of nutritrion labels.



Adapted from Grunert and Wills (2007), Grunert et al (2010b) and Drichoutis et al (2005).

1.4.9 Nutrition label education

Nutrition labels are often described as educational tools (Kleef and Dagevos, 2015). However, they may be ineffective at reducing obesity and NCDs "due to their complexity" (Chavasit et al., 2017). The requirement to educate consumers about "how to use" nutrition labels is included within the US Nutrition Labelling and Education Act (NLEA) (US Food and Drug Administration, 1995) and the EU Regulation 1169/2011 (EC, 2011). The EU Regulation on the provision of food information for consumers states in Article 1, paragraph 10 that:

> *"Education and information campaigns are an important mechanism for improving consumer understanding of food information".*
>
> (EC, 2011, Article 1, 10)

The combination of the consistent provision of mandatory nutrition labels with consumer education as required by the US NLEA has been described by Satia et al (2005) as intended "*to make nutrition information on food labels easier to understand and enable consumers to more easily compare food by nutrition content, thereby making it easier to plan a healthful diet*" (Satia et al., 2005, p. 393). Assumptions that consumers will receive explanatory information about "how to use" nutrition labels are also included in the theoretical modelling of the impact of mandatory nutrition labelling on European obesity levels (Bonsmann and Wills, 2012; Sassi et al., 2009). The inclusion of nutrition label education in the legislation therefore underpins the belief that, in order to make informed choices, consumers need to be provided with both accurate and relevant nutrition information, as well as the cognitive ability and skills to evaluate this information (Howlett et al., 2008).

The need to educate consumers about nutrition labels is also consistently highlighted following evaluations of the disappointing impact of this information on consumers' purchases (Campos et al., 2011; Drichoutis and Nayga, 2006; Hawley et al., 2013; Hieke and Taylor, 2012; Sacks et al., 2011; van 't Riet, 2013; Volkova and Ni Mhurchu, 2015). To render nutrition labelling effective at shaping consumers' food choices, research suggests that the provision of further education or information campaigns may also be required (Gorton et al., 2009; Hawley et al., 2013; Lachat and Tseng, 2013). Furthermore, nutrition label education has also been called for to reduce the disparities in consumer use and understanding of nutrition labels between different educational and age groups

(Campos et al., 2011; Cowburn and Stockley, 2005; Macon et al., 2004; Sharif et al., 2014). In addition, even some front-of-pack nutrition labels may require education in order to be used and understood by consumers. For example, in their evaluation of consumer understanding of various front-of-pack nutrition labels in New Zealand, Gorton et al (2009) reported that the recently introduced %DI (percentage daily intake) colour coded front-of-pack nutrition labels were likely to require "extensive, hands-on, consumer education and be most useful for consumers who already use" nutrition labels (Gorton et al., 2009).

By definition, nutrition education has wide reaching ambitions to both teach the "science of nutrition" and to promote behaviour change when delivered by health professionals or as part of an intervention (Deshpande, 2003). As such, the focus of much nutrition education is on improving knowledge as well as promoting practical and sustainable behaviours which are useable in everyday settings. Specifically, nutrition label education may therefore serve to promote both detailed knowledge of the nutrition label (i.e. "how to read") as well as practical skills to enable use of this information to make healthier choices (i.e. "how to use") (Miller et al., 2002). The role of nutrition label education is underpinned by the theoretical framework of consumer use of nutrition labels which places nutrition knowledge as well as label perception and objective understanding as key antecedents to their use in purchase evaluations (Grunert and Wills, 2007) (Figure 6). Nutrition label education has also been described as a key tool to "combat lack of nutrition label understanding" by consumers (Taylor and Wilkening, 2008). From both legislative and theoretical perspectives, there exists a potential role for education to enhance the efficacy of nutrition labels on health improvement.

The potential role for nutrition label education interventions in specifically improving nutrition label use by consumers has been briefly noted by Campos et al (2011). Education to help consumers use nutrition or food labels to guide dietary choices appears to have been delivered in various forms including as part of dietary or nutrition education classes, during supermarket tours, or within online or in-class programmes with consumers or patients (Ireland et al., 2010; Petersen et al., 2013; Poelman et al., 2013; Steenhuis et al., 2004). Messages encouraging and explaining use of nutrition labels are also included in UK public health initiatives including the Change4Life campaign and the Eatwell Guide

(NHS Change4life, 2018b; Public Health England, 2016c). However, the effect of these interventions on improving consumer understanding or use of nutrition labels or the impact of this information on participants' dietary intakes does not yet appear to have been highlighted or encompassed in such work. Overall, there appears to be lack of insight into the effects of nutrition label education on improving consumer understanding and use of nutrition labels despite this existing research recommendation (Vyth et al., 2012).

1.5 Research gaps

1.5.1 Limitations of the existing literature

Overall, the research into consumer use and understanding of nutrition labels appears to have been mostly conducted with US (back-of-pack) and UK (front-of-pack) labels. Research is needed into consumer use and understanding of the current formats of mandatory and front-of-pack UK nutrition labels following the implementation of EU Regulation 1169/2011. Given the potential for mandatory nutrition information to impact on population health, research exploring consumer use and understanding of this information is specifically warranted (Lalor, 2014, Graham et al., 2012). In addition, although now also mandatorily declared, there appears to be little research concerning consumer engagement with online nutrition information displayed within supermarket websites.

Secondly, the review of the existing literature highlighted a concern that older adult consumers were less likely to understand nutrition labels than younger adults but may be more likely to use them. Whilst no published research was found which has specifically focussed on the needs of UK older adults relating to nutrition labels, the noticeable lack of research into motivational and nutrition knowledge characteristics which support use of nutrition labels in older adults has also been noted elsewhere (Miller and Cassady, 2015). UK Older adults are therefore under-represented in the research evidence on nutrition labelling and new research in the area of older adults use and understanding of labels is therefore required to support these adults use of this information and the intended benefits to their dietary health. A further definition of older adults and the rationale for focusing on this age group is presented in the next section.

Finally, there is a need to explore if consumer understanding and use of nutrition labels can be improved with label education. The requirement for education to support optimal use and impact of nutrition labels appears clear. However, the nature of and extent to which education may help improve consumer understanding or use of nutrition labels does not appear to have been extensively evaluated or reported in the research literature and will be a feature of this thesis.

1.5.2 The focus on UK older adults

Adults aged 50 years or older are an increasing population demographic in the UK (ONS, 2017) and will be a focus of the current research. Reflecting this, the number of adults who are aged over 65 years increased by 21% between 2005 - 2015 (ONS, 2017). In the UK, the 55-74yrs age group exhibits higher levels of obesity than other age groups (NHS Digital, 2018) (Figure 1). However, as indicated in the available literature, the impact on obesity of mandatory nutrition information is expected to be less among older, compared to younger, adults (Sassi et al, 2009).

Propagating an equitable impact of mandatory nutrition labelling on consumer health is also an onward consideration of the present research, particularly following the recent implementation of UK mandatory nutrition labels. Indeed, historic concerns that older adults may not be able to utilise nutrition label information as effectively as younger consumers were raised following the mandatory implementation of US Nutrition Facts Panels in the 1990s (Burton and Andrews, 1996; Cole and Balasubramanian, 1993; Cole and Gaeth, 1990; Moorman, 1990). This previous work investigated age related differences in ability to use nutrition label information in a complex environment and found that older subjects aged 60 yrs or older took longer to reach purchase decisions than younger consumers (Cole and Gaeth, 1990). In addition, adults aged over 55yrs who were considered at risk of osteoporosis were found to have difficulties using %DV information on the US Nutrition Facts Panels, including that information relating to calcium content (Block and Peracchio, 2006). Despite this, little research can be found on how to help these adults' use and understand nutrition labels, including UK versions. This is surprising since, as shown in the above literature review, older adults (i.e. from around 50 yrs of age) have consistently been shown to possess lower levels of understanding of various back and front-of-pack nutrition labels, compared to younger adults (Campos et al., 2011; Cowburn and Stockley, 2005; Grunert et al., 2010b; Grunert and Wills, 2007; Malam et al., 2009). Further reason to explore how to help these consumers better use nutrition labels includes concerns regarding these adults' health literacy levels. These are thought to be associated with nutrition label understanding (Carbone and Zoellner, 2012; Cha et al., 2014; Mackert et al., 2013), yet known to worsen with age. Amongst surveyed European adults, 58% of those aged 66-75 years old were assessed as having limited health literacy (Sørensen et al., 2015).

Older adults in the UK, including those currently aged 50yrs +, are unlikely to have received education on how to use nutrition labels in their earlier years. In contrast, nutrition label education is currently delivered to school children in the UK. Specific food competencies, including awareness and use of food labels to make healthy food choices, are now taught to 5 – 16 yr olds school children in-line with the national curriculum (British Nutrition Foundation, 2015). Perhaps consequentially, trust in food labels appears to decline among adults aged 47-61, and in 61yrs+ age groups, compared to younger adults (Worsley, 2003).

Conversely, older adults may use nutrition labels frequently and their health concerns may be an important motivator (Grunert and Wills, 2007; Macon et al., 2004; Ollberding et al., 2010; Post et al., 2010). In a survey of 1,262 Irish adults, consumers aged 51 years old or older were found to possess greater health-related motivations to eat healthily than younger adults aged 18-35 years old (Naughton et al., 2015). Furthermore, labels may be an important source of nutrition information for these adults. For example, a survey evaluating the value of nutrition label information on products suggests that older adults aged 45yrs or older are more likely to be willing to pay for nutrition labelling information on products, compared to younger ages (Gergori et al., 2015).

Now required, gaining insight into consumer use and understanding of nutrition label information among these older adults, including those in their 50s, could help inform strategies to support healthy independent living and positive health outcomes into "old" older age (Illario et al., 2015; Mak et al., 2014). The promotion of optimal understanding and use of nutrition information among older adults is also likely to be of importance with respect to their increased risk of diet-related diseases which require dietary management (Mak et al., 2014; NHS, 2017). In addition, older adults' specific nutrient requirements, including those which differ from younger adults (Buttriss et al., 2009; Public Health England, 2016a) should be noted here. For example, among adults aged 65 years or more, there is a requirement for relatively less energy but increased densities of specific nutrients, compared to younger adults (see Table 1). Although poor diet quality is thought to be common in older people (Elia et al., 2010; Mak et al., 2014), the determinants of these adults' food choices are not fully understood (Bloom et al., 2017; Whitelock and Ensaff, 2018), including the potential role of nutrition labels in these adults' purchase decisions.

Research into potential influences on older adults' purchase choices, including nutrition labels, is now timely given the recent analysis of time trend data on population dietary intakes from the UK National Diet and Nutrition Survey. This suggests that older adults (aged 65yrs or older) may not have improved their diets over time to the same extent as younger adults. Specifically, intakes of energy, free sugars, saturated fat and sugar sweetened beverages were not found to decline in this age group to the same extent as that observed for younger adults and children, over the 2008 - 2018 time frame (Public Health England, 2019). Research which sheds light on UK older adults' use of nutrition label information, provided with the intention of helping consumers to choose a healthy diet, is therefore warranted.

1.6 Research questions

Addressing the knowledge gaps in the existing research and with the ambition of supporting future strategies to enable improved dietary health in older UK adults, the following research questions were posed by this PhD project.

1. How well do older adults (aged 50 years or older) understand and use the back and front-of-pack nutrition labels which are currently declared in the UK?
2. To what extent do older adults' levels of understanding, personal knowledge and motivational characteristics support use of this information in purchase choices?
3. How often do older adult online shoppers use online product nutrition information displayed within UK supermarket websites? Why might they not engage with this information in this setting?
4. What evidence is there that nutrition label education can improve understanding and use of nutrition labels? What are the features of successful interventions?

5. Can nutrition label education improve understanding and use of the current UK nutrition labels among older adults?

1.7 Aims and objectives of the PhD

The overarching aim of this PhD project is to evaluate levels of understanding and use of the current UK nutrition labels among older adults and to develop and evaluate a pilot education intervention targeting understanding of this information. In addition, this project aimed to explore these consumers' engagement with online nutrition information available in UK supermarket websites.

Objectives are:

1. To develop and pilot data collection tools to evaluate understanding and use of current UK nutrition labels in older adults.
2. To survey older adult use and understanding of the current UK nutrition labels and potentially related characteristics, as well as these consumers' use of online product nutrition information.
3. To explore older adult engagement with online nutrition information within supermarket website environments.
4. To evaluate the effectiveness and features of previously reported educational interventions targeting nutrition label understanding and use.
5. To use the insights from 1, 2 and 4 to develop and evaluate a pilot educational intervention targeting understanding of the current UK nutrition labels in older adults.

1.8 The story and structure of the PhD thesis

This chapter has provided an overview of the legislation and format of the current UK nutrition labels and the role of nutrition labels in public health. A review of the literature has identified areas of missing insight concerning UK nutrition labels, older adults' use and understanding of this information and the potential role of education in increasing these. Following this chapter, this thesis can be considered in three parts (a - c, below):

(a) The development of online tools for use by older adults

The next chapter (Chapter 2) will describe the rationale for and the design of online data collection tools to evaluate use and understanding of the current UK nutrition labels which were then piloted in a study with undergraduate students (Chapter 3). Chapter 3 also describes how this pilot study informed refinement of the online survey questions as well providing insight for the various sample size calculations for the online survey of older adults, results of which are described in Chapters 4 and 7. These chapters aim to address research questions 1, 2, 3.

(b) Evaluation of use and understanding of nutrition labels among older adults and their engagement with online nutrition information

Use of the developed online tools to survey older adults' use and understanding of current UK nutrition labels and findings are described in Chapter 4. Chapter 5 then presents the results of the online survey relating to a sub sample of surveyed older adults who shopped online and their use of online nutrition information. Chapter 5 goes on to further explore shopper's engagement with this information by using "Think aloud" sessions and shopping tasks conducted within supermarket websites. These chapters answer research questions 1, 2, 3.

(c) Evaluation of the effects of nutrition label education

Chapter 6 describes the systematic review of the literature on interventions featuring nutrition label education and their effect on the outcomes of understanding and use. The following Chapter 7 uses this review evidence as well as survey results from Chapter 4 to develop and evaluate a pilot educational intervention on nutrition labels aimed at older adults. These chapters answer research questions 4 and 5.

To aid the telling and flow of the PhD story, each chapter includes a Discussion, within which is a section describing how the findings inform successive PhD project work. This section is headed "Findings in the context of the PhD". The final Chapter 8 then summarises the overarching findings of the studies described in Chapters 4, 5, 6 and 7 and discusses them in relation to the PhD aims, current literature and the implication for policy and practice. A schematic overview of the thesis chapters is shown in Figure 7

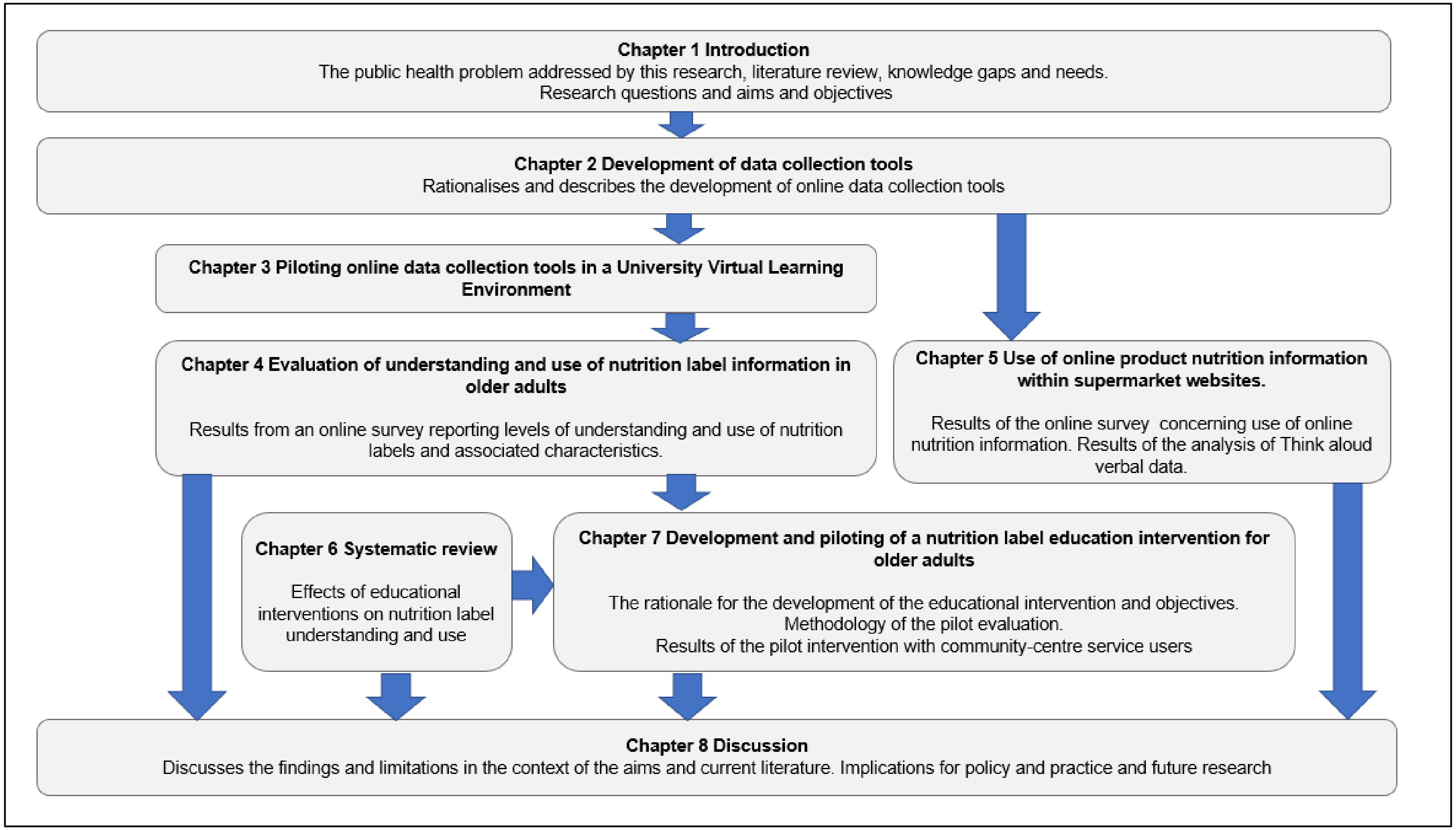


Figure 7 Structure of the thesis and outline of each chapter.

Chapter 2 Data collection tools

2.1 Overview and introduction

The need to evaluate use and understanding of current UK nutrition labels in older adults has already been outlined in Chapter 1. The first objective of this PhD work was to develop online data collection tools for this purpose. This chapter will rationalise and describe the development of the online data collection tools used to evaluate use and understanding of current UK nutrition labels, which are then used to collect data reported in Chapters 3, 4 and 5.

Insight from two areas was used to inform the development of online data collection tools. First, previous research in the area of consumer understanding of nutrition labels was examined to obtain insight into assessment and measures of use and understanding. Second, the researcher was able to develop and pilot these pilot data collection tools within a funded research opportunity to explore engagement and learning among University undergraduates (Chapter 3). The current chapter will begin by highlighting the prior research evaluating use and understanding of nutrition labels and rationalise the choice of measures selected. Also described here is how feedback and results from the pilot study with undergraduates informed the further revision of the online tools to develop a survey which was intended to evaluate use and understanding of nutrition labels in UK older adults (Chapter 4) as well as use of nutrition information in online supermarkets (Chapter 5).

2.2 Rationale for choice of measures used to evaluate use and understanding of nutrition labels

2.2.1 Evaluating consumer use of nutrition labels

Frequency of consumers' use of nutrition labels has been primarily researched using surveys which measure self-reported label "use" (Campos et al., 2011; Grunert and Wills, 2007; Ollberding et al., 2010). One study appears to have used objective measures of label use which involved observing if consumers were viewing this information whilst shopping in-store (Grunert et al., 2010). Assessing consumer viewing and attention to nutrition labels with eye-tracking technology has also been undertaken in experimental, computer-based, settings (Bialkova et al., 2010). Such approaches have been employed mainly to underpin research questions seeking to identify ways in which the label design may be modified to improve consumers' ability to locate and effectively utilise nutrition label information (Graham et al., 2012). Beyond use of labels on product packaging, consumer "use" of nutrition information displayed in online shopping supermarkets has also recently measured with eye-tracking in one study in which consumers' (n=40) viewing of product information pages was assessed (Benn et al., 2015).

The current PhD does not seek to formulate recommendations to change nutrition label design. Furthermore, the research questions require the evaluation of use and understanding of nutrition labels (on packaging), as well as online nutrition information, in relatively larger sample of older adults than could be achieved using individual participant computer-based "testing" (i.e. with eye tracking). It is also noted that observatory approaches to measuring objective "use" labels (i.e. in-store) are limited by the resources required. As such, surveying nutrition label use across a large number of consumers was considered more appropriate here, in order to provide an accessible way of evaluating label use and other respondent characteristics (Ducrot et al., 2015; Goodman et al., 2011; Jacobs et al., 2011; Macon et al., 2004; Méjean et al., 2013b; Su et al., 2015). Indeed, much of the research on consumer use of nutrition labels is based on data collected from national surveys, including the US National Health and Nutrition Examination Survey (NHANES) (Centre for Disease Control and Prevention, 2009).

2.2.2 Evaluation of self-reported use of nutrition labels

In the current study, a survey approach was selected to address the research objective of assessing use and understanding of current UK nutrition labels in older adults. It was therefore considered necessary to compile a survey questionnaire which evaluates these characteristics. To evaluate use of nutrition labels, questions used to assess label use used in other research studies and surveys were reviewed to select suitable options. Indeed, national surveys in the US and UK were examined, including the UK Food and You survey conducted by NatCen on behalf of the Food Standards Agency aims to evaluate consumer attitudes and knowledge and behaviours of food (NatCen, 2017). However, this questionnaire did not general include questions which assessed consumers' use of nutrition labels or online information, with the exception of use of out-of-home (i.e. restaurant) calorie labelling in Northern Ireland (Food Standards Agency, 2017). The US National Health and Nutrition Survey (NHANES), did however, include questions concerning how often consumers use Nutrition Facts panels which had been adapted for use within other research in this area (Centre for Disease Control and Prevention, 2009; Graham and Laska, 2012; Nayga et al., 1998; Ollberding et al., 2010). Such questions generally use a five-point frequency scale (i.e. always, often, sometimes, rarely, never) to estimate usage frequency.

Whilst self-reported measures of consumers' frequency of use of nutrition labels can overcome the resource challenges of observing consumers' actual label use when in-store, these may over estimate actual use (Grunert et al., 2010b). This is thought to be because self-reported measures of nutrition label use are based on respondents' recent memory and perceived behaviours (Soederberg Miller et al., 2015). Potentially reducing the tendency for participants to over-report, earlier research included multiple question items to evaluate frequency of use of nutrition labels when a product is "purchased for the first time", or in general when "buying foods" (Centre for Disease Control and Prevention, 2009; Graham and Laska, 2012; Nayga et al., 1998; Ollberding et al., 2010). In addition, questions assessing self-reported use of nutrition labels were also used in order to further evaluate respondent's self-reported use of specific components of nutrition labels (i.e. "fat" or "kcals") (Goodman et al., 2011). Furthermore, frequencies of use of nutrition labels for specific reasons (i.e. to determine the calorie content of foods) may also be assessed in such survey questionnaires (Guthrie et al., 1995). In recognition of this, several related questionnaire items were selected for use in the present research, in order to evaluate specific aspects of consumers self-reported “use” of nutrition labels.

In line with the conceptual framework of consumer use of nutrition labels (Figure 6) consumer label reading precedes its “use” in product evaluations (Campos et al., 2011; Grunert and Wills, 2007; Higginson et al., 2002a). For example,” reading” and “use” may be considered separately in terms of information engagement. Specific questionnaire items in other research has also distinguished label “reading” from “use of this information in purchase decisions” (O’Reilly et al., 1997). Such items also appear in a validated questionnaire evaluating use and understanding of UK nutrition labels by Mackison et al (2010). This approach to evaluating consumers self-reported uses of nutrition labels may therefore help to somewhat mitigate respondents’ overestimates of their frequency of use of this information (Goodman et al., 2011; Soederberg Miller et al., 2015). The questionnaire developed to evaluate use, understanding and perceptions of (previous) UK nutrition labels was therefore used a basis for the current study (Mackison et al., 2010). Specifically, it concerned three question items concerning self-reported frequency of reading, use and influence of nutrition labels on purchase decisions, which were adapted for use in the present study.

2.2.3 The requirement to develop a quiz to evaluating objective understanding of current UK nutrition labels

The research objectives require that evaluation of consumer understanding of nutrition labels encompass the current UK back and front-of-pack nutrition label formats. However, no prior assessment of consumer understanding of these current label formats has been recorded in the research literature. To develop a set of questions to evaluate understanding of these current UK nutrition labels, a review of previous research evaluating understanding of previous UK and other nutrition label types was first conducted. A summary of the questions used to measure objective understanding of nutrition label information within 16 research studies, which all described their measures or provided published questionnaires, is shown in Table 4.

As shown in Table 4, assessment of consumer understanding of nutrition labels has been conducted heterogeneously in the existing literature, and has used a variety of quiz question items with participants aged 18 yrs + (Byrd-Bredbenner et al., 2001; Byrd-Bredbenner and Kiefer, 2001; Ducrot et al., 2015; FSA, 2008; Grunert et al., 2010; Levy and Fein, 1998; Mejean et al., 2013; Pelletier et al., 2004; Sharf et al., 2012; Sinclair et al., 2013; Watson et al., 2013) or older than 51yrs (Byrd-Bredbenner et al., 2000, Macon et al., 2004). Such measures of understanding of nutrition labels nearly all include individual question items and tasks which specifically assess respondents' ability to answer questions relating to a provided nutrition label (Table 4). For example, in their survey, Sinclair et al (2013) use two questions to assess consumers' comprehension of the Canadian Nutrition Facts Panel (Sinclair et al., 2013). These items required the calorie content and percent Daily Values contributions (%DV) a serving of a food product to be calculated from the provided Nutrition Facts Panel, including for a different number of servings or daily requirements. Other researchers required respondents to locate (replay) basic label data "per 100g" of "per serving" provided on a typical label (Byrd-Bredbenner et al., 2001; Byrd-Bredbenner et al., 2000; Pelletier et al., 2004; van der Merwe et al., 2013) (Table 4).

2.2.4 The rationale for including assessment of understanding of "Reference Intakes" and "RI" label data

Also as shown in Table 4, much research attention appears to have been paid to the assessment of consumers' understanding of the meaning of specific elements of UK and US nutrition labels. These include "per serving" information, daily amounts and percentages as (%) contributions to the daily diet. Evaluating participants' ability to locate and define these specific label elements reflects those practical tasks commonly performed with this information, including those which would most likely impact selection of healthier products (Byrd-Bredbenner et al., 2001; Campos et al., 2011; Cowburn and Stockley, 2005; FSA, 2008; Levy et al., 1996; Levy and Fein, 1998; Mackison et al., 2010).

The current study needed to evaluate consumer understanding of elements of current UK nutrition labels, declared under EU Regulation 1169/2011, which were different from previous label versions. These changes included the use of the "Reference Intakes (RI)" terminology which replaced "Guideline Daily Amounts"

(GDA), as described in Chapter 1. Research has previously evaluated consumers' "general" understanding of the meaning of nutrition label terminology which aims to influence and guide dietary intakes (i.e. the DV or GDA) (Grunert et al., 2010b; Levy et al., 2000). Reflecting the importance of understanding this contextual information on nutrition labels when choosing products, Grunert et al (2010b) evaluated consumers' "conceptual understanding" of the meaning of GDAs as "guidelines for daily amounts" (i.e. 70g of fat) within their study on UK front-of-pack labels. Furthermore, these authors also go on to differentiate "substantive" consumer understanding as whether consumers can interpret the information on the label correctly (i.e. in terms of "per serving" and "%GDA" provided). The latter reflects one of the specific tasks consumers are expected to perform with this information in order to shape their food choices, as identified in the review by Cowburn and Stockley (2005); "evaluating nutrient content of products in the context of the daily diet" (Cowburn and Stockley, 2005; Levy et al., 2000).

The importance of consumer understanding of "Reference Intakes" information can be illustrated by the two main assumptions on which effective nutrition information is based. Described in the context of fast food calorie labelling (Elbel, 2011), the first is that consumers will know how much (i.e. energy) they "should" consume per day" and the second is that these consumers cannot themselves "estimate" the nutritional content of the product which is therefore provided on the label. Earlier research with US consumers appears to have also recognised the need for this label information and has focussed on consumer understanding of the meaning of the "Daily Values" terminology and "percent Daily Values" (%DV) information presented on US Nutrition Facts Panels, which is analogous to UK "Reference Intakes" (Levy et al., 1996, 2000; Levy and Fein, 1998). Specifically, consumers' ability to perform product comparisons, "calculate the dietary implications of products" and assess the product's "contribution to daily values" have been assessed using questionnaire item "tasks" (Levy and Fein, 1998). The evaluation of "understanding" of nutrition labels performed in the present PhD project will therefore include questions on the meaning of the current UK "Reference Intakes" terminology and association values ("%RI).

Table 4 **Summary of items used to measure objective understanding of nutrition labels across 16 studies**

Reference	Age of participants	Description of items used to measure objective understanding of nutrition labels (number of question items in brackets)	Administration, item types (MCQ= multiple-choice questions)	Number of participants	Label type (NFP = Nutrition Facts Panel)
Levy and Fein (1998) and in Levy et al (1996)	18-55yrs+	Comparing 2 products to find difference in nutrient levels, judgement of claims, assessment of dietary implications of adding a product to the diet, estimate contribution to daily intakes. (4 items)	Interviewer-administered	384800	US NFP
Levy et al (2000)	Mean age 43.9yrs (SD 12.5)	Define %DV, usefulness of %DV to assess nutrient content, how %DV would be used, classification of fat levels as high/medium/low based on %DV. (5 items)	Survey questionnaire (MCQ)	104	US NFP
Bryd-Bredbenner et al (2000) (2 studies)	Mean age 27.5yrs (SD 20.9). 65 -85yrs	Ability to locate (how many calories in a serving), manipulate (various serving amounts), judge claims (15 items)	Face to face interviews (not explicated reported).	100	US NFP
Macon et al., (2004)	51 - 81yrs	Interpretation of levels of nutrients (20g of fat) in a serving (high or low) (2 item)	In-person interviewer administered larger survey instrument (US continuing Survey of food Intakes)	2846	US NFP
Pellitier et al (2004)	18-65yrs	How many calories on the pack and where is this information from (locate)? Identification of fat content. Knowledge of how many calories should be consumed per day and what portion of your daily calorie allocation is this product? (6 items)	Interviewer-administered. (Participants visually pointed to location of information)	90	US NFP
Rothman et al (2006)	Mean age 43.0 yrs. (SD 14.6)	Items based on questions from "education materials". Ability to identify calorie or carbohydrate content of foods and to compare products. (24 items)	Questionnaire (MCQ). Health literacy and numeracy separately assessed, common errors recorded	200	US NFP
Malam et al (2009) described in FSA, 2008	18 – 65yrs+	Evaluation of single product and two-product comparisons. Nutrient levels and overall healthiness of products. Respondents used a 7-point scale to rate healthiness. Replay and computing tasks discounted. (4 items)	Interviewer-administered. Basic literacy and numeracy also assessed.	2932	Several UK front-of-pack formats

Mackinson et al., (2010)	Ages not specified	Location of nutrient content (sugar, fat) per 100g or per serving and per multiple serving. Comparison of nutrient (salt, saturated fat) content in two products. (10 items)	Multiple choice paper-based questionnaire. Self administered.	97	pre-2013 UK back-of-pack
Grunert et al (2010)	18 – 65yrs+	Conceptual understanding of meaning of GDAs and interpretation of the 70g value for fat. Substantive understanding of consumption of a serving leading to amounts of sugar over/under GDA. (4 items)	Take-home questionnaire (paper-based) (MCQ)	2019	Two formats of UK front-of-pack labels
Sharf et al (2011)	Mean age 21.4 yrs (SD 3.5)	Calculate calories in multiple servings. Sugar present? (4 items)	Interviewer-administered	120	US NFP
Van der Merwe (2012)	18- 55yrs+	Location of calorie or nutrient content “per 100g”, assessment of nutrition content claims and food label elements (10 items)	Interviewer administered.	229	South African (back-of-pack)
Sinclair et al (2013)	18 -64yrs+	Calorie content and %DV, serving sizes (2 items originated from the Newest Vital Sign assessment of health literacy)	Paper based survey.	639	Canadian NFP
Sharif et al (2014)	18-50yrs+	Calculate calorie content for multiple serving and grams of nutrients or %DV if varying amounts eaten, ingredients (6 items, Newest Vital Sign instrument)	Verbally administer by interviewers	269	US NFP
Ducrot et al (2015)	18 – 65yrs+	Rank 3 products according to nutrition quality i.e. lowest, intermediate or highest quality. (1 item)	Web-based survey.	14230	Four EU front-of-pack formats

2.2.5 Evaluating perceived understanding of nutrition labels

In addition to evaluating objective understanding, both Grunert et al (2010b) and Mackison et al (2010) have measured self-rated (subjective) understanding of nutrition labels. This reflects the possible role of subjective understanding in influencing consumer use of nutrition labels in the conceptual framework (Grunert and Wills, 2007). Previous evaluations of this characteristic have included consumers perceptions of which label formats are “easiest to use” (Grunert and Wills, 2007; Malam et al., 2009; Méjean et al., 2013a). In their questionnaire, Mackison et al (2010) used a 6-point understanding scale to measure how “easy” nutrition labels are “to understand”. These response options ranged from “Very easy to understand” to “Very difficult to understand”. It was therefore considered that this item evaluated the perceived *understandability* of nutrition labels among respondents. In contrast, Grunert et al (2010b) reported using a 10-point scale to evaluate participants’ *own* self-rated (subjective) understanding (i.e. 1= “I do not understand at all”, 10 = “I understand completely”). Similarly, other studies have also evaluated self-rated understanding (Gregori et al., 2014; Prieto-Castillo et al., 2015). These include a Spanish questionnaire which asked (sic) “*Do you understand nutrition labelling meaning*?” with the response options as: completely, partially, nothing, or no opinion (Prieto-Castillo et al., 2015). Two items, each reflecting either the understandability or self-rated understanding of nutrition labels were therefore selected for use in the pilot data collection tools.

2.2.6 Evaluation of food label understanding within health literacy instruments

Understanding of nutrition labels is a feature of some instruments which assess the adequacy of an individual’s health literacy. Health literacy can be defined as the ability to locate and use information concerning health (Carbone and Zoellner, 2012) and can be assessed using questions relating to the location and use of nutrition label information. The US Newest Vital Sign is one such instrument, which involves a researcher-administrated nutrition label “quiz” featuring a Nutrition Facts Panel which is used to provide answers to six open text box questions (Weiss et al., 2005). A UK version of the Newest Vital Sign instrument was recently published in the UK (Rowlands et al., 2013). These instruments were considered for use in the current study but were excluded following inspection of their question types which did not address the present research objectives (i.e. to assess understanding of the nutrition label). For example, these instrument's questions were found to be related to other aspects of the displayed food label (i.e. ingredients, allergens). Furthermore, questions required participants to conduct calculations with nutrient values in terms of the amounts provided by multiple servings and therefore use their numeracy skills rather than basic understanding of label data and terminology. These instruments also featured "open" text-box questions which are designed to be completed in the presence of a researcher and are therefore not compatible with online self-administered questionnaires which necessitate multiple choice questionnaires to avoid incomplete datasets (see Table 4). Finally, these instruments were designed to measure the distinct construct of health literacy and did not, therefore, include evaluation of consumers' conceptual understanding of the meaning of nutrition label terminology.

2.2.7 Measures used to evaluate understanding of the current UK nutrition labels in the present study

Question items selected for use in the current study were therefore based on those reported in the literature and required adaptation to reflect label types currently in use in the UK (i.e. those compliant with EU Regulation 1169/2011). For example, items concerning the conceptual meaning of "Reference Intakes (RI)" and corresponding label values were included by adapting those question items previously reported for other label types, including those displaying GDAs (Grunert et al., 2010b; Levy et al., 2000). In addition, questions items requiring respondents to simply locate basic label data and compare products were also considered relevant for inclusion given that these tasks are in-line with the basic tasks that consumers are expected to commonly perform with this information (FSA, 2008) (Table 5). These items were based on those appearing within the validated questionnaire by Mackison et al (2010) which featured ten multiple-choice question (MCQ) items evaluating consumer understanding of (previous) UK back-of-pack nutrition labels (Mackison et al., 2010). Specific question types selected for adaptation here included the identification of the product's serving size, amounts of specific nutrients present "per serving" or product comparisons.

Items requiring computing or manipulating of label values were minimised in favour of those requiring respondents to simply “locate” (replay), “evaluate” or “compare” nutrition label information, as defined in Table 5. This was because consumers’ use of nutrition labels to perform “calculations” was considered to be minimally in earlier research (Higginson et al., 2002; Malam et al., 2009, FSA, 2008). For example, assumptions made within the scientific rationale of the comprehension assessment undertaken as part of the Foods Standards Agency’s (FSA) previous front-of-pack nutrition signposting research also recognised that such calculations are unlikely to be performed by consumers when using nutrition labels (Cowburn and Stockley, 2005; FSA, 2008; Malam et al., 2009). Furthermore, consumers’ numeracy skills would then also be required to calculate (compute) nutrition label data, therefore requiring separate assessment of adequacy (Miller, 2014, Rothman et al., 2006). For these reasons, it was decided that the selection of items used to assess label understanding in the present study would not rely on participant numeracy levels and therefore not include emphasis on questions necessitating calculation or label data “manipulations”.

The three specific tasks (locate, evaluate, compare) which were chosen to assess consumer understanding of nutrition labels via a “quiz” were also those which have formed the basis of evaluation of consumer comprehension of various front-of-pack nutrition labels, by the UK Food Standards Agency (Table 5) (Malam et al., 2009; FSA, 2008). In summary, the validated questionnaire by Mackison et al (2010) was used as a guide on which to adapt multiple-choice quiz questions for use in this study, with the addition of further question items which aimed to evaluate conceptual understanding of “Reference Intakes (RI) terminology” and corresponding label data, as used by Grunert et al (2010b).

Table 5 Possible uses of nutrition labels (front-of-pack) during product evaluations (FSA, 2008)

	Single nutrient evaluation	**Overall product evaluation**
Replay (locate)	e.g. how many grams of fat in this product?	N/A
Compute	e.g. how many portions could I eat in a day and not have too much fat?	
Evaluate	e.g. how high is this product in fat?	e.g. how healthy is this product?
Compare products	e.g. which product is higher in fat?	e.g. which product is healthier?

2.3 Design of the pilot data collection tools

2.3.1 Pilot data collection tools

The data collection tools were piloted online within a separate study with undergraduate students which is reported in Chapter 3. These tools were presented to study participants as online questionnaires which were hosted on the Virtual Learning Environment (VLE). These pilot tools aimed to evaluate self-rated understanding and label understandability, as well as use of nutrition labels and potentially associated personal characteristics at pre and post-course time points. In addition, a quiz was developed to evaluate objective understanding of the current UK nutrition labels. The specific items within the pilot questionnaire and quiz data collection tools will be described next.

2.3.2 Pilot study pre and post-course questionnaires

Data collection questionnaires were used in the VLE study to assess nutrition label use and potentially related personal characteristics. Pre and post-course questionnaires are shown in Appendix A (pre-course) and B (post-course). Items included self-reported frequencies with which participants read and used nutrition labels, as taken from Mackison et al (2010). These were: (pre-course Q10) *In the last 6 months how often have you READ nutrition information on food labels*? (Q13) *In the last six months, how often have you USED nutrition information on foods* when buying food? In addition, at a later questionnaire location, (Q21) *How often does the nutrition information affect your purchases choices".* For each a five-point frequency sale was used (i.e. 1 = never, 5 = always). In addition, the frequency of use of 11 components of nutrition labels (i.e. kcals, fat, salt) were also included (Q16) using items taken from a Canadian questionnaire (Goodman et al., 2011). Frequencies of using nutrition labels for seven specific reasons (i.e. to determine the calorie content of the food) were also evaluated at pre and post-course (Q14) with items from the US Diet and Health Knowledge Survey (Guthrie et al., 1995). When assessed at post-course, the prefix "*Following the course, …"* was added to all items described above.

In Q12, participants were asked how important nutrition information was using a 5 point scale (i.e. don't know, not important, neither important nor unimportant, important, very important) (Mackison et al., 2010). How easy nutrition labels are to understand (i.e. perceived understandability) (Q18) was assessed with a 5-point scale taken from Mackison et al (2010) (i.e. 1= very easy to understand, 5= very difficult to understand). In addition, participants' self-rated understanding of 11 nutrition label components (i.e. Fat, Reference Intakes) were also evaluated (Q20) by using a 7-point scale adapted from Mackison (2010) (i.e. 1 = do not understand, 7 = understand completely). In addition, Q19 assessed self-confidence in own understanding (i.e. self-rated understanding) of nutrition label information using a five-point scale adapted from previous research (i.e. 1= very unconfident, 5 = very confident) (Grunert et al., 2010b; Mackison et al., 2010). When assessed at post-course, the prefix "*Following the course, …*" was added to all items described above.

The pilot pre-course questionnaire also included some items which aimed to evaluate specific personal characteristics which were identified as potentially related to use and understanding of nutrition labels within the earlier literature review (Chapter 1). These included personal motivations or interest in nutrition and levels of nutrition knowledge. Therefore, pre-course questionnaires items Q5, Q6 collected data on whether participants or members of their household have a medical condition that needed to be taken into consideration when shopping, or if they had ever received advice from a dietitian. A further two items in the questionnaire asked about self-rated interest in nutrition (Q8) and self-rated knowledge in nutrition (Q9) as adapted from existing questionnaires concerning use of nutrition labels (Ducrot et al., 2015; Jacobs et al., 2011; Méjean et al., 2013a).

The pilot pre-course questionnaire (Q1-Q4) also contained items on age, gender type of accommodation and if participants had responsibility for buying food themselves. Information on educational attainment and income was not included since this pilot study was restricted to recruiting undergraduates as participants (Chapter 3).

2.3.3 Pilot study: post-course quiz

The post-course quiz is shown in Appendix C. As described in Chapter 3, the quiz was created to help assess learning following participant's viewing of nutrition label learning materials concerning current UK nutrition labels. These learning materials were based on a current NHS webpage describing the content and meaning of information on UK nutrition labels (NHS, 2014). These course learning objectives concerned information on nutrition labels and how to use it and therefore broadly informed the post-course quiz “assessment” of participants’ learning (i.e. the evaluation of participants’ objective understanding of nutrition label information) (Chapter 3). Quiz items were adapted from selected items used in previous research to evaluate consumers objective understanding of nutrition labels, images of which were provided besides the questions. Items evaluated consumers’ conceptual understanding of terminology and basic label data, as reviewed above. Overall, the pilot data collection tool included a total of 11 MCQ items which were adapted from previous literature to assess conceptual understanding of “Reference Intake” terminology (Q3) and the RI value for fat (Q8) (Grunert et al., 2010b; Levy et al., 2000; Mackison et al., 2010). Items also assessed participants’ substantive understanding including identification of (replay) basic nutrient content values (Q1, Q5, Q9), serving size information (Q2), interpreting front-of-pack nutrient levels (Q6) and locating the percentage of reference intakes (%RI%) provided by a serving (Q7), as adapted from previous research (Grunert et al., 2010b; Mackison et al., 2010). Two questions asked participants to compare products on the basis of percentage fat (Q4) and using front-of-pack nutrition labels (Q10) (Grunert et al., 2010b). The last question (Q11) asked participants to calculate the percentage of the “Reference Intake” for salt which would be provided by multiple (two) servings (Levy and Fein, 1998).

Product packaging artwork displaying nutrition labels which were used in the quiz (and were compliant with current UK legislation), were kindly provided in high resolution artwork by Morrisons Supermarket PLC. Each quiz question was mandatory such that the quiz could not be submitted until all questions were answered. Each question item provided between three and five multiple choice answer options, which were ordered at random by the VLE platform “questionnaire creator” function. For the pilot post-course quiz, an overall quiz score for each participant was calculated as the number of correct answers out of 11.

2.3.4 Study design, data collection procedure and statistical analysis of the pilot study

Piloting of the data collection tools was conducted as part of a study with undergraduates which concerned the presentation format of the VLE (Chapter 3). Study design, participants, data collection and statistical analysis are described in Chapter 3.

2.3.5 Refinements to data collection tools following the pilot study

As part of the VLE study, feedback from three participants was obtained together with analysis of data collected using the pilot tools (Chapter 3). Evaluation of these aspects are described in detail in Chapter 3, including how these informed the development of the planned online survey of older adults. Briefly, specific changes to the survey questionnaire delivery and items included those listed below:

1. Questionnaire and question item completion needs to be mandatory, in order to avoid non-submission and incomplete data sets.
2. To avoid overly burdensome lists, remove item sections requiring participants to indicate frequency of use, or self-rated understanding of, the eleven specific nutrition label components.
3. Retain item on respondents' own self-rated (subjective) understanding of nutrition labels. Participants' feedback indicated they presumed the item on label *understandability* also referred to their own understanding. Responses to the two items did not appear different, so the latter item was dropped. Use numbers rather than words within this scale.
4. Questions concerning frequencies of reading, use and the influence of nutrition labels on purchase choices should be grouped together (i.e. within the same question number) to provide further distinction between different types of use
5. The item evaluating self-rated "nutrition knowledge" requires a specific definition or further elaboration (i.e. what sort of nutrition knowledge?)
6. Quiz questions should record the specific MCQ answer option selected by participants (i.e. not just when the designated "correct" option is selected).

Nutrition labels should be displayed larger. More MCQ answer options (at least 5) required to avoid participant “guessing”.

7. Nutrition labels which present unambiguous descriptors on “per serving” are required. This would avoid misinterpretation of this information despite participants correctly locating it.

2.4 Online survey of older adults

2.4.1 Online survey objectives and rationale

To address the PhD research objective 2, evaluation of use and understanding of current UK nutrition labels was required among older adults. Also required, as part of research objective 3, was the evaluation of the frequency of use of online nutrition information in older adult online grocery shoppers. An online survey approach was therefore selected pragmatically, reflecting resource limitations and the need to attract a large number of older adults, including online shoppers. Disseminating a link to a public-facing online survey was considered as the most practical means to facilitate both wider dissemination and a good response rate, as with some previous surveys concerning nutrition labelling (Ducrot et al., 2015; Méjean et al., 2013a). Acknowledging that not all individuals have access to the internet, the survey was also intended to be distributed within Third Sector Organisations in Yorkshire. These included settings where older adult education sessions with computer access were hosted (i.e. Beeston Community Centre Hub, Leeds, UK). Whilst the data collection tools had previously been piloted with younger adults (undergraduates) (Chapter 3) in the VLE, the development of the online survey revised and combined these three tools and also incorporated feedback from older adults, as described in the following sections.

2.4.2 Sample population

As defined and justified in chapter 1, section 1.5.2 an inclusion criterion for this survey of older adults aged 50 years or older was selected. This age cut off also reflected the literature in this area which has reported that age groups of around 50yrs or older as likely to have greater difficulties than younger adults at understanding nutrition labels (Block and Peracchio, 2006; Byrd-Bredbenner and

Kiefer, 2001; Levy and Fein, 1998; Miller and Cassady, 2012; Sinclair et al., 2013; van der Merwe et al., 2013). The decision to include an age-related eligibility threshold for survey participants also reflected the need to specifically capture this population of interest. Indeed, to date, assessment of older adults' use and understanding of nutrition labels has been evidenced as comparative with other age groups, using data from cross-sectional studies (Grunert et al., 2010b; Ollberding et al., 2010; Sinclair et al., 2013; Su et al., 2015). The focus on older adults was therefore considered plausible given that the later research objectives of this PhD focussed on the likely educational needs in this population. The decision to restrict survey respondents to those aged 50 years or older, rather than 18yrs+, was also pragmatic. Advertising the survey as suitable for those adults "50 years +" was considered to help enable "snowball" convenience sampling among this population, whereby respondents were asked to forward the link to known older adults.

In addition, there was a need for the survey to also capture older online shoppers. The age inclusion criteria therefore also reflected that adults aged 55-64 years are the age group of online shoppers who are fastest increasing in the UK (Office for National Statistics, 2017). It should be noted the survey was not limited to online shoppers; a question item relating to whether respondents undertook online grocery shopping was included in the survey.

2.4.3 The online survey questionnaire

The online survey questionnaire, including both parts A and B, is shown in Appendix D. The online survey platform formerly known as "Bristol Online Surveys" (now JISC) was selected to design and disseminate the online survey and manage data collection.

2.4.3.1 Part A: Use of nutrition labels and personal characteristics

Like the pilot questionnaires, the online survey also used three items to evaluate how often respondents read or used nutrition labels and how often these influenced purchases. These items were adapted based on the questionnaire by Mackison et al (2010) and, based on feedback from the pilot study, were grouped together (Q3) and worded as follows: *How often do you read nutrition labels when buying a food for the first time?; In general, how often do you read nutrition* *labels?; How often do nutrition labels affect your purchase choices?* For these, respondents used a five-point scale (i.e. never, rarely, sometimes, often, always) to indicate their frequency of use (see Figure 8). Reasons for using nutrition labels were also provided for respondents to indicate how often they used nutrition labels for each of these seven reasons (Q4) (i.e. "*To check if a food contains high or low levels of a nutrient you might want less of i.e. sugar, salt*") (Goodman et al., 2011; Guthrie et al., 1995). An additional list of reasons for not using nutrition labels was provided for respondents to indicate which ever applied (i.e. "*It takes too long to read"*) (Q5) (Guthrie et al., 1995; Jacobs et al., 2011; O'Reilly et al., 1997). As a result of the pilot study, items relating to frequency of use of specific components of the nutrition label (i.e. "Fat", "Fibre") were not included in the online survey to prevent respondent fatigue and shorten the length of the survey.

	Always	Often	Sometimes	Rarely	Never
How often do you READ nutrition information on food labels when buying a food product for the FIRST time?					
In general, how often do you READ nutrition information on food labels?					
How often does the nutrition information affect your PURCHASE choices?					

Figure 8 Online survey question items evaluating use of nutrition labels on product packaging

Based on the pilot questionnaire feedback (Chapter 3), evaluation of the understandability of nutrition labels was removed due to its ambiguity with self-rated confidence in respondents' own understanding. The item on self-rated confidence in own understanding of nutrition label information was retained for use in the online survey of older adults. This item (Q6) was adapted from previous research by using a seven-point scale (1= Not at all confident, 7 = I'm very confident) (Grunert et al., 2010b). In contrast to the descriptive 5-point scale used in the pilot tools, a 7-point numerical scale was used here reflecting that prior research had evaluated this outcome using a ten-point numerical scale (Grunert et al., 2010b).

2.4.3.2 Personal motivations

Respondents were asked to indicate yes or no, if they, or a member of their household had a personal diet or medical conditions, where looking at food labels was advised" (Q2) (Grunert et al., 2010b). This question was also selected using insight from those two items used in the earlier pilot study, as it was considered most able to reflect practical dietary restrictions and was similar to those used in other survey and studies (Centre for Disease Control and Prevention, 2009; Miller and Cassady, 2012).

The prior literature review has suggested a role for "personal involvement" in use of nutrition label information in younger adults (Celsi and Olson, 1988; Chandon and Wansink, 2007; Moorman, 1990) but no research into this characteristic was found among older adults (Chapter 1). Personal involvement with nutrition labels reflects an individual's enduring personal motivation to use nutrition labels and the personal importance of this information (Celsi and Olson, 1988; Moorman, 1990). Evaluation of this characteristic was undertaken in the online survey of older adults (Q7) using a ten-item inventory which evaluated personal involvement based on earlier work evaluating consumer involvement with product marketing (McQuarrie and Munson, 1987; Zaichkowsky, 2013) and previously adapted for use in research evaluating personal involvement with Nutrition Facts Panels (Walters and Long, 2012; Xie et al., 2015). Inventory items all concerned respondents' own perceptions of "nutrition labels" in terms of the following: interest, need for, relevance, value, meaning, appeal, importance of, fascination and involvement with and excitement about this information. Assessment of each was measured using a seven-point scale (i.e. 1 = unimportant, 7 = important). Respondents' levels of personal involvement with nutrition labels was calculated as a score (i.e. between 10 and 70) by summing scale responses for each inventory item. Previous research has reported good internal reliability of the scale (Cronbach's alpha = 0.85) (Chandon and Wansink, 2007). As a result of the inclusion of this inventory, the single items rating participants' "interest in nutrition" and the "importance of nutrition labels" which were used in the pilot study, were not included in the online survey.

2.4.3.3 Socio-demographics and other characteristics

Part A of the online survey also collected socio demographic information including respondents' age, level of educational attainment, current or pre-retirement occupation and ethnicity. In addition, whether respondent had responsibility for buying food was included at the start (Q1), as included in the earlier pilot study. Questions designed to obtain this information were taken from items used in the International Survey of Adults Skills (England) (Department of Business, Innovation and Skills, 2013) (Q14-Q18). Education and occupation (e.g. pre-retirement) were collected as opposed to yearly income as these have previously been found to be a comparable indicator of socioeconomic among older adults, without the issues associated with quantifying income from different sources (i.e. pensions, work etc.) (Grundy and Holt, 2001). Whilst it was not the aim of this research to relate label use with diet or health, self-rated dietary healthiness (Q19) and current health (Q20) were included based on items used within the 2009 NHANES survey (Centre for Disease Control and Prevention, 2009) and the Food and You survey (Food Standards agency, 2017). These used a five-point scale (i.e. poor, fair, neither healthy nor unhealthy, good, excellent). These were used to obtain a more complete picture of survey respondents' perceptions in these areas, as opposed to several questions assessing actual health status/conditions, including weight and height.

2.4.3.4 Nutrition knowledge assessment

The item evaluating self-rated nutrition knowledge within the pilot study questionnaires was replaced with an objective measure of this characteristic in the online survey. Despite the use of "self-reported" nutrition knowledge in the prior literature (Ducrot et al., 2015; Méjean et al., 2013a) the pilot study participants' feedback suggested this item was not well defined and might have therefore referred to their pre-existing nutrition label knowledge or understanding. In addition, the review by Miller and Cassady (2015) expressed concern about reliability of evaluating both self-reported nutrition knowledge together with self-reported label use. For these reasons, an objectively-evaluated measure of general nutrition knowledge (i.e. concerning healthy eating and nutrition) was therefore selected for use in the online survey.

To evaluate respondent's nutrition knowledge, priority was given to the selection of a short, minimally time-consuming questionnaire measure. In contrast, longer questionnaires evaluating nutrition label knowledge were known to involve several pages of questions and were unlikely to be completed by online survey participants (Grunert et al., 2010b; Parmenter and Wardle, 1999). A short scale evaluating procedural knowledge of how to eat a healthy diet was selected following its validation by Dickson-Spillmann et al (2011). These researchers had also reported an acceptable internal reliability of this questionnaire (Chronbach's alpha = 0.70) as well as an association between with scale score and dietary quality (Dickson-Spillmann and Siegrist, 2011). The scale included 13 true or false answer statements concerning what foods are recommended as part of a healthy diet. These included, for example; "*A balanced diet implies eating all foods in the same amounts*". Respondents' nutrition knowledge scores were calculated as the number of correct responses, with a possible maximum of 13. This nutrition knowledge scale was situated at the end of survey's Part B (i.e. the end of the questionnaire) to avoid influencing prior questions on diet and health and nutrition label use.

2.4.3.5 Use of technology, online shopping and online nutrition information

Part A of the online survey also included items (Q8-Q11) evaluating self-rated ability to use the internet and confidence in using technology which were evaluated using five-point (i.e. 1 = Poor, 5 = Excellent) and 7-point (1= Not confident at all, 7= Extremely confident) scales, respectively (Parasuraman, 2000). In addition, frequency of shopping online for food was evaluated with one item (Q12). For this, frequency options included: Never, Never but I intend to in the next 12 months, A few times a year, Monthly, Weekly. If respondents had selected a frequency with which they shopped online for food, they were then directed to two questions (Q13.i, ii) which evaluated frequency of use of online product nutrition information in this environment. Since no evaluation of self-reported use of nutrition information has been reported in the research literature, these items were worded by the researcher based on the earlier items evaluating use of nutrition labels (Mackison et al., 2010). These were (Q13.i) "*How often do you read product nutrition information when shopping online for food?*" and

(Q13.ii) "*When shopping online for food how often does nutrition information influence your purchase choices?".* As with the earlier items relating to nutrition labels (on-pack), these items also used a 5-point scale for respondents to indicate their frequency of label use (i.e. never, rarely, sometimes, often, always).

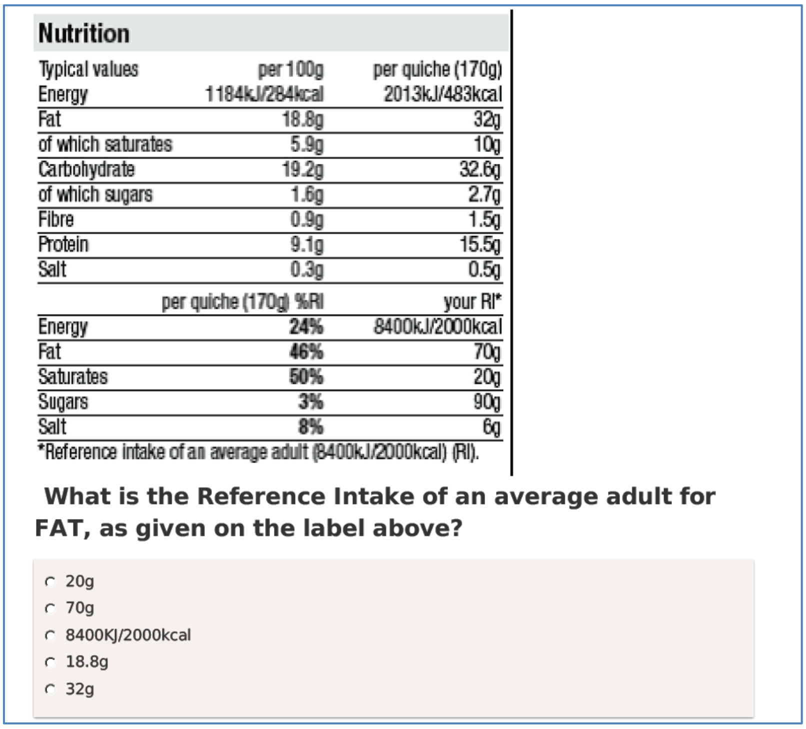
2.4.3.6 Part B: Objective understanding of nutrition labels

Part B of the questionnaire evaluated objective understanding of current UK back and front-of-pack nutrition labels (Appendix D). This used ten multiple-choice "quiz" questions relating to back (6 questions) and front-of-pack (4 questions) nutrition labels, based on those piloted previously in the VLE quiz (see earlier section 2.3.3). As described in this section, these questions were adapted from previous studies assessing conceptual and substantive understanding of the terminology and label data on various front or back-of-pack nutrition labels (Grunert et al., 2010b; Levy et al., 2000; Mackison et al., 2010). Some of the questions items which were included in the pilot quiz used in the VLE study were revised based on participant feedback and data analysis (Chapter 3). These revisions included increasing the number of multiple-choice answer options from three to five and replacing some images with new images of nutrition labels to prevent ambiguity (i.e. unambiguous serving size descriptors). In addition, due to the possible question burden by pilot study participants, the quiz was also shortened from 11 to 10 items by removing the question which required respondents to calculate nutrient content for multiple servings. This pilot question was poorly answered by undergraduate participants and was considered likely to reflect respondents' numeracy levels, rather than their understanding of the meaning of the information provided on the current UK nutrition labels.

Part B quiz questions are summarised in Table 6. An example of an on-screen survey question is also provided (Figure 9). Corresponding to the findings of the VLE study (Chapter 3), the web-based survey software (Bristol Online Surveys Ltd, Bristol, UK) allowed each respondent's selected multiple-choice answer option (i.e. not just the correct answer) to be recorded. Quiz scores reflecting objectively evaluated understanding of nutrition labels were calculated for each respondent as the number of correct responses out of possible maximum of ten.

Table 6 Summary of quiz questions in Part B of the online survey data collection instrument

Quiz question	Label type shown	Summary of quiz questions	Ability tested
1	Back	Amount of salt in one serving	Locate
2	None	Definition of “Reference Intakes” terminology	Define
3	Back	Locating value for “reference intake amount of fat”	Locate
4	Back	Meaning of “Reference intake amount for fat “How much should you aim to eat each day?”	Define
5	Back	Amount of sugar in a serving	Locate
6	Back	Percentage contribution to reference intake for saturates of a serving	Locate
7	Front of pack Traffic Lights	Identify nutrients at low levels	Interpret
8	Front of pack Traffic Lights	Locate % of reference intake for sugar provided in a pack (serving)	Locate
9	Front of pack Monochrome	Locate calorie content	Locate
10	Front of pack Traffic Lights	Comparing salt content of two products	Compare (using numeric information)


Nutrition

Typical values	per 100g	per quiche (170g)
Energy	1184kJ/284kcal	2013kJ/483kcal
Fat	18.8g	32g
of which saturates	5.9g	10g
Carbohydrate	19.2g	32.6g
of which sugars	1.6g	2.7g
Fibre	0.9g	1.5g
Protein	9.1g	15.5g
Salt	0.3g	0.5g

	per quiche (170g) %RI	your RI*
Energy	24%	8400kJ/2000kcal
Fat	46%	70g
Saturates	50%	20g
Sugars	3%	90g
Salt	8%	6g

*Reference intake of an average adult (8400kJ/2000kcal) (RI).

What is the Reference Intake of an average adult for FAT, as given on the label above?

- 20g
- 70g
- 8400KJ/2000kcal
- 18.8g
- 32g

Figure 9 An example quiz question in Part B of the online survey

2.4.4 Content and face validity of the online survey questionnaire

As indicated above, the data collection tool used in the online survey was developed using both the existing literature as well as the feedback and analysis of data from the pilot study (Chapter 3). Most of the items included in the online survey had therefore already been validated or assessed for their reliability in other studies, including those items from the questionnaire by Mackinson et al., (2010) where content and face validity had been assessed (Mackinson et al., 2010). For example, to assess content validity of their questionnaire, Mackinson et al (2002) consulted and obtained feedback from, “nutrition experts”, including dietitians, on questionnaire appropriateness and importance. Although the overall validity and reliability of the entire questionnaire was not ascertained for either of the primary outcomes of interest here (i.e. nutrition label use or understanding), the overall internal reliability of the instrument developed by Mackison et al (2010), from which several quiz items were taken, was considered good (Chronbach’s alpha from 0.72 to 0.91). Confidence in the content validity of the developed overall online survey can therefore be demonstrated (see Table 7).

However, the pilot study had been undertaken by younger adults (undergraduate students) and therefore content validity of the online survey questionnaire for older adults was recommended to be considered. In line with guidance on questionnaire design, a link to the draft online survey questionnaire was first shared with research supervisors, (older-adult focussed) dietitians and labelling experts to seek their feedback on the content validity of the online survey (Rattray and Jones, 2007). Feedback from these experts and the research team concerning content validity led to a definition of nutrition labels being included at the start of the questionnaire. This definition included a visual illustration of what was meant by nutrition labels (i.e. example images of back and front-of-pack nutrition labels) to distinguish this from other food label information (i.e. allergens, claims and ingredient listing) (see Appendix D). The inclusion of this definition of nutrition labels reflected a similar introduction provided to participants by interviewers before the start of the NHANEs survey administration, showcasing an image of a US Nutrition Facts Panel (Centre for Disease Control and Prevention, 2009).

Face validity has been described as "*conferred by a lay persons' acceptance that a procedure, statement or instrument appears to be sound and relevant*" (Lynn, 1986, p. 383). To consider the face validity of the developed questionnaire in terms of acceptability and readability, the draft online survey was also completed, individually, by five older adults (aged 50 years or older) whilst accompanied by the researcher. These volunteers were non-academic University staff, some of which were known to the researcher. Their verbal feedback was collected by the researcher during their completion of the questionnaire was used to make further refinements to quiz item wording (grammar) and image clarity of the "quiz" within Part B of the survey. For example, image and text size were made larger and the placement of the label and question test on the web-page amended using the Bristol Online Survey features. No other changes to the quiz were deemed necessary.

Table 7 Summary of the sources and validity of items used in the online survey of older adults

Outcome Variable	Items	Source and description	Location and number of items	Type of data
Use of nutrition labels (on packaging)	*How often do you read nutrition labels when buying a food for the first time?* *In general, how often do you read nutrition labels?* *How often do nutrition labels affect your purchase choices?*	Each question used a five-point frequency scale (always, often, sometimes, rarely, always). Questions adapted from the questionnaire Mackison et al (2010) which reported a good overall internal reliability (Chronbach's alpha from 0.72 to 0.91)	Part A. 3 items.	Ordinal
Self-rated understanding of nutrition labels	*How confident are you in your understanding of nutrition label information?*	Self-reported confidence in own understanding of nutrition labels adapted from taken from Grunert et al (2010b). A 7-point scale was used where 1 indicated "Not at all confident" and 7 = Extremely confident.	Part A 1 item	Continuous
Reasons for use and non-use	*When you do not use nutrition labels, why is this? Please select the reason(s) for this from the list below. Select all that apply to you.* *i.e. I usually buy the same product so I am familiar with the nutrition information, It takes too long to read, It is hard to see to read, The information is not always presented in the same way from one product to another, I really don't know what to do with the information, It is hard to understand, I prefer getting nutrition information from other sources besides labels, I am just not interested, It is not always on the product I need.*	Specific reasons for non-use of nutrition labels as based on items from a previous US NHANES survey (Gutherie et al, 1995). Multiple reasons were permitted to be selected by respondents.	Part A. 2 items	Categorical (non-use reasons). Ordinal (frequency of use for specific reasons)
Frequency of use of nutrition labels for specific reasons	Seven reasons for use were provided. These included: *To figure out how much food you should eat, To compare similar type of food with each other (e.g. choosing between ready meals), etc.*	Specific reasons for use and non-use of nutrition labels as based on items from a previous US national survey (Gutherie et al, 1995). Each question used a five-point frequency scale (always, often, sometimes, rarely, always).		
Technology use	*Do you have internet at home?* *How often do you access the internet?* *Using the scale, please indicate how confident you feel in general about using technology? (1= not confident at all, 7 = Extremely confident)* *How would you rate your ability to use the internet? (Excellent, Very good, Good, Fair, Poor)*	Four individual items assessing respondents self- rated ability to use the internet and confidence in their use of technology were taken from the Technology Readiness Scale of 10 items which was designed to assess propensity to adopt and embrace technology for accomplishing goals in home or work (Parasuraman, 2000). The scale was previously evaluated to have a good internal validity (Cronbach's alpha = 0.74 to 0.81). Items were selected to reduce length of the questionnaire.	Part A. 4 items	Ordinal (5-point Likert scale) and continuous (7 point scale)

Use of online nutrition information	*In general, how frequently do you READ nutrition information when shopping for food online?* *How often does the nutrition information affect your PURCHASE choices when you are shopping for food ONLINE?*	Self-reported frequency of reading of nutrition information and influence during online purchases. As adapted from Mackinson et al (2010). Each question used a five-point frequency scale (always, often, sometimes, rarely, always)	Part A. 2 items	Ordinal
Personal involvement with nutrition labels	*To me, nutrition information on food labels is: Important/Unimportant, Interesting/Uninteresting, Relevant/Irrelevant, Exciting/Unexciting, Means a lot to me/Means nothing to me, Appealing/Unappealing, Fascinating/Mundane, Valuable/worthless, Involving/Uninvolving, Needed/Not needed.*	Personal involvement with nutrition labels was evaluated using a ten-item scale adapted from previous studies to measure personal and enduring motivation to engage with nutrition label information (Celsi and Olson, 1988; Xie et al., 2015) which reported good internal reliability (Cronbach's alpha = 0.85) (Chandon and Wansink, 2007). The inventory evaluates ten characteristics relating to personal involvement, each with a 7-point scale i.e. level of interest, personal importance and relevance of nutrition labels. Each inventory items measured using 7-point scale (i.e. 1= not important, 7 = important). Scale total is the sum of responses to individual response score with possible minimum of 7 and maximum of 70	Part A. 10 items	Continuous
Nutrition knowledge	*Please read the following statements. Using your knowledge of nutrition, select either "true" or "false". Examples of the 13 statement include:* *Fruit can be fully replaced by vitamin and mineral supplements, If crisps did not contain salt you could eat more of them without any problem, Meat should be the basis of our daily diet*	Procedural knowledge of how to eat a healthy diet was assessed with a previously validated scale by Dickson et al (2011) with acceptable internal reliability (Chronbach's alpha = 0.70). The scale included 13 true or false answer questions concerning what food are recommended as part of a healthy diet. A maximum score of 13 out of 13 was possible.	Part B. 13 items	Continuous
Social and personal characteristics	*Do you or a member of your household have a personal diet or a medical condition where looking at food label information is advised?* *How would you rate your current health (Excellent, Good, Neither healthy nor unhealthy, Fair, Poor)*	Personal information on respondents age, sex, ethnicity, occupation (including pre-retirement) and educational attainment was obtained. Items were taken from the UK survey by the Department of Business, innovation and Skills, 2013) Self-rated health and dietary health were also evaluated using 5-point scales from the US NHANEs survey	Part A, 7 items	Categorical and ordinal
Objective understanding of nutrition labels	10 item Multiple choice quiz (see Table 5 for a description).	A maximum possible score of 10 out of 10.	Part B 10 items	Continuous

2.4.5 Sample size

Results from the pilot study were used to estimate the required sample size for the online survey. Since use and understanding of nutrition labels were the main outcomes of interest here, effect sizes for these were based on findings from the study piloting data collection tools which evaluated both these outcomes in undergraduate students (Chapter 3, section 3.3.11).

In summary, post-hoc analysis of data obtained in the pilot study (Chapter 3) was used to perform a sample size power calculation to indicate the varying statistical power of the small pilot sample to detect the observed differences between the two (SF and GF) groups in the outcome measures of nutrition label use and understanding. Calculations showed that, in order to obtain a statistical power of 80% to detect similar differences, the largest required sample size was 200 participants (i.e. two groups of n = 100), at the 0.05 significance level. Specifically, this enabled detection of a mean difference in frequency of use of nutrition labels of 0.3 (95% CI: -0.7, 0.01) when using a 5-point frequency Likert scale (i.e. 1= never, 5 = always). In terms of label understanding, the between groups effect size observed in the pilot study was a mean difference in quiz score (objective understanding of nutrition labels) of 1.5 correct question answers (95% CI: 0.2, 2.8). Based on the sample size power calculations, a group size of 30 participants (i.e. 60 in total) was required to detect this difference with a power of 80% at a 0.05 significance level. Therefore, encompassing both these outcomes, a survey sample size of 200 older adult respondents was aimed for.

Although it is not known to what extent this effect size is clinically, or otherwise, meaningful, this value was deemed an appropriate start for the present initial exploration of older adults’ understanding of the current UK nutrition labels. The sample size was also in line with some earlier studies which assessed these characteristics in other populations (see Table 4).

2.5 Conclusion

This chapter has described the literature used to inform the design of pilot data collection tools evaluating use and understanding of nutrition labels. Also described is the need for and specific development of a “quiz” to assess objective understanding of the new terminology and label data declared on current UK front and back-of-pack nutrition labels. These online data collection tools were first piloted in a study with undergraduates (Chapter 3) before being revised and combined, as described here, for use as an online survey for older adult consumers. Survey results concerning use and understanding of nutrition labels among these consumers will be presented in Chapter 4. Results concerning use of online nutrition information will be reported in Chapter 5.

Chapter 3 Piloting online data collection tools within the University Virtual Learning Environment (VLE)

3.1 Introduction and Overview

The first objective of this PhD project was to develop online data collection tools to evaluate use and understanding of current UK nutrition labels in older adults. A funded opportunity to pilot these tools, in collaboration with an experienced research team, arose in 2014 in response to the call for staff research proposals for the Leeds Trinity University Learning and Teaching Award Funding. A collaborative project was proposed to inform a University Strategic priority; student learning and engagement within the University Virtual Learning Environment (VLE). The aim of the funded project was to assess if the format of the VLE and presentation of learning materials influenced students' learning and engagement. As such, the project required the creation of new learning materials, learning "tests" and data collection on related participant characteristics. Since education on nutrition labels was not currently taught to the undergraduate participants here, this topic was considered suitable for use. Accordingly, the researcher was therefore able to pilot the data assessment tools evaluating use and understanding of nutrition labels described in Chapter 2, with an accessible sample of undergraduate students. The funded study required use of a two group between-subjects design, which used various pre and post-course measures of learning and engagement, including those obtained using the online pilot questionnaires.

In addition, the requirement for new learning materials to use in the study also facilitated complimentary work by the researcher in her review of the available consumer-facing materials/resources featuring the new UK nutrition labels. The available resources identified this area enabled the creation of two presentation formats of VLE course pages with content concerning the current UK nutrition labels (i.e. SF= Standard Format, GF= Grid Format).

3.1.1 Background to the funded project

In higher education, UK undergraduates are expected to view learning materials (i.e. lecture slides and supporting documents) within the University's online VLE. This platform also acts to organise course (module) materials within course "pages" and sub-folders. However, little is known about how best to organise and present VLE learning materials to promote such engagement and increase learning. One study has suggested that learner's navigation within the VLE might be important in learning process itself (Rakoczi, 2010). The funded project therefore reflected the need for further insight into student engagement and learning via the VLE and was intended to inform University best practice recommendations on the format and presentation of materials within this platform.

3.1.2 Aims of the study in the context of the PhD

The first aim of the funded project was to test the combined effect of two different formats of the VLE and learning materials on engagement and learning outcomes in undergraduates. In line with the first research objective of the current PhD, the second aim was to enable the development and piloting of basic online nutrition label education and data collection tools.

The piloting of these tools was used to obtain insight to inform the development of the online survey to evaluate use and understanding of nutrition labels among older adults (see Chapter 4). Results from this pilot study were also used to gain an idea of potential effect sizes with which to inform the sample size required for the larger online survey.

3.1.3 Research questions

Two main research questions guided the main funded VLE project:

1. What do measures of understanding and intended use of nutrition labels reveal about the optimal presentation of the VLE and learning materials?
2. What do measures of time spent viewing learning materials reveal about student engagement with these resources?

In relation to the piloting of the PhD data collection tools used here to evaluate participant understanding and use of nutrition labels, secondary research questions were as follows:

a. Were there any pre-course differences in participant characteristics concerning nutrition and labels which might impact on learning in this topic (i.e. overall test performance following the course)?

b. Did viewing, or format, of course materials have any effect on participants' use or understanding of nutrition labels, confidence in understanding, or learner engagement?

c. How can the VLE-based questionnaires and quiz questions be refined for use in the future online survey?

d. What effect sizes are observed here? (These can be used to inform samples size requirements for future survey data collection in the area of use and understanding of nutrition labels)

3.1.4 Objectives of the study

Objectives relating to the research questions were as follows:

1. To obtain and review the available consumer-facing resources and education materials explaining the current UK nutrition labels.

2. Based on those resources found, to create basic learning materials on UK nutrition labels and provide these as two different formats via the VLE course pages.

3. To develop pre and post-course online questionnaires and a post-course quiz to evaluate self-rated and objective understanding of nutrition labels, as well as frequency of use of this information and associated characteristics.

4. To pilot the data collection tool questionnaires with undergraduates using the VLE

5. To pilot the Mirimetrix 2 software screen recording and eye tracking technology.

6. To recruit and test ≥30 undergraduate student participants

3.1.5 Funding

The researcher, together with Dr Steve Jones (SJ), Marcus Sugden (MS) and Dr Julie Allen, designed and proposed this research project which was granted funding by Leeds Trinity University's Learning and Teaching Research Award in October 2014.

3.2 Methods:

3.2.1 Ethical approval

Ethical approval was received prior to the commencement of this study from the Departmental Ethics Committee for Sport, Health and Nutrition, Leeds Trinity University (Appendix E).

3.2.2 Learning materials

3.2.2.1 Review of available consumer-facing materials

In line with the objectives 1 and 2 of this study (above), consumer-facing resources on the current UK nutrition labels were reviewed to create new VLE course content for use in this study. At the time of undertaking (December 2014 - January 2015), the researcher was able to locate some publicly available material which specifically explained the current UK nutrition labels which were compliant with EU Regulation 1169/2011. These explanations appeared on the NHS Choice "Food Labels" webpage (NHS, 2014). Other public health and nutrition organisations materials (British Dietetic Association, British Nutrition Foundation and British Heart Foundation) were also reviewed but found to be utilising the previous format of nutrition labels (i.e. using Guideline Daily Amounts terminology and previous labels) within their resources. At the time of this review, an explanation of the nutrition information declared in the current front-of-pack nutrition labels was also provided for consumers within some UK supermarket websites, including Wm Morrisons Supermarkets PLC. Some food industry guidance on consumer communications of the new nutrition labels was also located (Buttriss, 2013; Food and Drink Federation, 2014).

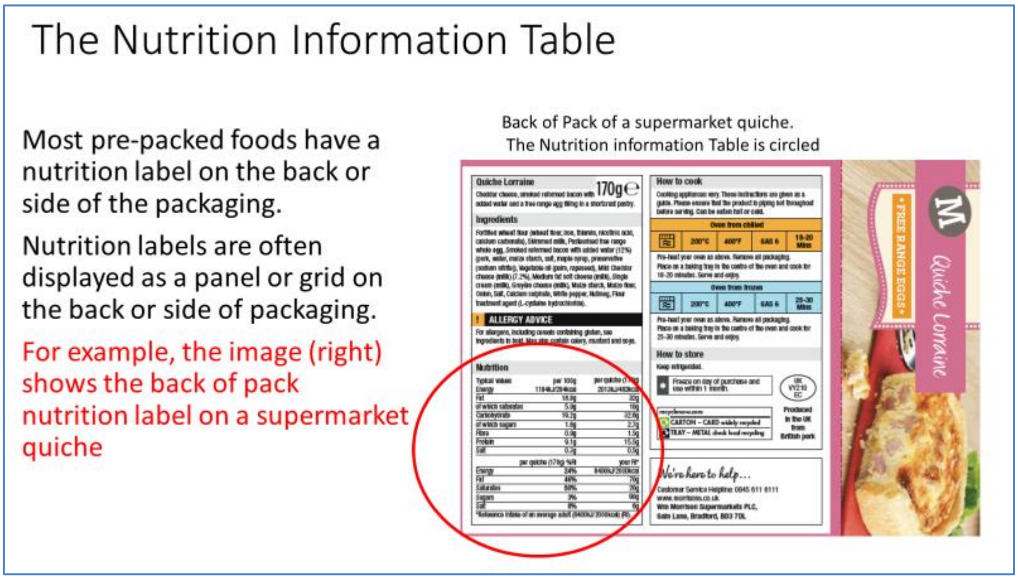
Furthermore, nutrition label information for consumers was also provided online by the US and Australian Government websites. For example, the Australian resources depicted an example of a product's packaging to illustrate nutrition information within the context of other information on the food label (i.e. ingredients, name of the food) (Food Standard Agency, Australia New Zealand, 2013). The US Food and Drug Administration (FDA) resources also included a visual guide to the information declared on the US Nutrition Facts Panels, including an illustration of the meaning of the percent daily values (%DV) (Center for Food Safety and Applied Nutrition, FDA, 2015).

3.2.2.2 Content of learning materials

In-line with the pre-existing NHS webpage, content and wording was translated to three PowerPoint point slides sets entitled: “Nutrition Labels on the back or side of pack”; “Nutrition Labels on the Front of Packaging”; “Reference Intakes” (Figure 10). Two additional slides were added. These included an image adapted from the US FDA webpage explaining %DVs which was adapted to state “%RI”. Also included was a visual illustration (Figure 10) of a front-of-pack nutrition label and explanation of the included components, as taken from the Morrisons Supermarket consumer website (with permission) (Figure 11). Learning objectives were to be achieved by reading the materials only. No other learning activities were included. Aside from the prior literature review (Chapter 1), which indicated specific potential challenges with label understanding, no assessment of learners’ needs (i.e. in relation to their nutrition labels understanding) was conducted.

Learning objectives were: (1) to appreciate the meaning of the information provided within nutrition labels shown on back and front-of-pack nutrition labels; (2) to be aware how to use the information displayed on nutrition labels when evaluating foods.

The researcher, together with the University’s e-learning manager (MS) used these PowerPoint slide sets to create a second version in which text was animated to appear beside images of nutrition labels. This version also included an audio voice-over narration of text (Articulate StoryLine Ltd). As shown in Figure 11, animated and narrated slides were presented with images and text which appeared (or was highlighted) in order of narration. These slides featured a progress bar at the bottom of the screen which showed the time remaining on each slide, which could also be skipped through by participants.



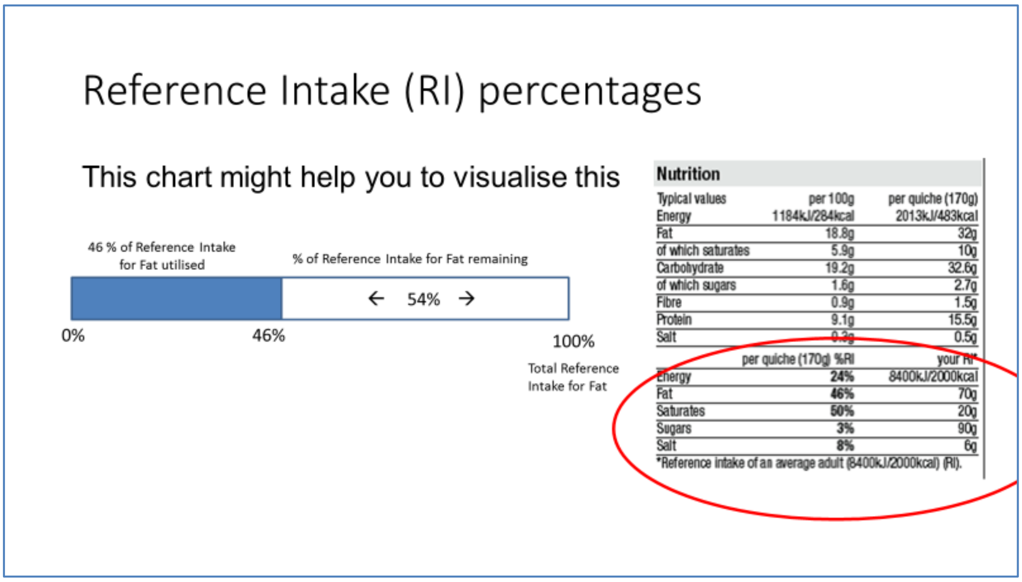


Figure 10 Two example slides from the Power Point learning material slide sets

3.2.3 Study design

A two group between-subjects study design was used to compare the effects of the VLE format and learning materials presentation on student learning and engagement. Each group used one of two VLE course page formats containing a specific format of learning material.

The formats of VLE pages and learning materials differed in two ways:

- The format of the VLE course page (organisation of materials). The VLE course pages were presented in either a “Standard Format” (SF) with topic and materials ordered sequentially in a list, or as a “Grid Format” (GF) which presented the learning materials within clickable boxes (see Figure 11).
- Presentation of learning materials. Content of the learning materials within the SF VLE page was the same as those within the GF format VLE page. However, SF learning materials presented this information using PowerPoint slide sets, whereas the GF learning materials presented this same content as narrated and animated slides (Figure 11).

Theoretically, there could have been four combinations of VLE format and learning materials presentation (i.e. SF + PowerPoint, GF + PowerPoint, SF + narrated PowerPoint and GF + narrated PowerPoint). However, this initial study aimed to show if there was any effect on learner engagement and learning, which could have then been further explored with a larger study. In addition, the Standard Format (SF) VLE page reflected the usual presentation and format of VLE materials experienced by existing University students, so was considered a reference point. Therefore, the two-group design (i.e. SF + PowerPoint and GF + narrated PowerPoint) was selected here to provide initial data on if it was feasible to expect any effect on students’ learning and engagement with VLE learning materials.

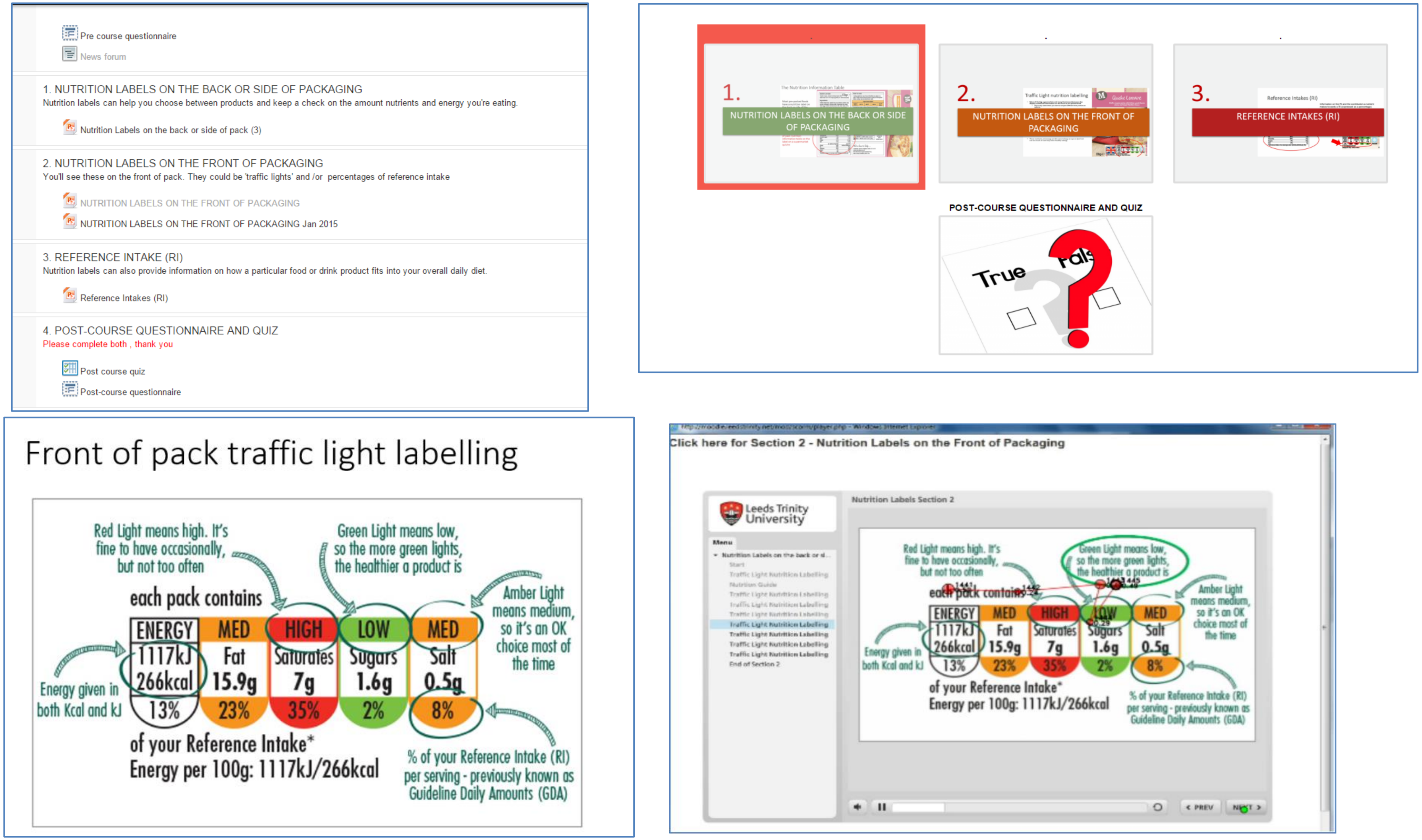


Figure 11. VLE course page and learning materials formats. Top left; standard format VLE page (SF), top right; grid format VLE page (GF). Examples of learning material delivery formats: bottom left; SF power point slide number 2.4, bottom right; GF animated slide 2.4 (shown with eye tracking indicators which did not appear for participants)

3.2.4 Measures

At pre and post-course, participants use of nutrition labels and specific characteristics which were also potentially related to use and understanding of this information were evaluated. In addition, participants' learning was assessed using a post course quiz which specifically evaluated objective understanding of current UK front and back-of-pack nutrition labels, elements of which were described in the learning materials. Finally, engagement with learning materials was measured via the VLE which recorded time spent on materials and questionnaires. Screen recording and eye tracking technology recorded time spent on each slide and number of eye gaze fixations on the computer screen areas of interest.

3.2.4.1 Personal characterises and use of nutrition labels

Data collection tools were designed to collect information on participants' characteristics, including use of nutrition labels and related personal characteristics (see Chapter 2 and Appendix A and B for data collection tools). These evaluated participants' personal characteristics which might impact on the use and understanding of nutrition labels and which may therefore affect between-group comparisons of learner engagement and learning. Briefly, measures included type of residence (i.e. own or catered), if participants or a member of their household had a health or medical condition which needed to be considered whilst shopping, whether they had ever studied nutrition or visited a dietitian, as well as their interest in nutrition and self-rated nutrition knowledge. Frequency of general label reading and use, as well as use of 11 specific label components were also evaluated using 5-point scales (1 = never, 5 = always), as were reasons for use and non-use (see Chapter 2). In addition, participants' self-rated confidence in understanding of nutrition labels and the perceived understandability of this information was also assessed at pre and post-course using 5-point scales (i.e. 1 = very unconfident, 5 = very confident; 1= very difficult to understand, 5 = very easy to understand, respectively). Self-rated understanding of the 11 specific nutrition label components was also evaluated using a 7-point scale (1=do not understand, 7= understand completely). These pre and post-course measures allowed exploration of whether there were any baseline differences in these characteristics at pre-course between groups, or if the course impacted in on these outcomes in participants.

3.2.4.2 Understanding of nutrition labels (assessment of learning)

A post course quiz was developed to evaluate objective understanding of nutrition labels and was to be completed by participants following their viewing of the learning materials (see Chapter 2 for details and Appendix C). Quiz development was informed by the prior literature evaluating objective understanding of nutrition labels (Grunert et al., 2010b; Levy and Fein, 1998; Sinclair et al., 2013). The quiz also aimed to evaluate participants' learning in line with the two broad learning objectives concerning the meaning of labels and how to use them to evaluate products. These learning objectives originated from the content of the resources used to create the VLE learning materials used here. The research team took the decision to measure objective understanding at post-course, rather than at both pre and post-course. This was to reduce participant burden and prevent any possible learning effect on participants understanding of nutrition label (and post-course quiz performance) of their undertaking of the same pre-course quiz.

3.2.4.3 Learner engagement

The VLE recorded the time taken by each participant to view the learning materials and complete the online questionnaires. In addition, time spent specifically on the post-course quiz was also recorded. The use of eye tracking equipment (Mirametrix S2, Mirametric Ltd.) enabled screen recording of participants' computer screens, as well as their eye movements. The software collected data on where participants looked on the computer screen as "gaze fixations" and their dwell time on each, which was indicated in seconds per fixation.

In line with the available funding, hard-copies of two other questionnaires evaluating cognition and psychological characteristics were completed by participants prior to the study, but these are not reported here. Formative feedback from participants was also collected from 3 participant volunteers following their completion of the course.

3.2.5 Participants

Participants were recruited from two undergraduate Psychology programmes in January and February 2015 by three research project students. These research students were trained and supervised by the researcher and SJ. A brief invitation to participate in the study was announced during lectures and this included a description of the study and the incentive (£5 University print credit). Those who expressed interest were invited to attend scheduled appointments where they read study information and voluntarily provided written consent to participate. The participant information sheet, consent form and post-course debrief information are shown in Appendix F. On arrival, participants were allocated alternately to either the SF or the GF group, in a quasi-randomised manner. Testing was undertaken using three computers located in the University's psychology laboratory

3.2.6 Procedure

The three research project students received training in data collection and the use of screen recording and eye tracking technology by the researcher and SJ before instructing individual participants. Each participant was given a unique log-on user name and password to use to access the VLE. Participants were then instructed to perform a simple 30 second eye gaze calibration viewing activity before starting to view the course VLE page and materials. Instructions to participants on how to proceed were provided on the VLE course page, including when to complete the pre and post-course questionnaires and quiz (Figure 11). Participants were told they were free to work through materials at their own pace; there was no time limit nor instruction to work quickly.

The study took participants a maximum of 1 hour to complete. Following their completion of the post-course questionnaire and quiz, participants were instructed to alert a member of the research team who offered a debrief information sheet and recorded their university email address in order to receive the £5 printing credit. At this stage, three participants were approached by the researcher to seek feedback on their participation in the study, including their experiences of using the VLE pages, learning materials and online questionnaires. This was undertaken whilst viewing a play-back video of their computer screen recording during which notes were taken by the researcher who asked questions about what participants thought and how easy they found the questionnaires to complete. Following their completion of the study, participants were then given the post-course debrief information sheet.

3.2.7 Analysis

3.2.7.1 Collected data

Responses to pre and post-course questionnaires and the post-course quiz, as well as time taken to view these and the learning materials, were collected for each login by the VLE platform. In addition, those eye tracking videos and computer screen recordings which were useable (i.e. fully recorded) were identified and viewed by the researcher who noted the total number of fixations and their dwell time whilst viewing a specific slide (slide 2.4) for both groups (Figure 11). This particular slide was chosen as it occurred approximately halfway through the learning material slide sets and required participants to view both image and text. All data was exported from the VLE platform into Excel spreadsheets before being analysed using SPSS (IBM version 21).

3.2.7.2 Statistical analysis

Self-reported frequency of use, self-rated confidence in own understanding and perceived understandability of nutrition labels were evaluated using 5-point scales (see Chapter 2). These were coded numerically before being analysed using mean and standard deviations. Continuous measures which were similarly described included time spent viewing materials, number of eye tracked-fixations, and quiz score. Categorical variables including sex, residence and if participants had a medical condition which needed to be taken into account whilst shopping for food were described using proportions (percentages). Descriptive statistics and frequencies were used to describe participant demographics and characteristics relating to use and understanding of nutrition labels, by group.

Statistical tests were conducted in line with the research questions concerning pre-course differences in personal characteristics between groups which might impact on use or understanding of this information. To test for between group differences at pre-course, chi-squared tests were performed on the proportions of categorical variables. Independent t-tests were used to test for differences between groups for measures of frequency of nutrition label use, time spent on materials and quiz score. Prior to these tests, the normality of the distributions of the responses to these measures was checked with indicators of skewness and kurtosis. Differences between groups in the proportion of correct answers to each post-course quiz question were analysed with chi square tests (or Fishers exact test where counts in the 2x2 contingency table were less than 5).

Post-hoc analysis was also conducted to explore characteristics associated with use of nutrition labels at pre-course, including confidence in self-rated understanding and perceived label understandability. For this, frequency of use of nutrition labels was dichotomised into “Frequent users” (who indicated they used this information “always” or “often”, and “Infrequent users” (who indicated they used this information either sometimes / rarely / never). Independent t-tests were performed to assess differences in continuously measured characteristics (i.e. self confidence in understanding of nutrition labels) and between frequent vs infrequent users.

Reflecting the secondary research questions concerning the effect of viewing on outcomes on use and understanding of labels, analyses were also conducted to assess differences in participants’ pre and post-course levels of self-rated understanding and use of nutrition labels, by using paired t-tests within each group. In addition, differences in these changes between groups was assessed using independent t-tests. To assess potential differences in learner engagement between groups, independent t-tests were conducted on the mean time taken to view materials (and complete the quiz) as well as number of eye fixations. A *p* value of < 0.05 was used throughout to indicate statistical significance.

3.3 Results

3.3.1 Data collection and analysis

A total of 33 undergraduates were recruited and provided informed consent before being allocated to either the SF (n=16) or the GF (n=17) groups. All participants completed the pre-course questionnaire by following the on-screen instructions to open and view the VLE learning materials. Due to the non-mandatory questionnaire submission on the VLE, a total of 32 participants completed the post-course quiz, and 31 completed the post-course questionnaire (Table 8).

Data analysis was not possible for one item within the post-course questionnaire (Q7) which evaluated the "importance of nutrition information". This was because the (ordered scale) answer options for that item were displayed in a "random" incorrect order due to a manual question-type selection error using the VLE questionnaire creator, which became evident following data collection.

Table 8 Number of participants completing the pre and post-course questionnaires.

	SF group	GF group	Total
Pre-course questionnaire	16	17	33
Post-course questionnaire	15	16	31
Quiz	16	16	32

3.3.2 Sample characteristics at pre-course

Demographic characteristics for all 33 participants are shown in Table 9. Participants' mean age was 20 years (SD ±1.7) and the majority (67%) were female. Most had responsibility for buying food (82%), had never visited a dietitian (85%) nor studied nutrition (97%). Most (88%) did not have a medical condition which required consideration when shopping. Self-rated knowledge in nutrition was moderate (i.e. mean of 3.5 out of possible max of 5 = very knowledgeable). Nearly all participants (n = 32, 97%) considered nutrition information on food labels as "important" or "very important". There were no significance differences in proportions, or levels, of these characteristics at pre-course between GF and SF groups, indicating a baseline balance (Table 9). This included participants' self-reported frequency of reading, or use, of nutrition labels. For example, participants reported that the frequency with which nutrition labels influenced their purchase choices was moderate overall (mean = 3.1 SD ±1.1) as assessed on a five-point scale (i.e. 1= never, 5 = always). Mean frequencies of such label use were not significantly different between SF and GF groups (mean difference = -0.5, 95% CI: -1.2, 0.3, p =0.21).

Participants overall interest in nutrition was moderate at pre-course as assessed using a 5-point scale where 5 was "very interested" (i.e. 13 were interested) (mean = 3.5 SD ± 0.9). However, mean levels of interest were slightly higher for the GF group (3.8 SD ± 0.7) compared to the SF group (mean 3.1 SD ± 0.9) (mean difference 0.7, 95% CI: 1.3, 0.7, p = 0.03).

3.3.2.1 Post-hoc analysis of characteristics of frequent vs infrequent nutrition label users.

At pre-course, over half of all participants n=18 (55%) indicated they had frequently (i.e. always or often) "read" nutrition labels in the last 6 months. Similar numbers of participants reported that they frequently "used nutrition labels when buying food" (n=13, 40%). Exploratory post-hoc analysis was performed to assess any differences in characteristics associated with frequency of use of this information during purchases, at pre-course. Frequent users were classified as those who indicated that this information influenced their purchase choices either "always" or "often" (n=12, 36%). Proportions of frequent and infrequent users were not significantly different between SF (frequent users =4) and GF (frequent users = 8) groups ($\chi 2(1)$ =1.7, p = 0.19).

Those whose purchase choices were frequently influenced by nutrition labels were found to possess significantly greater levels of interest in nutrition and self-rated nutrition knowledge than infrequent users (Table 10). In addition, participants' mean levels of self-confidence in their own understanding of this information, but not perceived label understandability, were also significantly higher among frequent compared to infrequent users (Table 10).

Table 9 Sample demographics and personal characteristics at pre-course

	Total (n=33)		SF Group (n=16)		GF Group (n=17)		P[1]
	n	**%**	**n**	**%**	**n**	%	
Gender							
Female	22	67%	11	69%	11	65%	0.81
Male	11	33%	5	31%	6	35%	
Residence							
Own accommodation/University self-catering	21	64%	10	63%	11	65%	0.90
Parent's house or University catered	12	36%	6	38%	6	35%	
Does food shopping							
No	6	18%	4	25%	2	12%	0.33
Yes	27	82%	12	75%	15	88%	
Self or household member with medical condition [a]							
No	29	88%	14	88%	15	88%	0.95
Yes	4	12%	2	12%	2	12%	
Ever visited a dietitian?							
No	28	85%	14	88%	14	83%	0.68
Yes	5	15%	2	12%	3	17%	
Ever studied nutrition?							
No	32	97%	15	94%	17	100%	0.49
Yes	1	3%	1	6%	0	0%	
Nutrition Labels are important/very important	32	97%	15	94%	17	100%	0.80
	Mean (SD)		**Mean (SD)**		**Mean (SD)**		
Age (Years), Mean (SD)	20 (SD 1.7)		20.1 (SD 2.1)		19.8 (SD1.3)		0.63
Interested in nutrition [c], Mean (SD)	3.5 (0.9)		3.1 (0,9)		3.8 (0.7)		0.03
Self-rated nutrition knowledge [d], Mean (SD)	2.9 (1.1)		3.1 (0.9)		2.7 (1.1		0.34
Frequency of reading [e]	3.2 (1.3)		3.0 (1.3)		3.4 (1.4)		0.59
Frequency of use [f]	3.1 (1.2)		3.0 (1.1)		3.3 (1.4)		0.62
Frequency of influence of on purchases [g]	3.1 (1.0)		2.9 (1.0)		3.4 (1.2)		0.21

[a] Do you or a member of your household have a health or medical condition that is to be taken into consideration when shopping? [b]Do you think nutrition information on food label is: not important, neither important nor unimportant, important, very important, don't know [c] How interested are you in nutrition? Responses ranged from very uninterested = 1 to Very interested = 5. [d] How would you rate your nutrition knowledge? Responses ranged from Very unknowledgeable =1 to very knowledgeable = 5. [e] Thinking about the last six months, how frequently do you READ nutrition information on food labels (1=never, 2=rarely,3=sometimes, 4=often, 5=always). [f] How frequently do you USE nutrition information on food label when buying food? (1=never, 2=rarely,3=sometimes, 4=often, 5=always). [g] How often does the nutrition information affect your purchase choices? (never=1, rarely=2, sometimes=3, often =4, always = 5). [1]Differences between groups as assessed with Chi Square tests or independent t-tests. (Abbreviations: SD= Standard Deviation)

Table 10 Pre-course sample characteristics, by frequency of influence of nutrition labels on purchase choices

	Frequent users [a] (n=21)	**Infrequent users [a] (n=12)**	**MD (95% CI)**	**p**
	Mean (SD)	Mean (SD)		
Self-rated nutrition knowledge [b], Mean (SD)	2.6 (1.3)	3.4 (0.9)	-0.8 (-1.6,-1.2)	0.02
Interest in nutrition [c], Mean (SD)	3.2 (0.9)	4.0 (0.7)	-0.2 (-1.5,-0.2)	0.02
Label understandability [d], Mean (SD)	3.5(1.0)	3.9 (1.3)	-0.4(-1.3,0.4)	0.28
Self confidence in own understanding of labels [f] , Mean (SD)	3.0 (0.9)	3.8 (0.9)	-0.8 (-1.4,0.1)	0.03

[a] Grouped by response to the pre-course question "How often do nutrition labels affect your purchase choices?" (i.e. Frequent users = Always/Often, Infrequent users = sometime/Rarely/never).
[b] *How would you rate your nutrition knowledge?* Responses ranged from Very unknowledgeable =1 to very knowledgeable = 5. [c] How interested are you in nutrition? Responses ranged from very uninterested = 1 to Very interested = 5
[d] Response options for; Label understandability ranged from 1= very difficult to understand, 5= very easy to understand). [f] Response options for self-confidence in own understanding of nutrition label ranged from 1= very unconfident, 5= very confident
(Abbreviations: SD= Standard deviation, MD = mean difference, 95% CI = 95% confidence Interval)

3.3.3 Perceived understanding of nutrition labels

3.3.3.1 Pre-course levels of perceived understanding

How "easy" nutrition labels are to understand (i.e. perceived understandability of nutrition labels) was evaluated using a 5-point scale at both pre and post-course (i.e. 1= very difficult to understand, 5 = very easy to understand). Mean levels of understandability were moderately high at pre-course for both SF (3.4 ± SD 1.1) and GF groups (3.9 ± SD 1.3). Similarly, participants' overall levels of self confidence in their own understanding of nutrition labels was also moderately high at pre-course for both SF (3.2 ± SD 1.5) and GF groups (3.4 ± SD 0.9) (i.e. where scale point 3 was labelled as "*neither confident nor unconfident").* There were no significant differences between groups in either of these characteristics at pre-course (Table 11).

Self-rated understanding was also assessed for each of 11 nutrition label components (i.e. KJ, salt, Reference Intakes) using a 7-point scale (i.e. 1 = Do not understand, 7 = Understand Completely) (see Table 11). At pre-course, label components for which understanding was rated lowest included “KJ” for both groups, with mean scores of 3.4 (SD ± 1.7) and 4.4 (SD ± 2.3) for the SF and GF groups, respectively. Of all label components, only participants’ mean pre-course scores for self-rated understanding of “fibre” differed significantly between SF (4.1 ± SD 1.5) and GF (5.4 ± SD 1.5) groups (mean difference = 1.3, 95% CI: 0.2, 2.3, $p = 0.02$) (Table 11).

3.3.3.2 Changes in perceived understanding from pre to post-course

Differences in pre and post-course scores for both these aspects of label understanding were assessed for each group using paired t-tests. Of note, mean levels of self confidence in understanding of nutrition labels significantly increased from pre (3.4 SD± 0.9) to post-course (4.0 SD± 0.9) (MD = -0.6, 95% CI: -0.9, -0.4, $p < 0.001$) for the GF group only (Table 11). However, there were no significance differences in pre to post course changes for either self-rated confidence in understanding, or understandability, between SF and GF groups (Table 11).

Following the course, self-rated understanding of the “KJ” element of the nutrition label was found to be significantly increased compared to pre-course, for both SF and GF groups (Table 11). However, there were no significant differences in mean changes in pre to post test scores between the groups, for self-rated understanding of any of the other ten label components (Table 11).

Table 11 Mean scores for perceived understanding of nutrition labels at pre and post-course, by SF or GF group

	Pre-course			**Post-course**			**Pre-post difference (paired t-test)[b]**				Between group differences (SF vs GF) in the pre-post-test changes [c]	
	SF (n=15)	GF (n=16)		SF (n=15)	GF (n=16)		SF (n=15)		GF (n=16)			
	M (SD)	**M (SD)**	P[a]	**M(SD)**	**M(SD)**	P[a]	**MD (95%CI)**	**P[b]**	**MD (95%CI)**	**P[b]**	**MD (95%CI)**	**P[c]**
Understandability of labels [d]	3.4 (1.1)	3.9 (1.3)	0.33	3.6 (0.9)	3.8 (1.1)	0.72	-0.2 (-0.7,0.3)	0.30	0.1 (-0.9,0.9)	0.89	-0.3 (-1.3,0.8)	0.60
Self confidence in own understanding [e]	3.2 (1.5)	3.4 (0.9)	0.64	3.4 (1.1)	4.0 (0.9)	0.06	-0.2 (-0.7,0.3)	0.42	-0.6 (-0.9,-0.4)	<0.001	-0.4 (-0.1,1.0)	0.12
Energy[f]	4.3 (1.3)	5.1 (1.7)	0.14	4.9 (1.4)	5.6 (1.2)	0.19	-0.6 (-1.4,0.1)	0.10	-0.7 (-1.6.0.3)	0.14	0.02 (-1.2,1.2)	0.97
KJ[f]	3.4 (1.7)	4.4 (2.3)	0.20	4.6 (1.2)	5.8 (1.5)	0.07	-1.3 (-2.3,-0.4)	0.01*	-0.4 (-2.5,-0.2)	0.02*	0.04 (-1.4,1.5)	0.94
Kcal[f]	5.1 (1.3)	5.4 (1.9)	0.61	4.9 (1.2)	5.8 (1.6)	0.07	0.2(0.3,-0.4)	0.47	-0.3 (-0.9,0.3)	0.29	0.5 (-0.3,1.3)	0.21
Fat[f]	5.2 (1.4)	5.8 (1.3)	0.14	4.9 (1.6)	5.5 (1.5)	0.74	0.2 (-0.5,0.9)	0.55	0.3 (-0.4,0.9)	0.43	-0.5 (0.4,-0.9)	0.91
Saturates[f]	4.5 (2.2)	5.0 (1.9)	0.42	4.6 (1.8)	5.6 (1.4)	0.18	-0.2(-1.1,0.8)	0.68	-0.5 (1.3,0.2)	0.14	0.4 (0.6,-0.8)	0.54
Carbohydrates[f]	4.9 (1.9)	5.7 (1.0)	0.09	4.7 (1.7)	5.4 (1.6)	0.87	0.2 (-0.6,0.8)	0.69	0.3 (-0.4,0.9)	0.41	-0.1 (-1.0,0.7)	0.71
Of which sugars[f]	4.3 (2.1)	5.1 (1.9)	0.25	4.5 (2.0)	5.5 (1.6)	0.33	-0.3 (-0.4,0.7)	0.44	-0.5 (-1.3,0.3)	0.18	0.2 (-1.0,1.4)	0.78
Fibre[f]	4.2 (1.5)*	5.4 (1.5)*	0.02*	4.1 (1.4)	5.1 (1.6)	0.74	0.0 (-0.8,0.8)	1.00	0.3 (-0.4,0.9)	0.39	-0.3 (-1.2 (0.7)	0.58
Protein[f]	4.9 (1.6)	5.2 (1.9)	0.63	4.2 (1.5)*	5.3 (1.7)*	0.04*	0.6 (-0.1,1.3)	0.11	-0.3 (-0.5,0.2)	0.43	0.7 (-0.3,1.5)	0.06
Salt[f]	4.8 (1.7)	5.8 (1.2)	0.05	4.5 (1.9)	5.9 (1.3)	0.15	0.2 (-0.8,1.2)	0.87	-0.2 (-0.7,0.3)	0.423	0.4 (-0.7,1.4)	0.46
Reference Intake [f]	5.0 (1.8)	5.9 (1.4)	0.11	5.5 (1.5)	6.1 (1.3)	0.31	-0.5 (-1.7,0.6)	0.33	-0.31 (-1.2,0.6)	0.484	-0.2 (-1.6,1.2)	0.74

[a] Comparison of pre-course, or post -course, scores between groups assess with independent t-tests. [b] Pre-post course difference in scores for each group. Difference assessed by paired t-tests (i.e. a -ve change indicates post-course score were higher than pre-course scores). [c] Differences in pre to post -course changes in scores between (SD vs GF) groups assessed with independent t-tests. [d] Response options for; Label understandability ranged from 1= very difficult to understand, 5= very easy to understand). [e] Response options for self-confidence in own understanding of nutrition labels ranged from 1= very unconfident, 5= very confident). [f] For each label component, response options for self-rated understanding ranged from; 1= do not understand, 7= understand completely. *Indicates compared means etc are significantly different at the level p < 0.05. Abbreviations: M=mean, SD= Standard deviation, MD= mean difference, 95%CI = 95% Confidence Interval)

3.3.4 Objectively assessed understanding of nutrition labels

The multiple-choice post-course quiz was completed by 32 participants, with overall mean scores of 7 out of 11 (SD ±1.9) for the SF group and 8.5 (SD ± 1.7) for the GF group. As shown in Table 12, individual quiz questions which were answered correctly by the most participants in each group included; (Q6) interpreting “low” nutrient levels using a front-of-pack traffic light panel (94%, 100% correct in SD and GF groups, respectively) and (Q7) locating the %RI for saturates provided by a serving (94% in both groups). However, there were no statistically significant differences between SF and GF groups in the proportions of participants who correctly answered any individual quiz questions (Table 12). An independent samples t-test suggest there was a potential difference in mean overall quiz score between the two groups (MD = 1.5, 95% CI: 0.2, 2.8) (Figure 12).

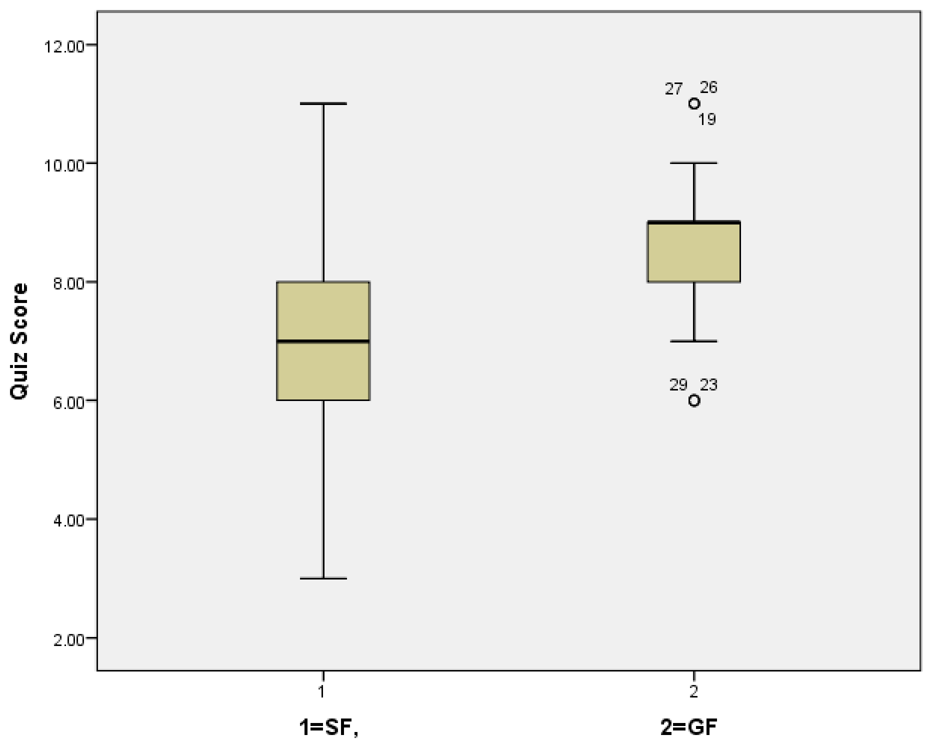


Figure 12 Boxplot of quiz scores for SF and GF groups (n = 32)

Individual quiz questions which were answered correctly by the fewest participants in both SF and GF groups included (Q1): identifying salt content per serving, which was answered correctly by 25% and 56% of participants in SF and GF groups, respectively. In addition, (Q2): identification of the serving size indicated on the label was answered correctly by 31% and 50% of SF and GF participants, respectively. The last question (Q11) required participants to calculate the percentage of the reference intake provided by two servings. This question was answered correctly by 38% and 44% of SF and GF group participants, respectively.

Due to the VLE quiz output (which indicated if participants had selected with the programmed “correct” or “incorrect” answers only), no information was gathered on the frequency with which participants selected the other individual (i.e. incorrect) multiple-choice answer options. As such, no information was available regarding the most commonly selected incorrect answers.

3.3.4.1 Post-hoc analysis of quiz score by frequent vs infrequent users

Post-hoc analysis of quiz score based on pre-course groupings of “frequent” versus “infrequent” nutrition label users was conducted. Within each group, no significant difference in mean quiz score was found between frequent and infrequent users (SF group MD= 0.7, 95% CI: -1.8,3.0, p = 0.56; GF group, MD= 1.6, 95% CI: -0.4,3.6, p = 0.11).

Table 12 Correct answers to individual post-course quiz questions, by SF or GF group

Quiz question (refers to back of pack label unless stated)	Number of participants who answered correctly				
	SF (n=16)		GF (n=16)		P[1]
	n	%	n	%	
(Q1) Locate amount of salt per serving (0.5g)	4	25%	9	56%	0.15
(Q2) Locate serving size (i.e. per pack)	5	31%	8	50%	0.47
(Q3) Define Reference Intake	11	69%	15	94%	0.17
(Q4) Evaluate which of two products contain greatest percentage fat (i.e. per 100g).	11	69%	14	88%	0.39
(Q5) Locate amount of sugar in a serving (7.5g)	9	56%	12	75%	0.46
(Q6) Interpret which nutrients are present at low levels FOP traffic lights (sugars only).	15	94%	16	100%	0.50
(Q7) Locate the percentage of an adults Reference Intake for saturates provided by a serving (49%).	15	94%	15	94%	1.00
(Q8) The meaning of "Reference intake" values for fat, saturates, sugars salt. (aim to eat less than 100% of these amounts).	12	75%	13	82%	1.00
(Q9) Locate energy provided by a serving on FOP panel (94Kcal)	14	88%	16	100%	0.48
(Q10) evaluate which product is healthier using FOP Traffic Lights and %RI information (one on the left)	11	69%	12	75%	1.00
(Q11) Calculate % of RI for salt provided by two servings (i.e. using multiples of BOP information)	6	38%	7	44%	1.00

[1] Differences in proportion of correct responses between SD and GF groups were tested with Fishers Exact test for a 2x2 contingency table. Abbreviations: FOP =Front-of-pack nutrition label

3.3.5 Use and viewing of nutrition labels (pre and post-course)

Using frequency responses as five-point scales (i.e. 1= never, 5 = always), mean levels of self-reported nutrition label use at pre post-course were evaluated for each group (Table 13). Paired t-tests showed that mean post-course frequencies of intended “reading” and “use” of nutrition labels were significantly greater than pre-course frequencies of use of this information for the GF, but not the SF, group (see Table 13). In contrast, there appeared to be no significant gains in pre post-course frequency with which this information would affect (future) purchase choices. However, there were no significant differences between SF and GF groups in any of these changes in mean pre post-course frequencies of nutrition label reading, use, or influence on purchase choices (Table 13).

3.3.6 Frequency of viewing specific components of the nutrition labels

Participants rated the frequencies of their viewing of specific individual components of nutrition labels at pre and post-course. Participants were asked to indicate the frequency with which they viewed (or would view) components such as “Fat” and “Reference Intake” using a 5-point scale (i.e. 1 = never, 5 = always) (Table 14). At pre-course in both groups, the components viewed most frequently were the ‘Kcals’ and ‘Fat’ whereas those viewed least frequently were “Fibre” and “%RI” (Table 14). At pre-course, the GF group had a significantly higher mean frequency of viewing of fibre (mean 1.9 ± 0.7) than the SF group (mean 2.8 ±1.1) (MD = -0.8, 95% CI: -1.5, -0.2, p = 0.01).

At post-course, significant increases in (intended) frequency of viewing of nutrition label elements were seen in both groups for most components (Table 14). However, viewing frequency of “Kcals” was not significantly increased at post-course in either group. In Table 14 it can also be seen that for both groups, the highest increase in mean pre post-course viewing frequencies was for the “% RI” component (SF group MD = -1.6 (95% CI: -2.4,-02.8) p = 0.001; GF group MD = -1.9, 95% CI : -2.1, -1.1, p = 0.001). However, there were no significant differences between groups in pre to post-course gains in viewing frequency for any label component (Table 14).

Table 13 Mean frequency of use of nutrition labels by group at pre and post-course, by group

Item	Pre-course			Post-course			Pre-post paired t-tests[b]				Between group differences (SF vs GF) in the pre-post-test changes [c]	
	SF (n=16)	GF (n=17)		SF (n=15)	GF (n=16)		SF		GF			
	Mean (SD)		P[a]	Mean (SD)		P[a]	MD (95%CI)	P[b]	MD (95%CI)	P[b]	MD (95%CI)	P[c]
Nutrition label READING [d]	3.0 (1.3)	3.4 (1.4)	0.59	3.3 (0.9)	3.8 (1.0)	0.07	-0.3 (-0.7,0.6)	0.096	-0.4 (-0.8,-0.1)	0.01*	0.1 (-0.4,0.3)	0.67
Nutrition label USE [e]	3.0 (1.1)	3.3 (1.4)	0.62	3.4 (0.9)	3.8 (1.0)	0.07	-0.4 (-0.9,0.6)	0.082	-0.5, (-0.9, -0.1)	0.02*	0.1 90.3,0.3)	0.72
Nutrition labels' influence on purchase choices [f]	2.9 (1.0)	3.4 (1.2)	0.21	3.2 (0.9)	3.6 (1.1)	0.17	-0.3 (-0.7,0.01)	0.06	-0.2 (-0.6,0.2)	0.33	-0.1 (-0.7,0.4)	0.56

[a] Independent t-test to compare pre-course, or post-course scores between groups
[b] Pre and post course scores for each group compared with paired t-tests. [c] Comparison of changes in pre to post-course scores between groups (i.e. a -ve change indicates post-course score were higher than pre-course scores) assessed by independent t-tests
[d] Pre-course questionnaire asked: In the last 6 months, how frequently have you READ nutrition information on food labels? Post-course questionnaire asked: Following the course, how frequently do you think you will now READ nutrition information on food labels? (Responses were: Never=1, Rarely = 2, Sometimes =3, Often = 4, Always =5)
[e] Pre-course questionnaire asked: how often do you USE nutrition information on food labels when buying foods? Post-course questionnaire asked: Following the course, how frequently do you think you will USE nutrition information on food labels when buying food? (Responses were: Never=1, Rarely = 2, Sometimes =3, Often = 4, Always =5)
[f] Pre-course questionnaire asked: How often does the nutrition information affect your purchase choices? Post-course questionnaire asked: Following the course, how often do you think that nutrition information will affect your purchase choices? Responses were: Never=1, Rarely = 2, Sometimes =3, Often = 4, Always =5
Abbreviations: SD= Standard Deviation, MD= Mean difference, 95% CI = 95% Confidence interval

Table 14 **Mean frequency of viewing individual components of nutrition information by group at pre and post-course**

Item[f]	Pre-course [a]			Post-course [a]			Paired t-tests pre-post[c]				Between group differences (SF vs GF) in the pre-post-test changes [d]	
	SF (n=16)	GF (n=17)	P[b]	SF (n=15)	GF (n=16)	P[b]	SF MD (95% CI)	P[c]	GF MD (95% CI)	P[c]	MD (95% CI)	P[d]
Per 100g	2.4 (1.0)	2.9 (1.4)	0.22	3.2 (1.2)	3.8 (1..1)	0.15	-0.8 (-1.3,-0.3)	0.01	-1.0 (-1.6,-0.4)	0.002	0.2 (-0.5,0.9)	0.58
Per serving	3.1 (1.2)	3.4 (1.2)	0.59	3.5 (1.1)	3.9 (0.9)	0.35	-0.4 (-0.9,0.1)	0.11	-0.6 (-1.0, -0.1)	0.01	0.2 (-0.5,0.8)	0.60
Serving Size	2.7 (1.2)	3.3 (1.2)	0.17	3.5 (1.1)	3.8 (1.1)	0.48	-0.7 (-1.4,-0.1)	0.03	-0.5 (-0.8,-0.2)	0.006	-0.2 (-0.9,0.4)	0.49
Energy	2.7 (1.1)	2.5 (1.2)	0.70	2.9 (1.1)	3.8 (1.1)	0.52	-0.2 (-0.9,0.5)	0.53	-0.8 (-1.3,-0.2)	0.02	0.6 (-0.3,0.4)	0.20
Kcals	3.6 (1.1)	3.5 (1.2)	0.82	3.7 (1.3)	3.2 (1.1)	0.81	-0.1 (-0.3, 0.2)	0.58	-0.1 (-0.6,0.01)	0.82	0.01 (-0.6,0.6)	0.99
KJ	2.1 (1.2)	2.2 (1.0)	0.78	3.1 (1.3)	3.6 (1.3)	0.69	-0.9 (-1.8,-0.1)	0.03	-1.1 (-1.7,-0.4)	0.01	0.1 (-0.9,1.2)	0.80
Fat	3.1 (1.2)	3.5 (1.3)	0.36	3.6 (1.1)	3.3 (1.3)	0.48	-0.5 (-0.4,-0.1)	0.03	-0.4 (-1.3,0.1)	0.13	-0.1 (-0.7,0.5)	0.77
Of which saturates	2.9 (1.4)	3.4 (1.4)	0.33	3.7 (1.2)	3.9 (1.0)	0.96	-0.8 (-1.3,-0.3)	0.003	-0.4 (-0.8,0.1)	0.11	-0.4 (-1.1,0.2)	0.19
Carbohydrate	3.0 (1.4)	3.0 (1.1)	0.99	3.3 (1.2)	3.8 (1.1)	0.31	-0.3 (-0.3, 0.2)	0.21	-0.8 (-1.3,-0.3)	-0.01	-0.4 (-1.1,0.2)	0.19
Of which sugars	2.9 (1.3)	3.1 (1.3)	0.51	3.5 (1.3)	3.8 (1.2)	0.64	-0.7 (-1.1, -0.2)	0.01	-0.6 (-1.1, -0.2)	0.01	-0.04 (-.7,0.6)	0.89
Fibre	1.9 (0.7)	2.8 (1.1)	0.014*	2.9 (1.1)	3.1 (1.2)	0.53	-0.9 (-1.5,-0.4)	0.004	-0.4 (-0.9,0.03)	0.07	-0.5 (-1.2,0.2)	0.10
Protein	2.7 (1.3)	3.1 (1.3)	0.35	3.3 (1.3)	3.4 (1.2)	0.93	-0.6 (-1.1, -0.1)	0.03	-0.3 (-0.7,0.2)	0.30	-0.4 (-1.1,0.4)	0.32
Salt	2.4 (1.0)	2.9 (1.1)	0.21	3.5 (1.3)	3.6 (1.3)	0.84	-1.1 (-1.7, -0.5)	0.002	-0.8 (-1.3,-0.2)	0.013	-0.3 (-1.1,0.5)	0.42
Reference Intake	2.5 (1.3)	2.7 (1.6)	0.89	3.3 (1.3)	3.8 (1.1)	0.28	-0.8 (-1.4,-0.2)	0.01	-1.2 (-1.9,-0.4)	0.01	0.4 (-0.5,1.3)	0.40
%RI	2.0 (1.3)	2.1 (1.1)	0.52	3.8 (1.2)	3.9 (1.0)	0.51	-1.6 (-2.4,-0.8)	0.001	-1.9 (-2.5,-1.1)	<0.001	0.1 (0.5,-0.8)	0.76

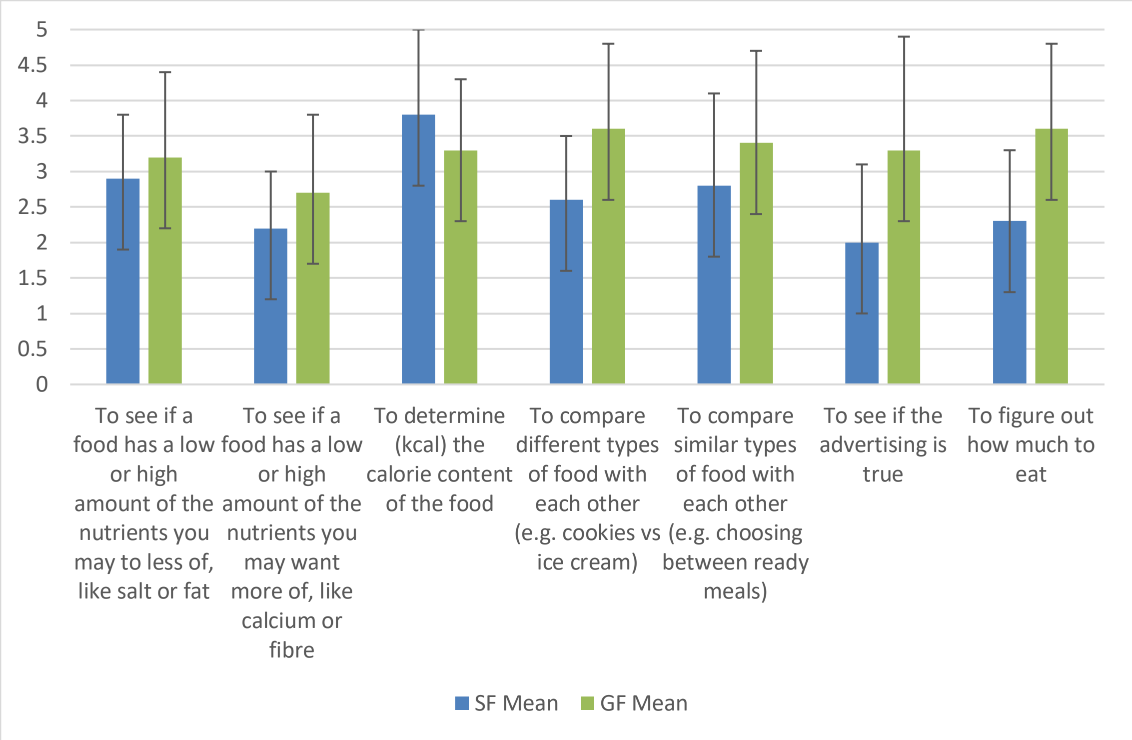
[a] Means and standard deviation. [b] Two-sample t-test to compare pre-course, or post course, scores between groups. [c] Pre and post course scores in each group compared with paired t-tests i.e. a -ve change indicates post-course score were higher than pre-course scores. [d] Independent t-test to compare pre and post-course changes between groups. [f] Pre /post course questionnaires asked: When looking at nutrition labels which components do you/ will you look at (tick all those that apply)? Responses were: Never=1, Rarely = 2, Sometimes =3, Often = 4, Always =5. (Abbreviations: MD = Mean difference, 95% CI = 95% Confidence interval)

3.3.7 Frequency of use of nutrition labels for each of seven different reasons

Participants frequency of use of nutrition labels was evaluated for each of seven different reasons (i.e. “to figure out how much of food to eat”) using a 5-point frequency scale (i.e. 1 = never, 5 = always). Mean levels of frequency of use for each reason were compared between groups as well as between pre and post-course levels (Table 15). At pre-course the GF group possessed significantly greater mean frequency of use of nutrition labels to “check if the advertising is true”, “to figure out how much food to eat” and to “compare different foods”, than the SF group (Table 15, Figure 13). In addition, post-course frequencies of intended use were significantly higher than pre-course for the following reasons;

- To see if a food has a low or high amount of the nutrients you may want more of, like calcium or fibre
- To see if a food has a low or high amount of the nutrients you may want less of, like salt or fat
- To compare similar types of food with each other (e.g. ready meals) (SF group only)

However, no significant differences in these gains was found between SF and GF groups



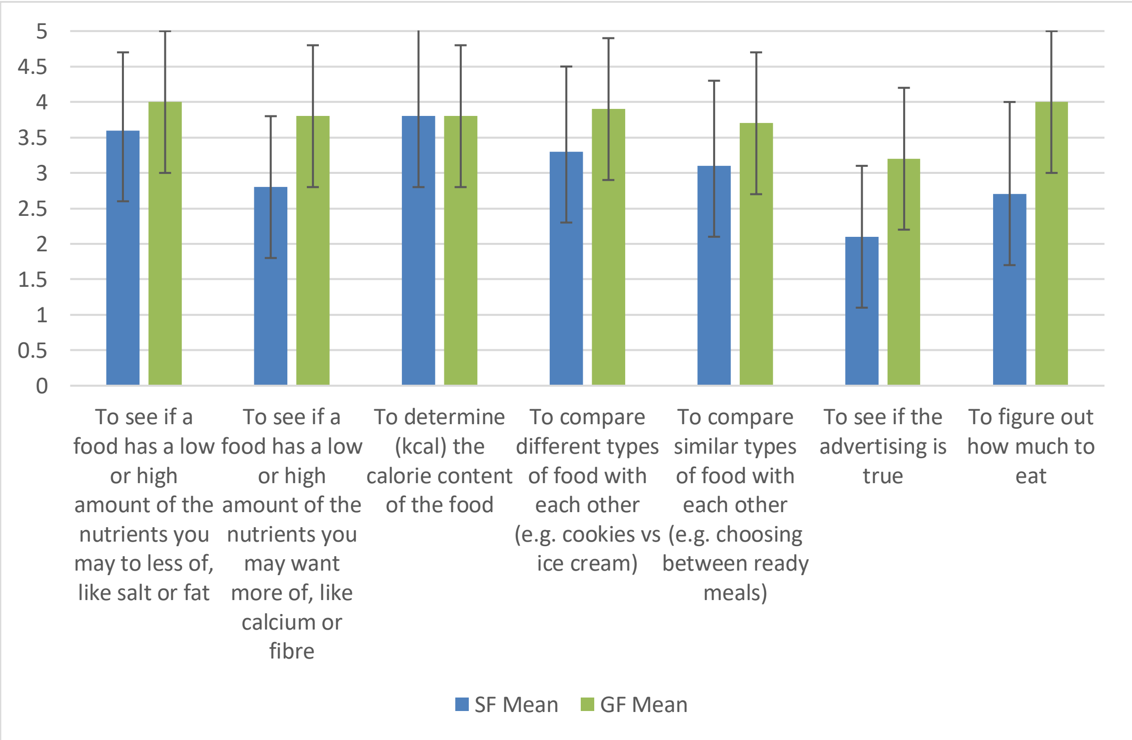


Figure 13 Pre-course (top) and post-course (bottom) mean frequency of use of nutrition labels for each of seven different reasons, by group

Table 15 Mean frequencies of use of nutrition labels for each of seven reasons, by group, at pre and post-course

	Pre-course [a]			Post-course [a]			Pre post-course paired t-tests (d)				Between group differences (SD vs GF) in the pre-post-test changes [d]	
Item [e]	SF (n=16)	GF (n=17)	P[b]	SF (n=15)	GF (n=16)	P[b]	SF MD (95% CI)	P[c]	GF Md (95%CI)	P[c]	MD (95% CI)	P[d]
To see if a food has a low or high amount of the nutrients you may want less of, like salt or fat	2.9 (0.9)	3.2 (1.2)	.53	3.6 (1.1)	4.0 (0.8)	.35	-0.7 (-1.2, -0.3)	.003*	-0.9 (-1.3.-0.5)	<.001*	0.1 (-0.4,0.7)	.61
To see if a food has a low or high amount of the nutrients you may want more of, like calcium or fibre	2.2 (0.8)	2.7 (1.1)	.14	2.8 (1.0)	3.8 (1.2)	.03	-0.6, (-1.0, -1.2)	.01*	-1.0, (-1.6, -0.4)	.01*	0.4 (-0.3,1.1)	.15
To determine the calorie (Kcal) content of the food	3.8 (1.2)	3.3 (1.0)	.18	3.8 (1.5)	3.8 (1.1)	.98	0.06 (-0.4,0.5)	.75	-0.5 (1.2,0.2)	.14	0.6(-0.1,1.3)	.15
To compare different types of food with each other (e.g. cookies vs ice cream)	2.6 (0.9))	3.6 (1.2)	.01*	3.3 (1.2)	3.9 (0.7)	.14	-0.5 (-1.0, 0.1)	.09	-0.4 (-0.8, 0.1)	.11	-0.5 (-1.2,0.2)	.14
To compare similar types of foods with each other (e.g. choosing between ready meals)	2.8 (1.3)	3.4 (1.3)	.19	3.1 (1.2)	3.7 0.9)	.16	-0.6, (-1.2, -0.02)	.05*	-0.1 (-0.6,0.4)	.79	-0.1 (-0.8,0.6)	.79
To see if the advertising is true	2.0 (1.1)	3.3 (1.6)	.01*	2.1 (1.0)	3.2 (1.0)	.01*	0.00 (-0.5,0.5)	.90	0.3 (-0.6,0.9)	.72	-0.3 (-1.0,0.7)	.71
To figure out how much to eat	2.3 (1.0)	3.6 (1.2)	.002*	2.7 (1.3)	4.0 (0.9)	.003*	-0.5 (-1.3,0.4)	.26	-0.4 (-0.9,0.08)	.09	-0.03 (-1.0,0.9)	.95

[a] Means (standard deviation), [b] Independent t-test to compare pre-course, or post-course, scores between groups.
[c] Pre and post course scores for each group compared with paired t-tests. [d] Two-sample t-tests to compare changes in pre to post-course scores between groups (i.e. a -ve change indicates post-course score were higher than pre-course scores). [e] The pre-course questionnaire asked: How often do you use nutrition information for the following reasons? Post-course questions included “Following the course, how often do you think you will now use nutrition information for the following reasons?”. Responses were: Never=1, Rarely = 2, Sometimes =3, Often = 4, Always =5. Abbreviations: MD= Mean difference, 95% CI = 95% Confidence interval

3.3.8 Time taken to view and complete quiz materials

For the SF group, the average time to view all the course materials and questionnaire was 24.4 minutes (SD 8.9). this was less than for the GF group (mean time = 28.1 minutes (SD 10.6) (see Table 16). Compared to the SF group, the GF group may have spent less time completing the post-course quiz, although this took around 5 minutes or less for each group (See Table 16).

3.3.9 Learner engagement: Eye fixations and dwell time

The mean number of eye-tracked fixations on slide number 2.4 were found to be significantly greater for the GF compared to the SF group (MD= -20.9, 95% CI: -29.7, -12.1) (see Table 16). Accordingly, the total dwell time spent viewing this slide was also significantly greater for the GF, compared to the SF group (MD = -13.7, 95% CI: -18, -9.5) (see Table 16).

Table 16 Mean number of (eye-tracked) fixations and time on slide 2.4, by group.

Engagement measure	SF mean (SD)	GF mean (SD)	Difference between groups	
	n=16	n=16	Mean difference	P[1]
Overall time spent reviewing course materials (including questionnaire and quiz) (minutes)	24.4 (8.9)	28.1 (10.6)	-3.7 (-10.7, 3.4)	0.30
Time spent on quiz (seconds)	330.4 (80.6)	285.1 (26)	45.3 (-4.9, 95.6)	0.08
	n=15	**n=12**		
Number of fixations on slide 2.4	30.3 (11.3)	51.3 (10.9)	-20.9 (-29.7, -12.1)	<0.001
Total dwell time on slide 2.4 (seconds)	16.1 (5.8)	29.8 (4.7)	-13.7 (-18, -9.5)	<0.001

[1]Independent t-tests between groups. SD = Standard deviation

3.3.10 Participant feedback on questionnaires and experience

Informal feedback was obtained from three study participants on their experience of taking part in this study and completing the questionnaires and quiz. This insight was used to inform development of the future online survey (see Chapters 2 and 4). Feedback was sought from three participants who were approached, at the researcher’s convenience, following their completing of the study and asked if they could provide their thoughts and feedback on the study and questionnaires. All three agreed to provide feedback whilst viewing a playback recording of their computer screen which showed their use of the VLE and questionnaire during the study. In addition, written feedback was collected from all participants within the final question of the post-course questionnaire. For example, all three participants commented that the questions evaluating reading, use and influence of nutrition label on purchase choices should be located together, not apart. These responses were positive “good” or focussed on time taken to complete the questionnaires. For the latter, two respondents indicated that the, items evaluating frequency of viewing or levels of self-rated understanding of 11 specific nutrition label components (i.e. “kcals”, “Fat”) were “too long”. Verbal feedback from the select three participants also confirmed this. They felt these sections were overly burdensome for participants and also not well defined (i.e. it was not clear if these related to front or back-of-pack labels).

Furthermore, these participants thought that items evaluating self-rated nutrition knowledge, or interest in nutrition, were insufficiently defined and possible similar and therefore their meaning of this was “guessed”. In addition, the two items relating to self-rated confidence in (own) understanding and perceived understandability of nutrition labels were both presumed similar and to relate to participants’ own understanding, rather than label-specific understandability. Finally, the nutrition label images and questions which related to them were also queried. In one case this was due to the question asking about the serving size, which appeared to be “per quiche” and therefore was considered as unfeasible by participants, when this serving size was in fact for a “mini” quiche product.

3.3.11 Statistical power of the pilot sample size

3.3.11.1 Post-hoc power calculations

Another objective of undertaking this study was to use the effect sizes assessed here to inform the required sample size for a larger survey planning to evaluate nutrition label understanding and use in older adults. Estimates of the post-hoc power of the sample size used here were calculated by using the software G-power (G*Power 3.1.9.2, Germany). These used the observed differences between SF and GF groups for measures of nutrition label understanding, frequency of use, and learner engagement (Table 17).

Objective understanding of nutrition labels (quiz score)

Based on the means and standard deviations of (post-course) quiz scores for each group as compared by independent t-tests, the power (1-β) of the sample size to detect the observed effect sizes of a between group mean difference of approximately 1.5 correct quiz questions (95% CI: 0.2, 2.8) was 62%, at the 0.05 significance level. As such, an increased group size of 30 participants per group was calculated as the sample size required to detect this effect size (in number of correct questions answers) with a power of 80%, at the same significance level.

Nutrition label use (influence on purchase decisions)

Results obtained in this study were used to calculate a post-hoc power analysis of the sample size to detect the observed small differences in frequency of use between SF and GF groups. Mean differences in self-reported frequency of label use was measured using a 5-point Likert scale (i.e. corresponding to never = 1, always = 5). The power of this study to detect the post-course observed difference in mean frequency of use of nutrition labels between groups (i.e. a mean difference of 0.3, 95% CI: -0.7, 0.01) was low (21%). As such, for this outcome the risk that a type II error (β) could occur was high (79%). A sample size of 100 participants in each group (i.e. 200 in total) would therefore be required in future to obtain a statistical power of 80% with a significance level of 0.05.

Self-rated understanding of nutrition labels

Means and standard deviations of participants' (post-course) self-rated understanding scores for the SF and GF groups were obtained using a 5-point scale (i.e. these ranged from 1= very unconfident, 5= very confident). These were compared by independent t-tests to calculate the power (1-β) of the existing sample size to detect the observed effect size between groups for this variable at post-course (see Table 17). At the 0.05 significance level, the power of the existing sample size to detect this difference was low (50%). As such, 40 participants per group would be required to detect the same effect with a power of 80%, at the same significance level.

Alternatively, differences in this outcome were also assessed using independent t-tests between frequent vs infrequent label users as part of the post-hoc analysis performed here (see previous section 3.4.2.1). For the existing sample size, a mean difference of 0.8 in self-rated understanding between groups was detectable with 67% power at the 0.05 significance level. As such, to detect differences between these user groups with an 80% power at the same significance level, a sample size 30 people in each group (n=60) would be required.

Table 17 Post-hoc calculated power of the sample to detect the observed differences between groups in specific outcomes

Outcome measure	SD	GF	Power (1-β) (%)	Group size required for 80% power at 0.05 significance
	n=16	n=16		
Quiz score, mean (SD)	7 (1.9)	8.5 (1.7)	62%	30
	n=15	n=16		
Self-confidence in understanding of nutrition labels (post-course) (5-point scale)	3.4 (1.1)	4.0 (0.9)	50%	40
Frequency of influence of nutrition labels on purchases (post-course), mean (SD) (5-point scale)	3.2 (0.9)	3.6 (1.1)	21%	100
	n=15	n=12		
Number of fixations on slide 2.4, mean (SD)	30.3(11.3)	51.3 (10.9)	99%	6

3.4 Discussion

This study represented a funded opportunity for the researcher to work in collaboration with other academics on three project aspects, at an early stage in the PhD journey. Aspects were: (1) a review of consumer-facing materials which supported consumer use of the new UK nutrition labelling formats, (2) the need to create and pilot online data collection tools to evaluate understanding and use of this information to inform the future survey in this area among older adults and (3) to obtain some insight into the potential variation in "quiz scores" (reflecting label understanding) which can be used to estimate the required sample size for this future survey, which aims to evaluate nutrition label use and understanding (Chapter 4). In the context of the PhD these three aspects will be discussed below, with reference to the initial pilot study research questions.

3.4.1 Review of consumer-facing nutrition label education materials

First, this work has provided the opportunity to gather insight into the available consumer-facing information designed to support consumer use of the new UK nutrition labels, following several changes to label format and terminology under new EU Regulations (Chapter 1). This review did show a lack of publicly available material in this area. This is potentially important since, at the time of this study, the majority of food products available in the UK marketplace were already displaying that food labelling compliant with the EU Regulation 1169/2011 and consumer were expected to use this information. However, it is possible that the number of UK resources which were found to present information concerning the previous nutrition labels (i.e. those which included sodium and "GDAs") reflected the fact that the official transition period (2014-2016) for the implementation of the new nutrition labels was currently in progress. As such, UK retailers' webpages and other country's resources on nutrition labels were also drawn upon to supplement the learning materials used in this study, which were based mainly on the NHS Choices webpage resource on this topic (NHS, 2014). Additional materials also referred to include the US FDA materials explaining the percentage daily values (%DVs) (Center for Food Safety and Applied Nutrition, FDA, 2015). These resources allowed the creation of two sets of text and image-based learning materials of different presentation formats which were provided for participants to use within the VLE (i.e. a SF VLE and PowerPoint slide set and GF VLE and narrated/animated version).

3.4.2 Piloting data collection tools evaluating use and understanding of current UK nutrition labels

Second, this project has enabled the development and piloting of data collection tools which were designed to evaluate characteristics related to use and understanding of the current UK nutrition labels, among undergraduate students. Overall, insight from the testing of these pilot tools within the VLE has provided valuable insight to inform the further development of online data collection questionnaire items, as indicated in this Chapter and detailed in Chapter 2. For example, analysis of data collected from participants with these tools and via the use of the VLE (i.e. time taken to complete materials and quiz questions), together with participants' verbal feedback has enabled further tool refinement of the forthcoming online survey of older adults (Chapter 2).

Specifically, piloting these online data collection tools and analysing data obtained with them also provided specific insight into how to optimise online survey data collection. For example, aspects of online data collection process which were considered important include: ensuring non-optional completion of questionnaires; designating the correct order of ordered-scale answer options; and collecting data on participant's selection of (any) multiple-choice answer options within the quiz. In addition, the average time taken to complete the online "quiz" by both groups (i.e. around 5 minutes or less) which was considered feasible for onward use within an online survey.

Further insight from the statistical analysis reported here as well as participant feedback was also valuable to help refinement items and the overall content of the questionnaire and quiz. For example, participants' self-confidence in own understanding of nutrition labels (self-rated understanding) appeared to increase following the course, this item was therefore retained for use in the online survey as an indicator of self-rated understanding. In contrast, the item relating to the perceived understandability of labels appeared to be presumed similar by participants and therefore removed. The specific revisions to the future online survey are listed in Chapter 2.

3.4.3 Potential for nutrition label education to influence label understanding and usage

Some initial insight into the possible effects of basic nutrition label education on participants' label understanding and use has also been provided by this pilot study. Analysis of the data collected using these pilot tools suggests there may be some effect of viewing and presentation format of learning materials on participants' understanding and anticipated use of UK nutrition labels. Specifically, the "grid format" (GF) VLE presentation and associated narrated/animated learning materials may have been more effective than the standard format at enabling participants' learning (and engagement) with the online platform.

To elaborate, objectively evaluated understanding of nutrition labels, as indicated by mean (post-course) quiz scores, for the GF group were significantly higher than for the SF group. This potential difference equated to correctly answering approximately 1.5 of the 11 quiz questions. However, any shortfall in comprehension between groups could not be attributed to a specific quiz question since there were no significant differences between groups in proportions of correct answers for each individual quiz question. Despite both groups having viewed the course learning materials, the variability in proportions of correct answers across post-course quiz questions should be noted. These ranged from 25% to 100% in both groups, with the highest proportions of correct answers corresponding to those questions which concerned front-of-pack nutrition label information. However, due to the limitation of the VLE "quiz creator" feature, no information was obtained on participants' most commonly selected (multiple-choice) answers which were incorrect. This may have provided insight into features of the materials which most facilitated learning, or else participants' common misunderstanding of the presented back-of-pack nutrition label information.

In addition, participants in the GF group may have also increased their self-rated understanding of nutrition labels more so than those in the SF group. For example, following their viewing of course materials, mean self-confidence in label understanding increased significantly for the GF, but not for the SF, group. This suggests the GF group may have felt more confident in their learning following the course. However, no significant difference in pre post-course changes of this characteristic were found between the GF and SF groups. In addition, responses to the item on how easy nutrition labels are to understand (perceived understandability of labels) did not change.

Findings are also mixed in terms of the potential effect of the course, or course format, on the frequency of use of nutrition labels. However, there are indications that GF group participants reported increased (intended) use of this information, compared to SF participants. For example, in contrast to SF group participants, mean frequency of (intended) reading and use of nutrition labels were found to be potentially increased from pre to post-course in the GF group only. However, this increase was not found to be significantly different between the SF and GF groups. Furthermore, pre post-course increases were not significant for either group concerning influence of this information on purchase choices. However, both groups appeared to increase their reported frequency of viewing of some specific components of nutrition labels, from pre to post-course. These include the "Reference Intake" and "%RI" label components, which were highlighted visually in the course learning materials. Conversely, the lack of effect of the course of pre-post levels of viewing of "kcal" information for either group may be explained by participants' pre-existing higher levels of frequency of viewing of this label component at pre-course, relative to other (i.e. %RI) components. Overall, the results suggest there may be some potential effect of undertaking the course, as well as the presentation of learning materials on participants' understanding and intended usage of nutrition labels and their specific components (i.e. %RI).

3.4.4 Learner engagement

Data was also analysed to obtain an indication of the possible effects of the course, as well as the different presentations of the VLE and learning materials, on learning and engagement outcomes, including understanding and use of nutrition labels. A favourable effect on learner engagement of the combination of the grid format (GF) VLE and narrated/animated learning materials was indicated by this study. For example, compared to the standard format (SF) group, GF group participants appeared to attend more to information presented on a specific slide (i.e. number of fixations) and spent longer viewing the overall course materials. Comparable findings have also been reported by other work undertaken within the specific VLE platform (called Moodle) used here. The organisation of Moodle course pages and materials was linked with undergraduate learners' attention and ease of navigation, which was also thought to have impacted on their learning processes (Rakoczi, 2010).

In addition, the narrated and animated slides presented to GF group participants may also help explain why these participants appear to have greater levels of engagement and learning (quiz score), compared to the SF group. Although differences were not significant, the GF group spent longer viewing the course materials and less time on the quiz, compared to the SF group. Since the GF group scored higher on average in the quiz, compared to the SF group, these findings suggest the materials provided to GF group participants may have facilitated greater engagement and effective learning.

Other research has also indicated that levels of exposure (amount of material viewed) when using internet-based nutrition education, may positively influence learning in relation to awareness of labelled serving size (Poelman et al., 2013). Furthermore, the requirement for GF group participants to watch and listen to slides (which were narrated and animated) may have also favoured these participants effective learning, compared to SF participants who needed to read the text and refer to images. One reason for this may be that SF participants needed to "switch" between images and text. Capacity to switch between images and text is thought to be an influence on how well these information sources are integrated (Baadte et al., 2015). Specifically, such capacity to switch between text and images was a factor in how learners allocated their attention to text integrated images and was also associated with task performance (text comprehension) (Baadte et al., 2015). This capacity maybe particularly important when learning about the visual information displayed on nutrition labels yet is not known to have been specifically explored in this area of education. Overall, the current study suggests organisation of materials on the VLE, as well as the presentation of the material itself, might help support learning and increased engagement.

3.4.5 Pre-course differences in personal characteristics between groups

In line with the study's primary research aims, analysis of the data was undertaken to address the research questions concerning differences between groups in any pre-existing (pre-course) characteristics related to participants' nutrition label use (i.e. frequencies of use of nutrition labels, levels of nutrition knowledge etc.), which might have influenced their learning or engagement with the course materials. For example, participants' levels of self-rated nutrition knowledge and label use characteristics were evaluated here since these have previously been associated with understanding of nutrition labels (Grunert and Wills, 2007). In addition, participants were recruited from undergraduate Psychology (i.e. non-nutrition) programmes and were quasi-randomised. As such, this evaluation was used to determine that there was no evident statistical imbalance at baseline in characteristics related to use of nutrition labels, between the SF and GF groups. These included participant's frequency of use of nutrition labels, interest in nutrition and their "advised" use of food labels, as well as their self-rated nutrition knowledge and self-rated levels of understanding and perceived understandability of this information. Furthermore, the proportions of "frequent" and "infrequent" label users did not vary significantly between SF and GF groups at baseline.

Post-hoc analysis of differences between "frequent" vs "infrequent" label users was also performed here to explore how specific characteristics related to frequency of use of nutrition labels, at pre-course. Indeed, specific characteristics did appear to differ significantly according to frequency of label use (i.e. frequent vs infrequent influence of nutrition label on purchases). These included, levels of self-rated nutrition knowledge and self-rated understanding of nutrition labels. These findings support other research that those consumers who use this information most frequently may possess higher levels of nutrition knowledge and subjective understanding (Campos et al., 2011; Grunert and Wills, 2007; Miller and Cassady, 2015).

3.4.6 Limitations

This study was limited by the lack of control group (i.e. who did not view the learning materials). Including such a control group would have helped further distinguish if there was an effect of participating in the intervention, or completing the pre post-course questionnaires/quiz, on characteristics relating to understanding and use of nutrition labels. In addition, it was decided not to require participants to undertake a pre-course quiz assessing (pre-existing) objective understanding of nutrition labels at baseline. Although this would have ascertained levels of baseline understanding of nutrition labels and enabled analysis of the effects of these on post-course quiz scores. Although unlikely, the lack of control group and the absence of this baseline measure of participants' pre-existing understanding of nutrition labels means that it is possible that participants' post-course quiz score simply reflects their pre-existing label knowledge. Given the study's primary aim, the inclusion of another set of pre-course questions was felt overly burdensome for participants. In addition, the decision to assess participant's learning at post-course only also reflected the usual use of the VLE by undergraduates. That is, to view course materials rather than performing repeated "tests". However, it is acknowledged that the insight obtained by using a control group and pre post-course assessments of objective understanding would have shed more light on the effect of intervention on the outcome of objectively evaluated nutrition label understanding within the current PhD project.

In addition, the combination of VLE and learning materials formats used in each group meant that it was not possible to conclude which change was more impactful on learning and engagement. However, the SF group were provided with VLE (list layout format) and (PowerPoint slides) learning materials format which reflected "usual" University practice, which was considered a comparator.

A further limitation was the small sample size used here. This was able to detect some significant differences between groups for mean quiz score, frequencies of nutrition label usage and learner engagement (viewing). However, these results should be treated with caution since the post-hoc power analyses show that, except for learner engagement (i.e. eye tracked number of fixations), the power of this sample to detect the observed effect sizes in differences between groups for nutrition label understanding and related outcomes was below 80%. As such, the probability of a type II error occurring (i.e. where no difference is found when this might exist) is higher than ideal. In addition, any between group differences in performance for specific individual quiz questions might have also been masked by this small sample size. The results from this pilot work did, however, provide a basis on which to estimate the size of sample which is required in the older adult survey evaluating use and understanding of labels (see Chapter 2 section 2.4.5 and Chapter 4 section 4.3.3).

Finally, multiple statistical tests were performed on the data here, increasing the chance of finding significant differences between groups or between pre post-course measures, due to multiple testing. This might have been improving had a stricter cut off e.g. $p<0.001$ been used.

3.4.7 Findings in the context of the PhD project

Given the potential differences in effects on label understanding of the two different formats of computer-based nutrition label education describe here, further insight into the effects of other educational interventions targeting understanding and use of nutrition labels is now warranted. Aspects of educational materials and intervention features which may impact on participants' understanding and use of nutrition labels should now be reviewed using the wider literature base. This work may highlight other important features of education which can enhance learning and understanding of labels. For example, the present learning material slide sets were based only on descriptive explanatory content (i.e. mainly from the UK NHS Choices webpage) and not on the needs of a target population as reporting in earlier research concerning education on nutrition labels (Dooley et al., 1998). In addition, since this pilot study took place entirely online within the University VLE (not "in-class"), it is also of interest to examine the evidence on the effects of nutrition label education delivery formats, including those undertaken "in-class", on consumers' nutrition label use and understanding. Further investigation into the area of nutrition label education will be explored with a systematic literature review in Chapter 6.

3.5 Conclusion

Overall, analysis of the data collected here, including participants' feedback, can now be used to further refine the online data collection tools to evaluate use and understanding of nutrition labels in the online survey of older adults (See Chapters 2 and 4). This pilot work suggests that the format of nutrition label education may potentially affect use and understanding of nutrition labels and warrants further research.

Chapter 4 Understanding and use of new UK nutrition labels among older adults

4.1 Abstract

Objective: To evaluate understanding and use of current UK nutrition labels and potentially supportive characteristics among older adults. **Methods:** An online survey questionnaire was used to evaluate frequency of the influence of nutrition labels on food purchases as well as levels of personal motivation and nutrition knowledge characteristics among older adults' (aged 50 yrs or older). Also assessed was respondents' objective understanding of terminology and basic label data declared on current UK front and back-of-pack nutrition labels. Descriptive statistics and logistic regression were used to identify characteristics predictive of frequent vs infrequent nutrition labels use. **Results**: Around half (51%) of the survey respondents (n = 181, mean age 58.6yrs) reported nutrition labels frequently influenced their purchases (51%). These respondents were more likely to be female, previously advised to use labels and report greater dietary healthiness, compared to infrequent label users. Logistic regression showed a one unit increase in personal involvement with nutrition labels, or nutrition knowledge, resulted in respondents being 10%, or 30%, more likely to report frequent label use, respectively (OR 1.1, 95% CI: 1.1, 1.2 and OR 1.3, 95% CI: 1.1, 1.5). Self-rated (OR 1.2 95% CI: 1.0, 1.5), but not objective (OR 1.1, 95% CI: 0.9, 1.3), understanding of nutrition labels also predicted frequent use of this information. Respondents overall objective understanding of nutrition labels was moderate but varied according to specific socio demographics and whether respondents had been previously advised to use food labels. Issues understanding the term "Reference Intakes (RI)" or locating "per serving" label data were identified. **Conclusions**: Frequent use of nutrition labels among these older adults is associated with greater personal motivations and nutrition knowledge, but not objective understanding of this information. Older adults, including those who use nutrition labels frequently, may benefit from education to improve their understanding of the current UK nutrition labels.

4.2 Introduction

Chapter 1 has shown a clear lack of research concerning consumer engagement with the current UK front and back-of-pack nutrition labels. The existing literature has also described several consumer characteristics which might be associated with nutrition label use including levels of nutrition knowledge, motivation, education and age, yet there is a lack of specific insight into these concerning nutrition label use among older UK adults. In addition, the literature suggested that whilst older adults may be more motivated to use nutrition labels, than younger adults, they may be less able to understand this information. The second research objective of this PhD was therefore to evaluate use and understanding of current UK nutrition labels and potentially related personal characteristics in older adults. This chapter describes the findings of the online survey of older adults which aimed to evaluate both objective understanding and use of current UK nutrition labels and potentially related personal characteristics.

4.2.1.1 Aims

The two aims of this study were to;

(1) Evaluate frequency of use and objective understanding of current UK nutrition labels in older adults. (2) Assess associations between these main outcome characteristics and sociodemographic and personal characteristics, including nutrition knowledge and personal involvement with nutrition labels.

4.2.1.2 Hypotheses

The previous review of the literature (Chapter 1) has described a conceptual framework of consumer use of nutrition labels, which indicates that nutrition knowledge and label understanding are key antecedents to use of this information in consumers' purchase evaluations (Grunert and Wills, 2007). Based on this framework, two hypotheses informed the design and statistical analysis of this survey which were described in Chapter 2.

1. Levels of label use and objective understanding of current UK nutrition labels will vary with specific socio demographics (age, gender, education) and levels of personal characteristics, including advised use of food labels, personal motivations and general nutrition knowledge.

2. Levels of objective and subjective (self-rated) understanding of nutrition labels, personal motivations and nutrition knowledge will determine frequency of use of this information in these consumers.

4.3 Methods

4.3.1 Study design and ethical approval

This study used an online survey questionnaire to collect data on understanding and use of the current UK nutrition labels from a convenience sample of adults aged 50 years and older. This study was granted written University Departmental Ethics Committee approval before commencing (Appendix G)

4.3.2 Survey questionnaire

The development of the pilot and online survey data collection tools has already been described in Chapters 2 and 3. Included in Chapter 2 is a description of how the existing literature was used to inform quiz question items, which needed to be adapted to refer to current UK front and back-of-pack nutrition labels. Measures of respondents' frequency of label use, personal involvement with nutrition labels and nutrition knowledge (of healthy eating) were also included in the survey, as also described in Chapter 2. The online survey is shown in Appendix D.

4.3.3 Sample size

An estimate of the required sample size for the survey has been calculated as 200 respondents assuming a power of 80% to detect a between group difference in both quiz score (1.5 correct answers) and frequency of label use (i.e. a 0.3 difference in the 1-5 frequency scale), at the 0.05 significance level (see Chapter 2 section 2.4.5). The origin of the data used to inform this calculation is described within the prior pilot study of undergraduates (Chapter 3, see 3.3.11).

4.3.4 Respondent eligibility

The initial survey screening question asked if respondents were 50 years old or older, in line with the rationale presented in Chapter 2 (section 2.4.1) and Chapter 1 (section 1.5.2).

4.3.5 Recruitment

A weblink to the online survey (hosted by Bristol Online Surveys, University of Bristol, UK) was distributed by email between July and November 2015. Convenience sampling was employed by initially emailing invitations to contacts at the local City Council, three regional Universities and Leeds based businesses, with instructions to forward to others. These were chosen because they are among the largest organisations in Leeds and therefore employ the largest number of people. Attempts were also made to include respondents from under represented communities, or those without computer or internet access at home. For example, the survey email invitation was also specifically shared with tutors at known Third Sector community centres in Leeds for promotion during their adult education computer skills classes (e.g. Beeston Community Hub, Leeds, UK). To also help recruit respondents, “snowball” convenience sampling was undertaken whereby potential respondents who had received the email were encouraged to forward the invitation to their contacts aged 50 yrs or older. These methods of enabling recruitment using relationships with community-based organisations and participants’ peer networks has been described in recent work examining strategies to recruit with older adults (McHenry et al., 2015). The email invited adults aged 50 years or older to complete a survey concerning “food choice and use of information” in order to aim to obtain data from respondents with a range of characteristics and motivations, not just those focused on nutrition label use.

4.3.6 Survey data analysis

4.3.6.1 Data management

All online survey questions and quiz items, except for those relating to online grocery shopping (reported in Chapter 5), were designated as mandatory to avoid missing data. This was identified as important during the piloting of data collection tools, to avoid incomplete questionnaires. Following the survey’s closure in November 2015, data was exported into Excel spreadsheets for analysis in SPSS. No open questions were present in the survey. Responses obtained using 5-point and 7-point response scales were first coded numerically before being analysed (see Chapter 2 section 2.4).

4.3.6.2 Statistical analysis of the online survey data

Ordinal outcome measures, including those measuring use and influence of nutrition labels and online nutrition information, were conservatively dichotomised for analysis according to analyses performed in other studies (i.e. Frequently = Always/Often, Infrequently = Sometimes/Rarely/Never) (Sharif et al., 2014). For continuously measured variables, frequency distributions were first assessed for normality using histograms and skewness and kurtosis indicators. Both nutrition knowledge scores and objective understanding of nutrient labels (quiz score) were found to be positively skewed and non-normally distributed and were therefore described using medians and the interquartile range. Respondents' ethnicity, education and occupation sub-categories were first described, before being collapsed into two categories for further analysis. For example, educational attainment was dichotomised as higher education (i.e. University level education including HNC/HND/Diploma) or less than higher education. Respondents' occupation was dichotomised as "managerial and professional occupations" or "other occupations" (including unemployed, lower supervisory and intermediate). Objectively assessed understanding of nutrition labels (quiz scores) was dichotomised using a median split (Block and Peracchio, 2006).

Differences between sub-groups in normally distributed continuous outcomes (i.e. items evaluated using 7-point scales; personal involvement scores, self-rated understanding of nutrition labels, confidence in technology) were assessed using independent t-tests. Differences in proportions of categorical variables by respondents' frequency of use of nutrition labels (i.e. frequent or infrequent) were examined using chi-squared tests (or Fisher's exact test where group sizes within 2x2 contingency tables were less than 5). Due to the non-normal distribution of respondents' nutrition knowledge scores, differences in this variable between sociodemographic, or quiz score, groups were analysed using the Mann-Whitney U test. A statistical significance level of $p < 0.05$ was used throughout. All analyses were undertaken using IBM SPSS Statistics software Version 21.

4.3.6.3 Regression analysis

To investigate characteristics predictive of frequency with which nutrition labels influenced purchases (i.e. frequent vs infrequent), logistic regression models were built. Independent variables which were potentially associated with use of nutrition labels in purchase evaluations were identified from the prior descriptive analysis and guided by the existing theoretical conceptual framework (Grunert and Wills, 2007), described in Chapter 1. In this framework, several non-independent influences on consumers' use of labels have been identified, including nutrition knowledge and label understanding which may also be associated themselves. In recognition of the interdependence of these exposure variables, separate models were built to examine the effects of each variable on the dependent variable (frequency of the influence of nutrition labels on purchase choices), while accounting for sociodemographic and other characteristics. Each model therefore included one of the following variables as key exposures: self-rated understanding of nutrition labels; objectively evaluated understanding of nutrition labels (quiz score); personal involvement with nutrition labels; nutrition knowledge score. Models were adjusted to account for age, gender, advised label use, occupation and educational attainment, based on the previous literature and the associations with these confounding characteristics which were found in the prior descriptive analysis. For all models, input was by the "enter" method. Following construction, assumptions for logistical regression models were tested and met. A statistical significance level of $p < 0.05$ was used throughout. All analyses were undertaken using IBM SPSS Statistics software Version 21.

4.4 Results

4.4.1 Responders

A total of 438 respondents viewed the initial age-screening question restricting respondents to those aged 50 years or older. Subsequently, 181 respondents completed the survey questionnaire. All participants gave online consent before their participation. No data was collected on non-respondents.

4.4.2 Sample Characteristics

The 181 respondents were aged 50 - 93 with a mean age of 58.6 years (SD ± 7.8 years) (see Table 18). Most respondents were female (73%) and of white British ethnicity (90%) with university level education (65%) and had (including pre-retirement) occupations classified as Managerial or Professional (65%). Most respondents rated their diet and general health as "good" or "excellent" (78%, 80% respectively). Almost a third (30%) indicated that themselves or a member of their household had a personal diet or medical condition such that looking at food label information had previously been "advised".

Table 18 Survey sample characteristics

	Respondents (n=181)	
	n	(%)
Gender		
Female	132	(73%)
Male	49	(27%)
Age		
50-59	116	(64%)
60-69	51	(28%)
70+	14	(8%)
Advised label use [a]		
No	126	(70%)
Yes	55	(30%)
Ethnicity		
White/White British	162	(90%)
White Other	6	(3%)
Black/Black British (e.g. African, Caribbean)	5	(3%)
Asian/Asian British (e.g. Pakistani, Chinese)	4	(2%)
Other/mixed ethnic groups (e.g. White and Black Caribbean)	4	(2%)
Education		
University	84	(46%)
HNC/HND/Diploma	34	(19%)
City and Guilds Technical or Trade Certificate	8	(4%)
AS / A Levels	13	(7%)
NVQ / GNVQ	9	(5%)
O Levels	22	(12%)
CSEs	5	(3%)
None	6	(3%)
Occupation		
Managerial/Professional	118	(65%)
Intermediate Occupations	49	(27%)
Semi routine or Lower supervisory and technical	10	(6%)
Small employers own account workers	2	(1%)
Unemployed	2	(1%)
Healthiness of diet [b]		
Good or excellent	141	(78%)
Fair or worse	40	(22%)
General Health [c]		
Good or excellent	145	(80%)
Fair or worse	36	(20%)
Age, mean years (SD)		58.6 (7.8)
Nutrition knowledge [d], median (IQR)		11 (10, 13)
Personal involvement with nutrition labels [e], mean *(SD)*		47 (10.0)

a Respondents answered yes or no to the question; "*Do you or a member of your household have a personal diet or medical condition where looking at food label information is advised*"? b Dietary healthiness was self-rated using the question item "How would you rate the healthiness of your diet" using a five point scale (i.e. "Excellent, Good, neither healthy nor unhealthy, fair , poor") which was diachotomised (i.e. 1= Excellent/Good, 0 = Neither, Fair, Poor) , c General healthiness was self-rated using the question item "How would you rate your general health?" using a five point scale (i.e. "Excellent, Good, neither healthy nor unhealthy, fair , poor") which was diachotomised (i.e. 1= Excellent/Good, 0 = Neither, Fair, Poor). d Nutrition knowledge quiz score is out of maximum of 13, e Personal involvement with nutrition labels score was of a maximum of 70.. Abbreviations: SD = Standard Deviation, IQR= Interquartile Range.

4.4.3 Respondents levels of nutrition knowledge and personal involvement with nutrition labels

Nutrition knowledge scores were generally high with a median score of 11 out of 13 (IQR 10 to 13). Within the 13-item nutrition knowledge test, the item with the fewest correct responses (51.9%) was "*A healthy meal should consist of lean meat, one quarter vegetables and one quarter side dishes*". The item with the most correct responses (98.3%) was; "*A healthy diet means nothing more than eating vitamins*" (Table 19). Median nutrition knowledge scores among those with high educational attainment (median = 11.5 IQR: 10,13) were significantly higher than those with lower educational attainment (median = 10 IQR: 9,12) ($U= 2859$ $n_1= 118$ $n_2= 63$ $p = 0.01$). The only other difference in nutrition knowledge scores between sociodemographic groups was between white British (median = 11 IQR:10,13) (mean rank 93.8) and non-white British ethnicities (median = 10 IQR:7,12) ($U =1078$, $n_1= 162$ $n_2= 19$, $p = 0.03$).

Table 19 Percentage of correct responses to each question within the general nutrition knowledge test

Question	% correct (False)
Fruit can be fully replaced by vitamin and mineral supplements	85.1
A healthy diet means nothing other than eating vitamins	98.3
If crisps did not contain salt you could eat more of them without any problem	86.7
To eat healthily, you should eat less, it does not matter what foods you reduce	86.8
Meat should be the basis of our daily diet	92.8
Instead of eating fruit you can drink fruit juice	82.9
If you have eaten high-fat foods you can reverse the effect by eating apples	90.6
A diet with a high proportion of fruit and vegetables is just as unbalanced as a diet high in fat	74.6
A healthy meal should consist of lean meat, one quarter vegetables and one quarter side dishes	51.9
Fat is always bad for your health, you should therefore avoid it as much as possible	88.4
A balanced diet implies eating all the foods in the same amounts	93.9
To eat healthily, you should eat less fat. Whether you also eat more fruit and vegetables does not matter	69.1
For healthy nutrition, dairy products like milk and yogurt should be consumed in the same amounts as fruit and vegetables	79.6
Mean score for sample (n=181)	83% (SD 16%)

Levels of personal involvement with nutrition labels ranged from 20 to the maximum score of 70 with a mean score of 47 (SD ± 10). Items which respondents scored highest (out of 7) within the personal involvement with nutrition labels inventory were; importance (mean = 6 SD ± 1.3), need (mean = 6 SD ± 1.3), and relevance (mean = 5.8 SD ± 1.2) (Table 20). Higher levels of personal involvement with nutrition labels were found in those who had been advised to read food labels (mean = 50.2, SD ± 8.9) compared to those who had not been advised to do so (mean = 45.6, SD ± 10.2) (mean difference = 4.6, 95% CI: 7.7, 1.5, p= 0.004).

Table 20 Personal involvement with nutrition labels: respondents mean score of each inventory item

Inventory item		Score (1-7)
1	**7**	Mean (SD)
Unimportant	Important	6.0 (1.26)
Boring	Interesting	5.2 (1.51)
Irrelevant	Relevant	5.8 (1.20)
Unexciting	Exciting	2.7 (1.53)
Means nothing me	Means a lot to me	4.9 (1.50)
Unappealing	Appealing	3.5 (1.48)
Mundane	Fascinating	3.4 (1.62)
Worthless	Valuable	5.5 (1.34)
Uninvolving	Involving	3.8 (1.51)
Not needed	Needed	6.0 (1.27)
Mean score for inventory (out of 70) (n=181)		**4.7 (10)**

4.4.4 Frequency of use of nutrition labels

4.4.4.1 Reading nutrition labels

Reading nutrition labels when buying a product for the first time was frequently (i.e. always/often) reported by 71% of respondents (Table 21). Frequent reading of nutrition labels in "general" (i.e. not just when a product is purchased for the first time) was indicated by over half 51% (n=93) of survey respondents. Over 40% (n = 73) of respondents stated they generally read nutrition labels "sometimes". Frequent general readers were more likely to be female (p= 0.04) or previously "advised" to look at food labels (p=0.01), than infrequent readers (Table 21). Levels of nutrition knowledge were higher in frequent (first time purchase only) nutrition labels readers (median = 11, IQR: 10,13), compared to infrequent readers (median = 11, IQR: 8,12) (U= 2697, n_1= 128, n_2 = 53, p = 0.02) (Table 22). Levels of personal involvement with nutrition labels were consistently significantly higher in frequent compared to infrequent nutrition label readers and users (Table 22).

4.4.4.2 Frequency of influence of nutrition labels on purchase choices

Around half of respondents reported that nutrition labels frequently influenced their purchase choices (mean = 51%, 95% CI: 44%, 59%). Frequent rather than infrequent influence of nutrition labels on purchases was more likely to be reported by females, those who were advised to use labels and those who reported "excellent" or "good" dietary healthiness, compared to these groups' counterparts (Table 21). In addition, levels of nutrition knowledge and personal involvement with nutrition labels were significantly higher in those who reported that nutrition labels frequently, rather than infrequently, influenced their purchases (i.e. for personal involvement with nutrition labels, mean difference = 8.77, 95% CI: 11.4, 6.11, p <0.001) (see Table 22).

Table 21 Respondents' sociodemographic and health-related characteristics, by frequency of use of nutrition labels

	n=181	Reads nutrition label first time a product is purchased			Reads nutrition labels generally			Nutrition labels affects purchases		
	Total n (%)	Infrequent n (%)	Frequent n (%)	P[1]	Infrequent n (%)	Frequent n (%)	P[1]	Infrequent n (%)	Frequent n (%)	P[1]
Gender										
Female	132 (73%)	35 (27%)	97 (73%)	.18	58 (44%)	74 (56%)	.04	57 (43%)	75 (57%)	.02
Male	49 (27%)	18 (36%)	31 (63%)		30 (61%)	19 (39%)		31 (63%)	18 (37%)	
Advised use[a]										
No	126 (70%)	41 (33%)	85 (76%)	.15	69 (55%)	57 (45%)	.01	71 (56%)	55 (44%)	.002
Yes	55 (30%)	12 (22%)	43 (78%)		19 (35%)	36 (65%)		17 (31%)	38 (69%)	
Ethnicity										
White British	162 (90%)	49 (30%)	113 (70%)	.41	79 (48%)	83 (52%)	.91	75 (46%)	87 (54%)	.06
Not white British	19 (10%)	4 (21%)	15 (79%)		9 (47%)	10 (53%)		13 (68%)	6 (32%)	
Education[b]										
< Higher education	63 (35%)	20 (32%)	43 (68%)	.60	29 (46%)	34 (54%)	.61	30 (48%)	33 (53%)	.84
Higher Education	118(65%)	33 (28%)	85 (72%)		59 (50%)	59 (50%)		58 (49%)	60 (51%)	
Occupation[c]										
Managerial/professional	118(65%)	34 (29%)	84 (71%)	.85	61 (52%)	57 (48%)	.25	57 (48%)	61 (52%)	.75
Other occupation	63(35%)	19 (30%)	44 (70%)		27 (43%)	36 (57%)		31 (49%)	32 (51%)	
Healthiness of diet[d]										
Good or better	141 (78%)	37 (26%)	104 (74%)	.09	65 (46%)	76 (54%)	.20	61 (43%)	80 (57%)	.01
Fair or worse	40 (22%)	16 (40%)	24 (60%)		23 (58%)	17 (42%)		27 (68%)	13 (32%)	
General Health[e]										
Good or better	145 (80%)	47 (32%)	98 (68%)	.06	75 (52%)	70 (48%)	.09	73 (51%)	72 (49%)	.35
Fair or worse	36 (20%)	6 (17%)	30 (83%)		13 (36%)	23 (64%)		15 (42%)	21 (58%)	

Percentages in the Total (first) column are for total sample, and all other percentages are for each (part) row corresponding to each of the three indicators of nutrition label use (described in column headings). a Respondents answered yes or not to the question; "*Do you or a member of your household have a personal diet or medical condition where looking at food label information is advised*"? b Educational attainment was dichotomised as higher education (i.e. University level education) or less than higher education . c Occupation was dichotomised as Managerial and Professional occupations and Other Occupations (including unemployed, lower supervisory and intermediate). d Dietary healthiness was self-rated using the question item "How would you rate the healthiness of your diet" using a five point scale (i.e. "Excellent, Good, neither healthy nor unhealthy, fair , poor") which was diachotomised (i.e. 1= Excellent/Good, 0 = Neither, Fair, Poor) , e General healthiness was self-rated using the question item "How would you rate your general health?" using a five point scale (i.e. "Excellent, Good, neither healthy nor unhealthy, fair , poor") which was diachotomised (i.e. 1= Excellent/Good, 0 = Neither, Fair, Poor). 1.Difference within groups as assessed by Chi-squared, independent t-tests or Mann-Whitney U tests. Statistically significant differences were assessed as $P< 0.05$.

Table 22 Respondents personal characteristics, by frequency of use of nutrition labels

	Sample total (n=181)	Reads nutrition labels the first time a product is purchased			Reads nutrition labels generally			Nutrition labels affects purchases		
		Infrequent n= 53	Frequent n= 128	P[3]	Infrequent n=88	Frequent n=93	P[3]	Infrequent n= 88	Frequent n= 93	P[3]
Age, mean (SD)	58.6 (7.8)	59.1	58.4	.6	59.2	58.0	.32	59.0 (7.7)	58.2 (7.8)	.52
Personal involvement[1], Mean (SD)	47 (10.0)	41.1 (10.6)	49.5 (49.5)	<.001	43 (9.9)	50.7 (8.8)	<.001	42.5 (9.7)	51.3 (8.4)	<.001
Nutrition Knowledge[2], Median *(IQR)*	11 (10, 13)	11 (9,12)	11 (10,13)	.03	11 (8,12)	11 (10,13)	.23	11 (9, 12)	12 (10, 13)	.003

1 Personal involvement with nutrition labels score was of a maximum of 70. 2 Nutrition knowledge quiz score is out of maximum of 13 3 Difference within groups as assessed by independent t-tests or Mann- Whitney U tests. Statistically significant differences were assessed as *P*< 0.05. Abbreviations: SD = Standard Deviation, IQR= Interquartile Range.

4.4.5 Reasons for using nutrition labels

All respondents indicated how often they used nutrition label information for each of seven provided reasons. These included "*To figure out how much of a food to eat*", performing product comparisons, or to check levels of specific nutrients. For each reason, a 5-point scale was used to indicate frequency (i.e. always, often, sometimes, rarely, never) (see Figure 14). Frequency responses for each reason were collapsed into "frequent" (i.e. always or often) and "infrequent" (i.e. sometime, rarely, never) users. Those reasons cited the most (i.e. had the highest number of frequent responses) were as follows:

1. "To see if a food has a high or low amount of the nutrient you may want less of like salt" (frequent users n=114, 63%),
2. "To determine the calorie content of the food" (frequent users n=97, 54%),
3. "To compare similar types of foods with each other" (e.g. between ready meals)" (frequent users n=81, 45%).

The lowest proportion of "frequent" responses were given for the three following reasons (ascending order) (1) "To see if advertising claims are true" (frequent users n=34, 19%), (2) "To figure out how much of a food to eat" (frequent users n=44, 24%), (3) "To compare different types of food with each other (e.g. ice cream v cookies)" (frequent users n=55, 30%).

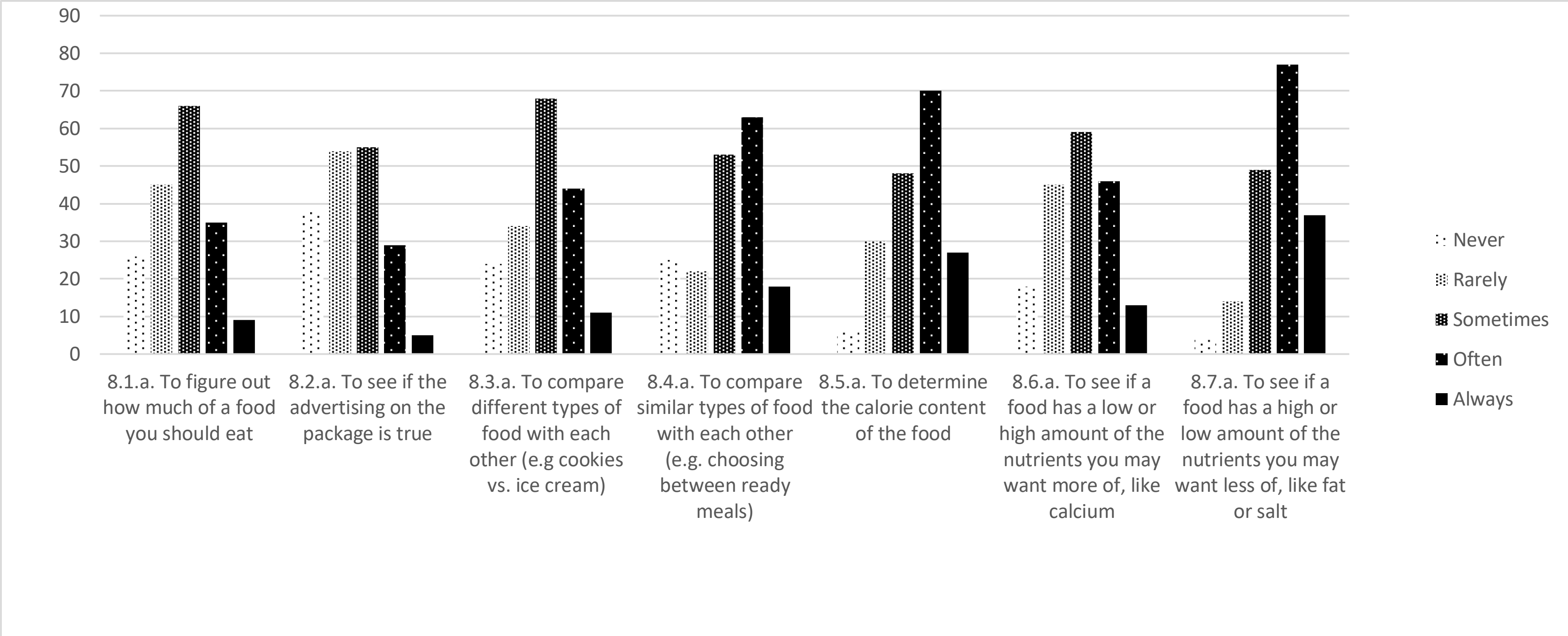


Figure 14 Number of survey respondents selecting specific frequencies of use of nutrition labels, for seven specific reasons

4.4.6 Reasons for not using nutrition labels

All survey respondents were asked why they did not use nutrition labels, from a list of nine possible reasons from which they were asked to tick as many as applied. The three most popular reasons for nutrition label non-use were; “*I usually buy the same product so I am familiar with the nutrition information*” (34% of responses), “*Its hard to see to read*“ (18.8% of responses), and “*The information is not always presented in the same way from one product to another*” (18.3% of responses) (see Figure 15). Reasons for non-use which received the least responses were (in ascending order); “*I really don’t know what to do with the information*” (2.6%); “*I’m just not interested*” (2.9%); “*I prefer getting this […] from other sources*” (4.4%); “*It is hard to understand*” (4.7%).

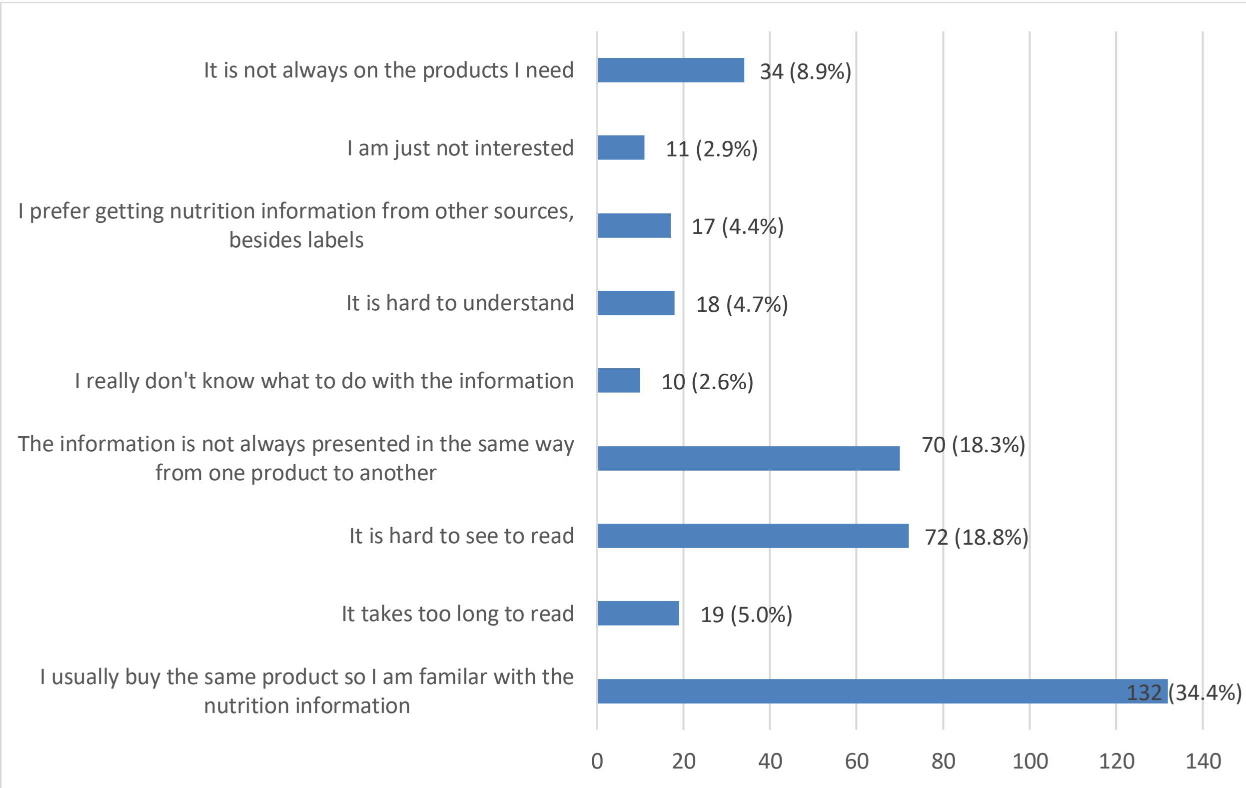


Figure 15 Number of respondents who selected each reason for not using nutrition labels (% of total responses).

4.4.7 Understanding of nutrition labels

4.4.7.1 Understanding of nutrition label data and terminology

Individual quiz questions which were answered correctly by the fewest respondents concerned defining terminology and the meaning and identification of corresponding label data (Table 23). For example, around half (54%) of the sample selected the correct definition of the "Reference Intakes (RI)". In addition, whilst 83% of respondents were able to locate the Reference Intake (RI) value for fat (i.e. 70g) as indicated on the label, only 44% selected the correct meaning of this in terms of dietary recommendations (i.e. "less than 100%"). Over half (59%) of respondents were able to locate the value of the "*percentage of your reference intake for saturates provided by a serving*". Identification of basic label data relating to nutrient content per serving was also variable. For example, 69% of respondents were able to correctly identify the amount of salt per serving, whilst 84% correctly located the amount of sugar in a serving. It can also be seen from Table 23 that, in general, questions relating to front-of-pack nutrition labels were answered correctly by a greater number of survey respondents than back-of-pack questions.

Figure 16 illustrates these findings using an example back-of-pack nutrition label indicating the percentage of respondents who correctly answered individual quiz questions, corresponding to specific label elements. The percentage of respondents who selected the most popular incorrect multiple-choice answer option is shown in Table 23. For example, it is of interest to note that when asked to locate the amount of salt in one serving 21% of respondents incorrectly selected the answer option of "6g". This value appeared on the displayed label as the "Reference Intake" for salt (Figure 16). In addition, how much of the "Reference Intake" for fat which should be consumed per day was correctly selected by 44% of the sample whilst a further 29% of respondents selected "50%" to be consumed per day (Table 23).

Table 23 **Summary of individual quiz questions and percentage of respondents selecting the correct and most popular incorrect responses**

Label type	Question summary	Ability tested	Correct answer option	% correct	Most frequently selected incorrect option	% selecting this [a]	Comments on incorrect answer options
BOP	Amount of salt in one serving	Locate	0.39g	69	“6g”	21	6g is the Reference Intake value for salt.
BOP	Definition of “Reference Intakes” terminology	Define	*Daily guideline*	54	“Specific Reference Intakes relevant for that particular type of food”	20	-
BOP	The value for the reference intake amount of fat”	Locate	70g	83	“8400KJ/2000kcal”	7.2	8400KJ/2000Kcal appears at bottom of displayed back of pack nutrition label
BOP	How much of the reference intake for fat should you aim to eat each day?	Define	Less than 100%	44	“50%”	29.3	-
BOP	Amount of sugar in a serving	Locate	0.3g	84	“0.5g”	7.2	0.5g is the amount of sugar in 100g
BOP	Percentage of reference intake for saturates for a serving	Locate	8%	59	“1.5g”	25	1.5g is the amount of saturates per serving in grams
FOP TL	Nutrients at low levels	Interpret	Sugars only	86	“No nutrients are present at low levels”	6.1	-
FOP TL	Percentage (%) of reference intake for sugar provided in a pack (serving)	Locate	8%	82	“7.5g”	12.2	7.5g appears in the FOP TL lozenge for sugars.
FOP Mono	Locate calorie content	Locate	94kcal	80	“235kcal”	10	235kcal appears in sentence below the FOP label indicating energy per 100g
FOP TL	Comparing salt content to find lowest (both FOP same colours)	Compare	The right	90	“the one on the left”	7.7	

Abbreviations: BOP= Back-of-pack nutrition label, FOP: Front-of-pack nutrition label, TL = Traffic Lights, Mono = Monochrome. [a] % of respondents who selected the most popular incorrect answer option. *Daily guideline amounts of nutrients (i.e. energy, fat, saturates, sugars and salt) which are recommended for a healthy diet

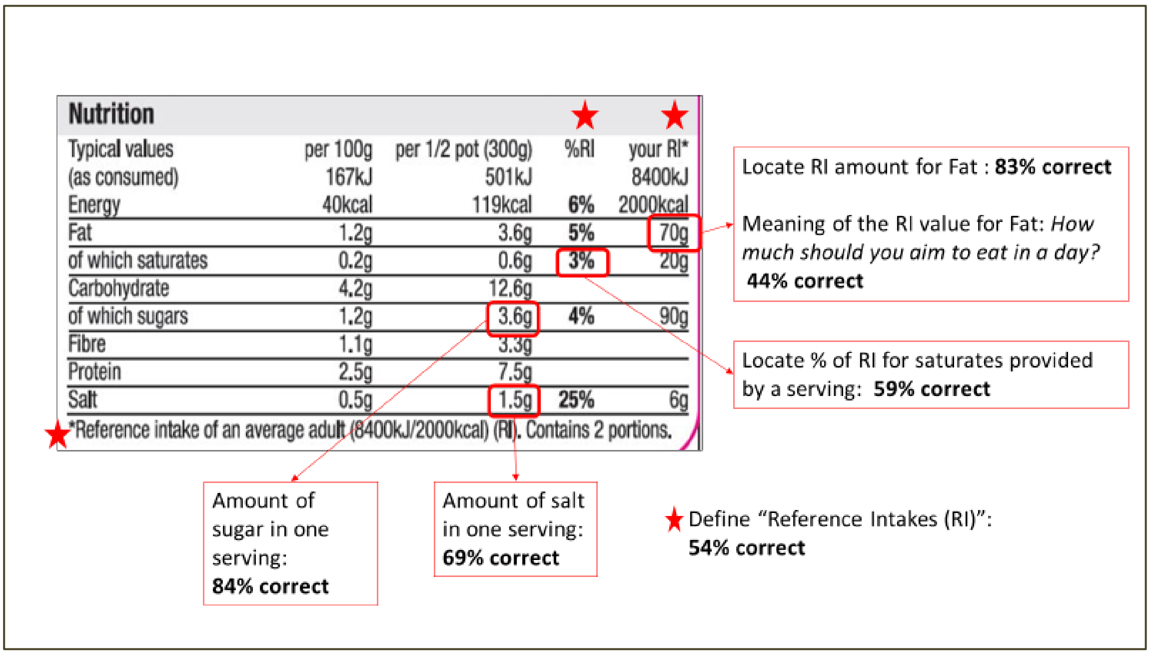


Figure 16 Illustration of the percentage of correct responses for individual quiz questions concerning specific back-of-pack nutrition label elements (shown using a single nutrition label for illustration purposes).

4.4.7.2 Objectively evaluated understanding of nutrition labels (quiz score)

Respondents overall quiz scores, reflecting objectively evaluated understanding of nutrition labels ranged from 2 to the maximum of 10, with a median score of 8 (IQR 6 to 9). Associations between quiz scores and socio demographics and other characteristics were analysed using quiz score in two groups; as a median split (Table 24). Compared to those scoring higher, those who scored below the median quiz score were more likely to be older (mean age difference 2.4 years, 95% CI: 0.1, 4.6, p = 0.04).

Proportions of those who scored the median quiz score or above were greater in males compared to females (see Table 24). In addition, significantly larger proportions of those scoring the median quiz score or above were found among those who had higher, compared to lower, educational attainment (Table 24). Those scoring the median quiz score or higher also possessed significantly greater nutrition knowledge test scores (median = 12, IQR: 9,12) compared to those who scored lower (median = 12, IQR: 10.25,13) (U=2736.5, n_1= 96, n_2 = 85, $p < 0.001$). Furthermore, the proportion of respondents scoring these higher quiz scores was lower among those who had been "advised" to look at food labels, compared to those who had not been advised ($\chi^2(1)$= 4.0, p = 0.04) (Table 24).

As shown in Table 24, objectively evaluated understanding was not associated with the reported frequency with which nutrition labels were read or influenced purchases. In other words, there was no significant difference in quiz scores between infrequent and frequent nutrition label users.

4.4.7.3 Self-rated understanding and associations

Self-rated understanding of nutrition labels across the survey sample was moderately high (using a 7-point scale, mean = 4.8, SD ± 1.6), with no significant differences in levels within sociodemographic and characteristic groups. Self-rated understanding was significantly higher in those who read label information frequently the first time they purchased a product, compared to those who did so infrequently (mean difference = 0.8, 95% CI: 0.3,1.3, p = 0.002) (Table 25). Similarly, those who reported that nutrition labels frequently influenced their purchases had significantly higher levels of self-rated label understanding compared with those who were influenced infrequently (mean difference = 0.5, 95% CI: 0.02, 0.92, p = 0.04) (Table 25). However, self-rated understanding of nutrition labels was not associated with objectively evaluated understanding of this information (mean difference in self-rated understanding between quiz score groups = 0.13, 95% CI = - 0.33, 0.60, p = 0.57) (Table 24).

Table 24 Characteristics of survey respondents according to levels of objectively evaluated understanding of nutrition labels (quiz score)

Characteristics			Objectively-assessed understanding of nutrition labels (quiz score)		
		Sample Total n (%)	< median score[1] n (%)	≥ median score[1] n (%)	*P* [3]
Gender		**n = 181**	**n = 85**	**n = 96**	
	Female	132 (73%)	69 (52%)	63 (48%)	.01
	Male	49 (27%)	16 (33%)	33 (67%)	
Advised use[a]					
	No	126 (70%)	53 (42%)	73 (58%)	.04
	Yes	55 (30%)	32 (58%)	23 (42%)	
Ethnicity					
	White British	162 (90%)	73 (45%)	89 (55%)	.11
	Non-White	19 (10%)	12 (63%)	7 (37%)	
Education[b]					
	Higher education	118 (65 %)	48 (41%)	70 (59%)	.02
	< Higher education	63 (35%)	37 (59%)	26 (41%)	
Occupation[c]					
	Managerial/Professional	118 (65%)	49 (42%)	69 (58%)	.05
	Other occupation	63 (35%)	36 (57%)	27 (43%)	
Healthiness of diet[d]					
	Good or excellent	141 (78%)	66 (47%)	75 (53%)	.54
	Fair or worse	40 (22%)	19 (48%)	21 (52%)	
General Health[e]					
	Good or excellent	145 (80%)	67 (46%)	78 (44%)	.68
	Fair or worse	36 (20%)	18 (50%)	18 (50%)	
Age, years mean (SD)		58.6 (7.8)	59.9 (7.6)	57.5 (7.2)	.04
Nutrition knowledge score[f], median (IQR)		11 (10, 13)	11 (9,12)	12 (10-13)	<.001
Personal involvement with nutrition labels score[g], mean *(SD)*		47 (10.0)	47.0 (10.4)	47.01 (7.8)	.95
Self-rated understanding of nutrition labels[h], mean (SD)		4.8 (1.6)	3.3 (1.5)	3.1 (1.6)	.57

1 The median quiz sore was 8 out of a maximum of ten. a Respondents answered yes or not to the question; "*Do you or a member of your household have a personal diet or medical condition where looking at food label information is advised*"? b Educational attainment was dichotomized as higher education (i.e. University level education) or less than higher education . c Occupation was dichotomized as Managerial and Professional occupations and Other Occupations (including unemployed, lower supervisory and intermediate). d Dietary healthiness was self-rated using the question item "How would you rate the healthiness of your diet" using a five point scale (i.e. "Excellent, Good, neither healthy nor unhealthy, fair , poor") which was diachotomised (i.e. 1= Excellent/Good, 0 = Neither, Fair, Poor) , e General healthiness was self-rated using the question item "How would you rate your general health?" using a five point scale (i.e. "Excellent, Good, neither healthy nor unhealthy, fair , poor") which was diachotomised (i.e. 1= Excellent/Good, 0 = Neither, Fair, Poor)..[f] Nutrition knowledge quiz score is out of maximum of 13, [g] Personal involvement with nutrition labels score was of a maximum of 70. [h] Self-rated understanding of nutrition labels was measured using a 7-point scale (1 = not at all confident in understanding, 7 =extremely confident in own understanding). [3]Difference between groups as assessed by Chi-squared for proportions, independent t-tests or Mann Whitney U tests. Statistically significant differences were assessed as *P*< 0.05. Abbreviations: SD = Standard Deviation, IQR= Interquartile Range.

Table 25 Self-rated and objectively evaluated understanding of nutrition labels, by frequency of label use

		Reads nutrition labels the first time a product is purchased			Reads nutrition labels generally			Nutrition labels affect purchase choices		
	Total n = 181	**Infrequent** n =53	**Frequent** n = 128	P*	**Infrequent** n = 88	**Frequent** n = 93	P*	**Infrequent** n = 88	**Frequent** n = 93	P*
Self-rated confidence in own understanding[1], Mean (SD)	4.8 (1.6)	4.2 (1.5)	5.0 (1.5)	.002*	4.5 (1.5)	5.1 (1.6)	.015*	4.5 (1.6)	5.0 (1.5)	.04*
Objective understanding of nutrition labels (Quiz score)[2], Median (IQR)	8 (6,9)	8 (5,9)	8 (6,9)	.71	8 (6,9)	7 (6,9)	.82	8 (6,9)	8 (6,9)	0.91

[1]Self-rated understanding of nutrition labels was measured using a 7-point scale (1 = not at all confident in understanding, 7 = extremely confident in own understanding).
[2]Quiz score out of a maximum of ten. *Difference between groups as assessed by independent t-tests or Mann Whitney U tests. Statistically significant differences were assessed as $P < 0.05$.
Abbreviations: SD = Standard Deviation, IQR= Interquartile Range.

4.4.8 Regression of characteristics predicting frequent influence of nutrition labels on purchases

To test hypothesis 2, four logistic regression models were built to explore the effects of levels of label understanding and other personal characteristics on the likelihood that nutrition labels frequently or infrequently influenced purchase choices. As a single indicator of respondents' nutrition label use, frequency of influence on purchases, rather than reading of labels, was selected for use here as the outcome variable. This was because, compared to questions on "reading" or "general" use of labels, this item was also expected to most closely reflect any impact of nutrition labels on respondents' food choices. Furthermore, this outcome variable was associated with self-rated dietary healthiness (Table 21).

Models were informed by the conceptual framework of nutrition label use described in Chapter 1, whereby understanding of nutrition labels, as well as nutrition knowledge, are both thought to inform consumers' use of labels in purchase evaluations (Grunert et al., 2010b). Accordingly, in the current data self-rated and objectively evaluated understanding were both associated with levels of nutrition knowledge. As such, models were constructed to take into account these causal frameworks. That is, considerate of the possibility that including all these variables in the same model was likely to have violated assumptions concerning low levels of collinearity in regression models (Schisterman et al., 2017). Individual models were therefore built for each of the independent characteristics selected for inclusion. These were: nutrition knowledge, personal involvement with nutrition labels, self-rated understanding of nutrition labels, and objectively evaluated understanding of nutrition labels (quiz score).

Models showed that nutrition knowledge, personal involvement with nutrition labels and self-rated, but not objectively evaluated, understanding of nutrition labels were significant predictors of the frequency of the influence of nutrition labels on purchase choices (Table 26). This included when models were adjusted for age, gender, if food label use had been advised, educational attainment level, and occupation. Specifically, a one unit increase in personal involvement with nutrition labels or nutrition knowledge resulted in respondents being 10% and 30% more likely, respectively, to report that nutrition labels frequently influenced their purchase choices (OR 1.1, 95% CI: 1.1, 1.2 and OR 1.3, 95% CI: 1.1, 1.5, respectively). In addition, greater self-rated (OR 1.2, 95% CI 1.0, 1.5), but not objectively evaluated (OR 1.1, 95% CI: 0.9, 1.3), understanding of nutrition labels significantly predicted frequent influence of nutrition labels on purchases (Table 26).

Table 26 Regression analysis of characteristics predicting frequent influence of nutrition labels on purchase choices

Model	Characteristic	Odds of frequent v. infrequent influence of nutrition labels on purchase choices by unit change in characteristic			
		Unadjusted models		Adjusted models[1]	
		OR (95% CI)	P	OR (95% CI)	P
1	Personal involvement with nutrition labels[2]	1.1 (1.1, 1.2)	<.001	1.1 (1.1, 1.2)	<.001
2	Nutrition knowledge[3]	1.3 (1.1, 1.5)	.002	1.3 (1.1, 1.5)	.004
3	Self-rated understanding of nutrition labels [4]	1.2 (1.0, 1.5)	.04	1.2 (1.0, 1.5)	.04
4	Objectively evaluated understanding[5] (quiz score)	1.0 (0.9, 1.2)	.78	1.1 (0.9, 1.3)	.38

[1] Variables included as confounders: educational attainment level (diachotomised as. higher education or less than higher education), age, “advised” label use (yes/no), gender (females/male), occupation (dichotomised as Managerial and Professional occupations or Other Occupations; including unemployed, lower supervisory and intermediate). [2] Personal involvement with nutrition labels score was of a maximum of 70. [3] Nutrition knowledge score is out of maximum of 13. [4] Self-rated understanding of nutrition labels was measured using a 7-point scale (1 = not at all confident in understanding, 7 =extremely confident in own understanding). [5] Objectively evaluated understanding of nutrition labels (quiz score) was out of a possible maximum of 10.
Abbreviations: OR = Odds Ratio, CI = Confidence Interval

4.5 Discussion

4.5.1 Summary of findings

This study aimed to evaluate use and understanding of current UK nutrition labels among older adults aged 50 yrs or older. The online survey was completed by 181 older adults, who were mostly white British females with high educational attainment. Over half of respondents (51%) reported that nutrition labels frequently influenced their purchase choices. In support of hypothesis 1, frequent nutrition label use was more likely by females or those who indicated that themselves or a household member had been advised to read food labels for diet or health reasons, compared to their counterparts. In support of hypothesis 2, frequent influence of nutrition labels on purchases was predicted by increasing self-rated understanding of labels as well as greater nutrition knowledge scores and personal motivation to engage with nutrition labels (personal involvement with nutrition labels). Overall, levels of objective understanding of current UK nutrition labels were moderately high among survey respondents, with some evidence of variation according to socio demographics and personal characteristics including levels of nutrition knowledge or if respondents had been advised to read food labels. However, findings suggest that understanding of the meaning of specific elements of nutrition labels, including for the term “Reference Intakes” and associated values was not widespread. Furthermore, greater levels of objective understanding of current UK nutrition labels did not predict respondents’ frequent influence of this information in purchase choices.

4.5.2 Characteristics associated with use of nutrition labels in older adults

Findings here indicate that over half (51%) of surveyed older adults claim to use nutrition labels “frequently” to influence their purchase choices. This proportion is in-line with general estimates that around 50% of consumers are thought to use nutrition labels, as indicated by review evidence (Campos et al., 2011). In addition, those survey respondents who frequently used labels during their purchase choices were also more likely to report more they had healthier diets, compared to infrequent users. This finding also reflects review evidence that consumers’ nutrition label use is linked with healthier diets (Campos et al., 2011;

Anastasiou et al., 2019). However, frequency of use of nutrition labels did not appear to vary across survey respondents according to educational attainment or age, as reported elsewhere among older adults (Macon et al., 2004). Frequent use of labels was associated with being female and possessing higher levels of nutrition knowledge in keeping with much of the literature in this area with other populations and with different label types (Drichoutis et al., 2005; Malam et al., 2009; Grunert, Wills, et al., 2010; Ducrot et al., 2015; Miller and Cassady, 2015), including the US Nutrition Facts Panels (Levy and Fein, 1998; Byrd-Bredbenner et al., 2000; van der Merwe et al., 2013; Sinclair et al., 2013; Sharif et al., 2014).

Findings also suggest that those who indicated that themselves or a household member had previously been "advised" to look at food label information for a personal diet or medical condition were more likely to be "frequent" users than those who had not been advised. Other evidence has also linked health conditions to use of nutrition labels among US adults, including those with chronic diseases (Post et al., 2010; An, 2016). The current study also goes further to indicate that these "advised" respondents possess greater levels of personal involvement with nutrition labels (i.e. enduring personal motivation to engage with this information) than those who had not been "advised". In addition, increasing levels of personal involvement with nutrition labels predicted frequent use of nutrition labels in purchases. Both are new findings in older adults, but are in line with the available evidence from younger adults, which suggests that those consumers who possess increased levels of enduring motivating to process this information (i.e. personal involvement) are more likely to use it (Moorman, 1990; Chandon and Wansink, 2007) or attend to it longer (Xie et al., 2015), than those with lower levels.

Respondents' popular reasons for not using nutrition labels included that they were familiar with the product they were buying since they had purchased it before. This was reflected by findings which show more respondents report "frequently" reading nutrition labels the first time a product is purchased (71%), compared to reading in general (51%). These findings agree with review evidence in which consumers tend to view nutrition label more often for "new" product purchases (Grunert and Wills, 2007; Campos et al., 2011). In addition, presentation differences "from one product to another" and "it's hard to see" were the second most popular reasons selected by participants for their "non-use" of nutrition labels. Difficulties reading labels “likely due to the deterioration of eye sight with age” was reported by 47% of those aged 55 years or more in recent data from the Food and You UK survey conducted for the Food Standards Agency (NatCen, 2017). However, the present findings suggest respondents’ reasons for not using nutrition labels rarely included perceived lack of understanding of nutrition labels (i.e. “*it’s hard to understand*”), which was stated by less than 5% of respondents. Correspondingly, respondents’ overall self-rated (subjective) understanding of this information was moderately high and did not vary according to sociodemographic and personal characteristics.

Both “subjective” and “objective” understanding of nutrition labels are thought to theoretically precede label use in purchase decisions (Grunert and Wills, 2007). Indeed, these survey findings show that increasing levels of self-rated understanding of nutrition label in these older adults predicted frequent use of nutrition labels during purchases choices. However, respondents who reported using nutrition labels frequently during their purchase choices did not possess greater objectively evaluated understanding of nutrition labels compared to those who used this information less frequently. Furthermore, levels of objective understanding (quiz score) did not predict frequency of use of this information during purchase choices, even when accounting for other characteristics (age, gender, advisory label use etc.).

These latter findings among surveyed older adult conflicts with the majority of other literature in this area which has linked objective understanding with participants’ frequency of use of this information in research with other populations (Levy and Fein, 1998; Byrd-Bredbenner and Kiefer, 2001; Sinclair et al., 2013; Ducrot et al., 2015; Koen et al., 2018), including older adults (Macon et al., 2004). Among US older adult females, frequent nutrition label use was linked with being more likely to correctly locate information “per serving” (Byrd-Bredbenner and Kiefer, 2001). However, findings among UK older adults here do reflect one study with younger Latino adults in the US, which found that their reported utilisation of Nutrition Facts Panels was not associated with tested comprehension of this information (Sharif et al., 2014). In line with these authors’ suggestions, it is possible that those older adults who claim to use this information most frequently may not entirely understand it. It may therefore be beneficial for these adults to receive education on this topic to improve the impact of the current UK nutrition labels on food purchase choices and health.

4.5.3 Characteristics associated with objective understanding of current UK nutrition labels

Levels of objectively evaluated understanding of current UK nutrition labels appeared moderately high in the surveyed older adults, as assessed using the online quiz. However, levels of such understanding were found to vary with specific sociodemographic and personal characteristics, including with age, educational attainment and general nutrition knowledge. For example, those who scored the median quiz score or above were also more likely to have higher nutrition knowledge, higher educational attainment and be slightly younger than those who scored lower in the quiz. These findings are in line with the literature which also highlights age declines in objective understanding of nutrition labels across other populations (Grunert et al., 2010b; Campos et al., 2011), including among older adults (i.e. aged over 51yrs) (Macon et al., 2004) and those categorised at “young older” and “older old” when performing tasks with US Nutrition Facts Panels (Byrd-Bredbenner and Kiefer, 2001).

These findings also highlight a role for general nutrition knowledge in supporting objective understanding of nutrition labels in older adults. In agreement, one cross-sectional study of UK shoppers has also linked nutrition knowledge with understanding of front-of-pack nutrition labels, including across consumer’s advancing age (Grunert et al., 2010b).

More surprisingly, respondents who were female or advised to read food labels appeared to be more likely to score lower than the median quiz score, compared to those who were male or who had not been advised. Furthermore, respondents’ increasing personal involvement with nutrition labels was not associated with levels of objective understanding of the current UK nutrition labels. As such, these findings suggest there is potential that disparities in objective understanding of this information may exist between those of different motivation levels or according to if they have been “advised” to read food labels to manage health conditions. This is a concern given that motivations to use nutrition labels may reflect individual medical or health care professional advice to use this information to make dietary modifications. These are reasons to further investigate the potential for education to help decrease gaps in understanding between adults in this age group.

Finally, in the current study, self-rated (subjective) understanding was not associated with levels of objectively evaluated understanding of the current UK nutrition labels in these older adults. In other words, those who scored the median score or higher in the quiz were not more likely to possess higher self-rated understanding compared to those who scored lower. A similar disconnect between self-rated and actual understanding has been identified in younger adults who thought they understood nutrition label better than they actually did (Sharf et al., 2012). Given that (subjective) self-rated understanding appears a determinant of frequent use of nutrition labels in purchase choices in these adults, both perceived (subjective) and actual (objective) understanding of nutrition labels now warrant further investigation with respect the possible effects of nutrition label education.

4.5.4 Respondent's understanding of specific aspects of current UK nutrition labels

4.5.4.1 References Intakes terminology, values and %RI information

Findings show that there is some lack of understanding about the meaning of the "Reference Intakes" terminology (formerly Guideline Daily Amounts) and corresponding values (i.e. RI for fat) among the surveyed older adults. These values are intended to reflect general dietary guidance for daily intakes of specific nutrients and energy. Only 54% of survey respondents correctly stated that Reference Intakes were a "daily guideline amount of nutrients (i.e. energy, fat, saturates, sugars and salt) which are recommended for a healthy diet". In contrast, 20% of respondents thought that this term meant "Specific Reference Intakes relevant for that particular type of food". In comparison, previous research evaluating consumer understanding of "Guideline Daily Amounts (GDA)" terminology has found that relatively higher levels (61%) of UK adults (n=2,019) could correctly identify GDA as a "*guide to the amount of energy (calories) and maximum amount of some nutrients (e.g. fat, saturated fat, saturates, salt, sugars) a person should be eating in a day*" (Grunert et al., 2010).

Furthermore, the current survey findings indicate that whilst most respondents were able to locate specific label data relating to RI values, they may not entirely understand the meaning of these. For example, 83% of respondents correctly located the “Reference Intake” value for fat (i.e. 70g) on the label. However, when asked “how much of the Reference Intake for fat should you aim to eat each day?”, only 44% of respondents correctly stated this was “no more than 100%”, whereas 29% selected “50%”. This finding may contrast with earlier the research concerning GDA terminology wherein Grunert et al (2010b) found that 83% of UK participants correctly answered that on average adults “should eat no more than the GDA of 70g of fat for the day” (Grunert et al., 2010b). In addition, research previously conducted in the US after the mandatory implementation of Nutrition Facts Panels found that among 192 participants, only 29% could correctly define that %DVs referred to the “percent of the maximum daily amount recommended for fat” (Levy et al., 2000). Furthermore, the present findings may reflect findings from the Food Standards agency’s Food and You survey which reported that older people (aged over 55) were less likely than younger people (aged under 35) to know the “recommended calorie intake for either men or women” (NatCen, 2017).

Survey evidence presented here also suggests there may also be some variable understanding of the meaning of the “%RI” information displayed on current UK front and back-of-pack nutrition labels. These are intended to indicate percentage contribution of nutrients provided by a serving of product. Only 59% of respondents in the current survey were able to correctly locate the percentage of the Reference Intake (“%RI”) for saturates provided by a serving using the back-of-pack nutrition label. A further 25% of respondents selected the answer to this question as the number of grams which were displayed “per serving”. In contrast, more of the current survey respondents (82%) were able to locate the %RI for sugar in a serving, when this was provided within a current UK front-of-pack nutrition label. Difficulties locating values on back-of-pack nutrition labels may be explained by the fact that these labels provided both “per 100g and “per serving”, whereas front-of-pack labels declare nutrient information relating to “per serving” only. In addition, it is possible that survey respondents did not understand the meaning of the “%RI” information and so were unable to locate them correctly within back-of-pack nutrition labels. Poor consumer understanding of the meaning “%DV” or “%GDA” information has been queried before by US and UK label researchers (Fuan Li et al., 2000; Grunert et al., 2010b; Gregori et al., 2014). Specifically, a question concerning the precise meaning of information provided by %GDA appeared to be among the most poorly answered with 47% of the sampled UK adults correctly selecting that these are “per serving” (Grunert et al., 2010).

The current findings therefore suggest there exists potential to increase awareness and understanding of “Reference Intakes” terminology and values as well as “%RI” information declared on the current UK nutrition labels, among older adults.

4.5.4.2 Nutrient content information on “per serving”

The current study also indicated that there was likely to be some difficulties experienced by these older adult consumers when identifying specific components of nutrition labels relating to nutrient contents “per serving””. For example, concerning back-of-pack nutrition labels, 69% of respondents were able to locate the amount of salt in a serving. However, 21% of respondents selected this was “6g” (which was, in fact, the declared RI value for salt). In a later question, most survey respondents (84%) were able to correctly identify the amount of sugar in serving using a back-of-pack label, while similar proportions (80%) were able to locate calorie content “per serving” as declared on a current front-of-pack label.

Ability to locate nutrient content data per serving, has been noted as possibly one of most basic tasks to perform using nutrition label information, including with those labels in other countries, including with older adult aged over 65 years (Cottee et al., 2000; Byrd-Bredbenner and Kiefer, 2001; van der Merwe et al., 2013). However, there exists other evidence of poor consumer understanding and lack of attention to labelled serving size information which might impact on consumers’ ability to locate nutrient content “per serving”. For example, serving size information presented as mandatory on US Nutrition Facts Panels may also not always be used or well understood (Campos et al., 2011; Zhang et al., 2016; Miller et al., 2017a; Kliemann et al., 2018). Overall, the variable findings presented here in terms of respondents’ ability to locate nutrient content, or %RI information “per serving”, suggests there may be some potential to increase understanding of the location of these types of basic label data, among UK older adults.

4.5.5 Strengths and limitations

This study used a self-selected convenience sample which was recruited online by disseminating a survey web-link to organisations within one UK city. Survey respondents were mostly female, of white British ethnicity and highly educated. It is also acknowledged that only 181 respondents were recruited whilst a target of 200 was aimed for. Consequently, the number of respondents from non-white British ethnicities and lower educational attainment levels is lower than that seen in the general UK population. In addition, it is likely that the online recruitment led to a limited number of "old" older adult respondents and resulted in the majority of respondents being of younger ages of 50-59 yrs (64%). However, the use of the online survey was a pragmatic decision to enable older adult online shoppers to be captured, results for which are reported in the preceding Chapter 5. As such, further evaluation of understanding and use of current UK nutrition labels now requires a larger more representative population sample, reflecting the different socioeconomic groups and backgrounds which are also under-represented in the existing research (Cavaliere et al., 2017; Nabec, 2017). Greater representation of populations who are not able to access the internet should also be captured, for example, by using in-store shopper intercept or paper-based questionnaires.

Future work including different age groups (i.e. those aged under 50 years) would also enable the exploration of effect of ageing on consumers' use and understanding of current UK nutrition labels. This work would therefore be comparable to the cross-sectional study literature already reviewed (Chapter 1) and evaluate the effect of age on understanding of current UK nutrition labels, although this has been performed previously with other label formats (Grunert et al., 2010b; Campos et al., 2011). This survey did aim to sample a large number of older adult respondents who were aged over 50 yrs, as a basis on which to evaluate their understanding of the current UK nutrition labels. The findings of the current study with respect to these adults' nutrition label use and levels of understanding are therefore considered to be an initial snap shot and best-case scenario, among UK older adults.

Another limitation here is the assessment of nutrition label use which used respondents' self-reported frequencies therefore likely to be over-estimated (Grunert et al., 2010b). To mitigate such over-reporting, label "use" was defined in the survey items to reflect different aspects of nutrition label use (i.e. reading, influence on purchases) (Goodman et al., 2011; Miller et al., 2015). Furthermore, respondents' selected frequencies of use were also conservatively dichotomised as either "frequent" or "infrequent" users, which included classifying the "sometimes" responses into the "infrequent" category. Nonetheless, consumers' own definitions of label use may vary and whilst they may indeed look at the nutrition label yet not actually further process this information further (Cowburn and Stockley, 2005; Campos et al., 2011). Findings are, however, comparable to review evidence, which is also based mainly on self-reported estimates (Campos et al., 2011).

A strength of this study is the evaluation of objective understanding of current UK nutrition labels which was conducted using a 10-question quiz. Quiz questions were designed to reflect consumer understanding of those front and back-of-pack nutrition labels in use in the real-life food market place by using actual back and front-of-pack nutrition labels which display mandatory and additional (supplementary) information compliant with the new UK legislation. Although these questions were adapted from existing validated questionnaire instruments and prior research and piloted as described in Chapters 2 and 3, this particular quiz has not been formally validated for use in older adults (Rattray and Jones, 2007). In addition, it should be noted that the quiz was not designed to "test" the comprehensibility of individual label formats nor compare levels of understanding between back and front-of-pack labels types. Furthermore, the online survey approach necessitated the use of multiple-choice question answer options which may have facilitated respondents' identification of correct answers via deductive processes or guess work. Accordingly, this quiz may have therefore resulted in an over-estimation of objective understanding of nutrition labels compared to requiring respondents to complete open-answer text boxes, as noted elsewhere (Levy et al., 2000; Mackison et al., 2010; Grunert et al., 2010b). However, the use of this multiple-choice approach did enable collection of some valuable data on the most popular incorrect answers. Overall, quiz scores recorded here are likely to reflect a best-case scenario of objective understanding of the current UK nutrition among older adults.

Finally, another strength of this study is that respondents pre-existing nutrition knowledge was also objectively evaluated in contrast to those studies which relied on self-reported measures of this important characteristic (Méjean et al., 2013a; Ducrot et al., 2015). This now provides a relatively more reliable evaluation of older adult survey respondents nutrition knowledge (of healthy eating) as well as the association of this characteristic with self-reported frequency of label use, as suggested by other researchers (Miller and Cassady, 2015).

4.5.6 Findings in the context of the PhD project

Highlighted here is the importance of older adults' personal characteristics relating to their understanding and use of nutrition labels. Findings also point to possible difficulties in these adults' understanding of specific elements of current UK nutrition labels. In addition, there exists the possibility that those older adult respondents who report using nutrition labels frequently, including those who have been advised to read food labels, may not entirely (objectively) understand the information provided. These same respondents may, however, possess high levels of self-rated (subjective) understanding. It is suggested that improvements in nutrition label understanding, including in individuals who may already use this information frequently, or presume they understand it, could help these adults to utilise this information more accurately. In particular, respondents' understanding of nutrition label elements including "Reference Intakes" terminology and corresponding label values as well as "per serving" information could be improved.

These survey findings provide an initial basis on which to devise specific educational learning objectives aimed at improving understanding and use of current UK nutrition labels in older adult consumers. Previous research with US adults has also suggested that labelling education should be targeted to aspects of the label that are not "fully understandable without consumer education" (Byrd-Bredbenner et al., 2001). Promoting understanding of these aspects, as well as increasing consumers' personal characteristics which drive label use (such as their personal involvement with nutrition labels and nutrition knowledge) may now be considered as part of educational strategies which aim to help older adults to use nutrition labels. As such, the incorporation and effect of these components within previously reported nutrition label educational interventions targeting consumer use and understanding of nutrition labels warrants investigation. This will be reviewed in Chapter 6, next.

4.6 Conclusion

This study is the first known exploration of older adults' understanding and use of current UK nutrition labels following the implementation of new labelling legislation, from 2014. Findings of the online survey show that specific socio demographics as well as levels of nutrition knowledge and personal motivations are associated with frequent use of this information in older adult survey respondents. However, findings also indicate that respondents who reported that their purchases were frequently influenced by nutrition labels may not fully understand all aspects of the current nutrition labels. Specific areas which may require improvement in understanding include the meaning of "Reference Intakes" terminology and associated values. Given that nutrition labels are now mandatory in the UK, this insight may now be used to inform strategies and education to support older adults to use this information and increase its impact on dietary health.

Chapter 5 Online grocery shopping: Exploring the use of product nutrition information by older adults.

5.1 Abstract

Background: Online grocery shopping has the potential to support older adults' access to healthy foods. Since nutrition information recently became mandatory for products sold online, this study aimed to explore older adults use of online product nutrition information within supermarket websites. **Methods:** An online survey was used to evaluate self-reported frequency of use of this nutrition information among older adult online grocery shoppers. Further insight into these consumers' use of nutrition information within supermarket websites was obtained with a convenience sample of eight experienced online shoppers (aged 50-66yrs). Participants were asked to "Think aloud" whilst using their usual supermarket website to find what they perceived to be healthy (soup and ready meal) food products. Verbal data and corresponding computer screen recordings were collected and thematically analysed to identify themes relating to how participants found and evaluated healthy products using supermarket websites and product nutrition information. **Results**: A total of 70 online food shoppers were surveyed (aged 50-87 yrs). Fewer respondents reported that they used online nutrition information frequently, compared to labels on packaging. Frequent use of online nutrition information was associated with levels of respondents' personal motivation to engage with nutrition labels and frequent use of nutrition labels on pack ($\chi^2(1) = 6.8$, $p= 0.01$, $\varphi = 0.31$). Think aloud data analysis (n=8) produced three themes: (1) Search efficiency, (2) definition of healthy and (3) information engagement. The use of supermarket website product search functions as well as the presentation of nutrition information on webpages may reduce engagement with online product nutrition information. **Conclusions**: It is likely that older adults who shop online for food use nutrition information infrequently. To increase the use of this information during online purchase evaluations, greater prominence and presentational consistency is recommended in supermarket websites.

5.2 Overview

Legislation which mandated the display of nutrition information for products sold online (i.e. by distance selling) was introduced in the UK from 2014 (Department of Health, 2016a). However, there is lack of research insight exploring consumers' use of this online product nutrition information within supermarket websites, including among older adult shoppers (Chapter 1). Therefore, the third research objective of this PhD project was to explore the use of nutrition information in online supermarkets by older adult shoppers. This chapter will present the results from the online survey of older adults which relate to their use of online supermarket shopping and product nutrition information. The development of the online survey data collection tool items used for this purpose has been described in Chapter 2. The current chapter will also rationalise and describe the collection and analysis of verbal "Think aloud" data from experienced older adult online shoppers during their use of supermarket websites. This approach was employed to explore participants' use of nutrition information and supermarket websites in a real-life context by using simulated shopping tasks.

5.3 Introduction and background

Shopping online removes the need to walk through supermarket aisles to find a product. Instead, consumers can navigate virtual product categories using the supermarket website menu tabs to list product types, or by searching using text. Sales via this shopping channel are predicted to increase from current levels of 6.7%, to 10% of all grocery sales by 2020 (Mintel, 2018). In 2018, 47% of UK adults reported doing some of their grocery shopping online (Mintel, 2018). Compared to in-store, supermarket websites may provide consumers with a greater opportunity to compare products and exercise control over their purchases (Verhoef and Langerak, 2001).

In addition, shopping for groceries online was considered by 28% of adult consumers to reduce the physical difficulties of in-store visits (Morganosky and Cude, 2000). Consumers' motivations to use online grocery shopping are known to be related to their changing life-stages, including ageing (Hand et al., 2009; Droogenbroeck and Hove, 2017). In the UK, the number of UK older adults who shop online is also increasing faster than any other age group, with current estimates showing around 31% of adults aged 55yrs+ currently shop online for food (Watts, 2016; Office for National Statistics, 2018). At the same time, there is an apparent lack of insight into how older adults use supermarket websites. However, evidence from (non-supermarket) experimental studies suggests that older adults may require more support than younger consumers to properly use internet searches and websites relating to health (Miller and Bell, 2012; Wagner et al., 2014).

Providing a means to deliver or support healthier eating interventions, online grocery shopping could support improved access to and evaluation of healthier foods (Jilcott Pitts et al., 2018). For example, previous research has found that participants in a weight loss trial who shopped online had less “high fat foods” in their households than those who shopped in-store (Gorin et al., 2007). Furthermore, a study which provided Australian internet shoppers with purchase-specific dietary advice (on the saturated fat content of purchases) and recommended foods lower in saturated fat, was found to lower the saturated fat content of the intervention participants’ online food baskets (Huang et al., 2006). However, neither study reported the extent to which these consumers engaged with the product information (i.e. online nutrition labelling) displayed in these real-life supermarket websites.

In general, product information is thought to contribute to consumers’ product evaluation and decision-making during online shopping (Darley et al., 2010). However, a previous evaluation of an intervention displaying nutrition information (traffic lights) on selected products within a real Australian online supermarket found a lack of effect on shoppers’ real-life purchase choices (Sacks et al., 2011). One study has further examined the extent to which product information was viewed by consumers’ (aged 19-34) when performing their “weekly shops” in a selected online supermarket (Benn et al., 2015). These authors found poor levels of engagement with product information (including nutrition), which was not specifically explained by participants during their subsequent “play back” interviews (Benn et al 2015). Furthermore, despite the recent mandatory display of nutrition information in UK supermarket websites, there is currently a lack of insight into consumer use of this specific information in real-life contexts. There is now an opportunity to explore the potential for online retail to support healthy eating and ageing strategies and to enable information use and facilitate consumers’ healthy food choices.

The aim of this research was to examine the extent to which online product nutrition information is used by older adults when shopping online. This study also aimed to investigate how such information is used in a real-life context within UK supermarket websites.

5.3.1 Rationale for the use of mixed methods to explore use of online nutrition information

Investigating how consumers behave online is a growing field of research. Screen recording and quantification of product selection times and webpage views are common tools used to evaluate what consumers do whilst selecting products online (Anesbury et al., 2016). Measures of how often participant's visit the "deeper levels" of websites can be obtained using questionnaires and assessment of task performance, including in research exploring the role of aging in website usability (Wagner et al., 2014). A mixture of quantitative objective measures of information use (i.e. eye tracking), as well as explanatory qualitative interviews, have also been employed within UK research to explore use of general product information, in younger adults (Benn et al., 2015).

Qualitative methodologies which aim to collect and analyse data on consumer's thoughts and reasoning processes are also common in research examining consumers' use of nutrition labels (Food Standards Agency, 2010; Health Canada, 2010; Deakin, 2011). Such methods have been described as aiming to develop "*concepts which help us to understand social phenomena in a natural (rather than experimental) setting, giving due emphasis to the experiences and views of all the participants"* (Pope and Mays, 1995, p.311). Beyond simply quantifying "how often" consumers' use nutrition labels, qualitative enquiry has attempted to collect additional explanatory data concerning how and why consumers (do not) use this information in their daily lives. For example, work with focus groups has revealed the reasons why nutrition information may not be used by some consumers in everyday shopping (Health Canada, 2010; Deakin, 2011).

The use of individual "interviews" with consumers is also of value in the field of nutrition label research. Such methods have been described as offering an "*opportunity for an interactional, adaptable and flexible exchange between the researcher and participant, which can lead to a deeper understanding of attitudes* *and behaviours*" (Edwards and Holland, 2013, p.101). For example, away from the supermarket, individual consumer interviews have also cast light on why specific types of consumers may or may not use nutrition information, depending on their food consumption goals (Wahlich et al., 2013). In addition, interviewing consumers during, or following, their accompanied shopping trips is another common method of data collection. Such interviews may involve participants concurrently or retrospectively describing what prompted their purchase choices. This approach can help explore the real-life practical constraints and situational circumstances which influence use of nutrition labels and purchases (Higginson, Draper, et al., 2002; Food Standards Agency, 2010).

In the context of the literature on the impact of nutrition labels on health, reviewers have also recommended the use of qualitative approaches to further explore why consumers may or may not use the growing number of front-of-pack nutrition labels (Hieke and Taylor, 2012). Qualitatively exploring how consumers use the provided nutrition information "in the context of online shopping" has also been recommended following the disappointing evaluation of the impact of a nutrition label display intervention within a real-life online grocery stores (Sacks et al., 2011).

5.3.2 The Think aloud method

Previously, work investigating consumers' use of nutrition labels and other influences on purchase choices has used the "Think aloud" method (Rayner et al., 2001; Higginson et al., 2002a and 2002b; Chase et al., 2003; Reicks et al., 2003; Henry et al., 2003; Barnett et al., 2013). This method involves the consumer verbalising their own thoughts as they complete their usual shopping or specific tasks, with verbalisation recorded for future analysis (Charters, 2003). Ericsson and Simon (1993) state that this method can "*generate verbalisations, subordinated to task-driven cognitive processes, without changing the sequence of thoughts and slowing down only moderately due to the addition verbalisation*" (Ericsson and Simon, 1993, xxxii). Think aloud methods, including during participants' performance of "tests", are common in computer usability testing (Nielsen, 1994).

Beyond focus group or generalised post-task interviewing, strengths of the Think aloud approach include the ability to conduct this research in a real-life setting which reflects competing environmental influences (Chase et al., 2003; Demangeot and Broderick, 2006; Barnett et al., 2013). For example, in order to research "how" consumers use nutrition labels (in-store), including which specific nutrition label elements are "looked at", the Think aloud method has been used during accompanied shopping "tasks" which required participants to concurrently narrate their thoughts whilst selecting products (Higginson et al., 2002a and 2002b; Rayner, et al., 2002). Furthermore, Think aloud methods have also been used to collect insight into what factors are considered when consumers are purchasing food (Chase et al., 2003; Reicks et al., 2003; Henry et al., 2003). Following food labelling changes in Europe, the use of the Think aloud method during researcher-accompanied shops has allowed the exploration of how allergic consumers in Spain make food purchase decisions based on the available information and other cues (Barnett et al., 2013).

To explore older adult engagement with nutrition information within online supermarkets, a mixed methods approach was used. This included a survey of older adult online shoppers as well as individual Think aloud interviews which were selected to address research objective 3. This approach was considered suitable to provide insight into the understudied area of consumers' use of nutrition information during online shopping, specifically in a real-life context, by older adults.

5.4 Methods

5.4.1 Study design

An online survey was first developed (Chapter 2) and used to evaluate older adult consumers' self-reported use of nutrition labels (Chapter 4). The survey also evaluated these adults' use of online nutrition information when shopping for groceries in online supermarkets (see Chapter 2, section 2.4.3.5). In addition, individual Think aloud sessions were also performed with eight experienced older adult online shoppers. These aimed to help explain the survey findings by exploring why these consumers used (or did not use) product nutrition information provided in UK supermarket websites. This study received written ethical approval from the Leeds Trinity University Department of Sport Health and Nutrition Research Ethics Committee prior to commencement (Appendix G).

5.4.2 Participants

5.4.2.1 Online survey of online grocery shoppers

Recruitment of respondents for the online survey is described in Chapter 2 (section 2.4.1) and Chapter 4 (section 4.3.5).

5.4.2.2 Recruitment and sampling of Think aloud participants

Think aloud session participants were recruited separately by convenience sampling in July-September 2015. Email invitations were sent to large employers including regional Universities, businesses and City Councils as well as Third sector organisations based in Leeds, UK. The emails invited experienced online shoppers aged 50yrs or older to participate in a session described as '*finding out about how consumers make food choices during online shopping'*. A target sample size of ten participants was agreed in advance by the research team. This number was based on previous research using retrospective interviews with a similar number of online shoppers (n=10) (Benn et al., 2015). Eligibly criteria for Think aloud participants were; (1) having shopped online for food at least once in the past three months; (2) being aged 50 yrs or older, and (3) able speak and read English. A total of eight interested potential participants responded to the email invitation and were each sent study information and consent forms (Appendix H) via email and asked to read this and indicate if they met the eligibility criteria. Sampling of experienced, rather than entirely novice, online shoppers who possessed some familiarity of their usual websites was considered necessary to capture meaningful insight into the shoppers use of supermarket website and product information.

All eight prospective Think aloud session participants were deemed eligible and individual meetings with the researcher (of between 40-60 minutes) were then arranged at mutually acceptable times at either the University or in participant's own homes. All participants lived in Yorkshire and provided written consent in advance of their participation. All eight participants participated in Think aloud sessions and received a £5 supermarket voucher for their time. None of the participants were previously known to the researcher.

5.4.3 Data collection

5.4.3.1 Online survey

A detailed description of the data collection tool used in the online survey is included in Chapter 2 and Appendix D. Specific question items evaluated respondent's use of internet and technology as well as their frequency of online grocery shopping. Those who indicated that they undertook online grocery shopping were automatically directed to questions asking about their frequency of use of online nutrition information, including how often they read this information and its influence on their online purchase choices. Analysis of survey data relating to respondents' characteristics, including online shopping and their use of nutrition information, is described in Chapter 4 (section 4.3.6.2).

5.4.3.2 Collection of data from Think aloud participants

To explore their use of website and product nutrition information within online supermarkets, participants were asked to Think aloud whilst performing tasks to find "healthy" food products at their usual online supermarket. Think aloud sessions were undertaken by the researcher from July to September 2015, according to the protocol shown in Appendix I. To help ensure this approach was a reliable method for gathering information about what participants are thinking in that moment, a brief training session was first undertaken with each participant prior to data collection. For this, participants were first asked to practice "thinking aloud" using a simple task of counting aloud the number of rooms whilst visualising their walking path through their home (Ericsson and Simon, 1993; Barnett et al., 2013).

Using a laptop which was fitted with screen recording software (Mirametrix S2, Boston, US), participants were first asked to access their usual online supermarket. They were then asked to Think aloud about how they would select a 'soup' product, followed by the "healthiest soup" and finally a "healthy ready meal" (e.g. a lasagne). These tasks were designed to stimulate participants' non-prompted engagement with nutrition information, based on tasks used within previous in-store research with shoppers (Higginson et al., 2002a; Rawson et al., 2008; Food Standards Agency, 2010). This prior research had described the need to task participants with selecting the "healthiest" product to indirectly prompt their engagement with nutrition information and hence unravel "how" this information was used to shape decisions (Higginson et al., 2002a).

The tasks encompassed two different product types which therefore required use of the website to access different product categories. The specified products (soup and ready meal) were also based on previous research showing that label use is observed more for these types of composite, nutritionally ambiguous products, compared to other product types (Graham and Jeffery, 2012). Nutrition label information was not mentioned by the researcher during recruitment or the Think aloud sessions to avoid influencing participants' behaviour during the shopping tasks. If participants asked what was meant by healthy (n=1), they were told "*healthy for you*" to avoid prompting about nutrition (Higginson et al., 2002a). Audio recording of participants' Think aloud sessions and corresponding computer screen recordings of website use, were collected.

Following these sessions, participants then completed a link to the online survey questionnaire (described in Chapter 2 and shown in Appendix D) to collect data on socio demographics and use of nutrition labels and technology.

5.4.4 Data analysis

5.4.4.1 Hypotheses and quantitative data analysis

The statistical analysis of selected survey data relating to respondents' demographics and characteristics encompassing online shopping and frequency of use of online nutrition information are described here. Hypotheses tested were: (1) Characteristics of online grocery shoppers will not differ from non-online grocery shoppers; (2) Socio demographic, personal and nutrition and technology-related characteristics will be associated with frequency of use of online nutrition information.

Differences in proportions of these characteristics between online and non-online shoppers, were first examined using chi-squared (or Fisher's exact tests according to if group sizes were less than 5). The effect size phi (φ) is also reported to indicate the strength of differences in the chi-squared tests performed.

5.4.4.2 Analysis of Think aloud session data

This exploratory research was intended to identify themes from online shoppers' own Think aloud narratives relating to consumers use supermarket websites and online nutrition information, in the context of finding and evaluating product healthiness. Thematic analysis was selected for this purpose given that this has been used as a general approach to identify and describe patterns in verbal data (Braun and Clarke, 2006). Thematic analysis was also used in prior research using Think aloud methodology to explore information use and influences on purchases in specific consumer types (Barnett et al., 2013). Coding and theme creation were inductive (Thomas, 2006; Green and Thorogood, 2018), without reference to a coding framework, although the overarching conceptual framework guiding the wider PhD project has been outlined in Chapter 1. An interpretive approach was adopted by using coding and categorisation during analysis as well as constant comparison of cases (Strauss and Corbin, 1990). A realist epistemological stance to interpreting participants' narratives was adopted; participants' accounts were considered as being reflective of their thoughts, cognitions, and reported behaviours and that their language (and corresponding computer screen actions) provided the means through which the researcher was able to access these (Draper and Swift, 2011).

Audio recordings of each participant's Think aloud narratives were transcribed by the researcher. Screen shots of participants' computer screens which corresponded to their narratives were also included in these transcripts for context. Whole transcripts (reflecting all three tasks) were read multiple times and initial manual open coding was undertaken on each by the researcher. In addition, open coding of a sub-set of four transcripts was conducted independently by two Graduate students not involved with study design or data collection. Initial coding was informally discussed among these coders and then shared with the research supervisory team who had not been involved in data collection. Differences in coding or transcript interpretation were discussed at length with reference to paper copies of the transcripts. Subsequently, transcripts were then imported into NVivo 12 Plus software (QSR International, Melbourne, Australia) after which nodes were used to code data across all transcripts by the researcher.

An initial list of potential themes and sub-themes was created by aggregating similar nodes and with use of the software data view functions. Themes were discussed extensively with a supervisor experienced in qualitative research with older adults who was not involved in initial study design or data collection. Themes were then iteratively adjusted until a final set of distinct themes and sub-themes were agreed to adequately describe the data in terms of the research question (Draper and Swift, 2011).

5.5 Results

5.5.1 Survey sample characteristics

A total of 70 respondents (aged 50-87 yrs) were classified as online food shoppers out of the 181 older adults who completed the survey (Table 27). Most online grocery shoppers reported doing so “a few times a year” (22%, n = 40) or monthly (11%). A further 13 respondents had never shopped online for food but were planning on doing so in the next 12 months and were classified as non-online shoppers. Most online shoppers were female (73%), aged between 50-60yrs (74%), with university level education (70%) and Managerial/Professional level occupations (70%).

Proportions of these socio demographics did not vary between online and non-online shoppers (Table 27) with the exception of being previously advised to read food labels for medical or diet reasons, which was reported by a higher proportion (40%, n = 28) of online shoppers compared to non-online shoppers (24%, n = 27) ($\chi^2(1) = 5.0$, $p = 0.03$, $\varphi = 0.2$). Similarly, proportions of respondents who reported daily internet use, as opposed to less frequent, were significantly greater among online shoppers compared to non-online shoppers ($\chi^2(1) = 6.4$, $p=0.01$, $\varphi = 0.188$). The proportion of survey respondents who rated their ability to use the internet as either “good” or “excellent” (compared to “good” and “fair or poor”) was also significantly higher for online shoppers (79%) compared to none online shoppers (59%) ($\chi^2(2) = 7.1$, $p= 0.03$, $\varphi = 0.2$). In contrast, self-rated confidence in technology was evaluated (using a 7-point scale) as high by both online (mean 5.3, SD 1.6) and non-online shoppers (mean = 5.5, SD 1.5).

5.5.2 Self-reported use of nutrition labels and online product nutrition information

Reading of product nutrition labels (i.e. in a physical store) was reported frequently (i.e. “always/often”) by similar proportions of online shoppers (n = 32, 46%) and non-online shoppers (n = 61, 55%) (Table 27). In contrast, only 19% (n=13) of online shoppers claimed to read online product information as frequently (Table 27) (Figure 17). Among online shoppers, frequency of reading online nutrition information was related to frequency of (general) reading of nutrition labels (i.e. on packaging) ($\chi^2(1) = 3.6$, $p= 0.06$, $\varphi = 0.23$). However, frequency of reading online nutrition information was not related to respondents' sociodemographic characteristics, including whether respondents had indicated themselves or a household member had been advised to read food labels (Table 28).

Due to this question being non-mandatory, only 69 of the 70 respondents who were classified as online shoppers completed the question on how often online nutrition information influenced their purchase choices. There was no significant difference in the proportions of online (53%) and non-online shoppers (50%) who claimed that nutrition labels (i.e. present on product packaging) frequently influenced their purchase choices (Table 28). Among online shoppers, however, frequent influence of online product nutrition information on purchases was reported by much fewer respondents (19%) (Figure 17,Table 28). Frequency with which online nutrition information influenced purchases was related to the frequency with which nutrition labels (on packaging) influenced purchase choices ($\chi^2(1) = 6.8$, $p= 0.01$, $\varphi = 0.31$). However, frequency of use of online nutrition information was not related to respondents' sociodemographic characteristics (Table 28).

5.5.3 Nutrition knowledge and personal involvement with nutrition labels

Among online shoppers, levels of nutrition knowledge did not differ significantly between frequent and infrequent users of online nutrition information (Table 29). However, those who reported frequently reading nutrition information online possessed significantly higher levels of personal involvement with nutrition labels compared to infrequent readers (MD=-12.4, 95% CI: -18.2, -6.6, $p < .001$) (Table 29). Likewise, those who reported that online nutrition information frequently influenced their purchase choices also possessed greater levels of personal involvement with nutrition labels compared to infrequent users (MD = -1.06, 955 CI: -16.4,-4.8, $p = .001$) (Table 29).

Table 27 **Characteristics of survey respondents by online and non-online shoppers**

Characteristics		Online shoppers n=70 n (%)	Non-online shoppers n= 111 n (%)	P[4]
Gender	Female	51 (73%)	81 (73%)	.90
	Male	19 (27%)	30 (27%)	
Age (years)	**50-60**	52 (74%)	64 (58%)	
	60-70	14 (20%)	37 (33%)	.08
	70+	4 (6%)	10 (9%)	
Education				
	Higher Education	49 (70%)	69 (62%)	.28
	< Higher education	21 (30%)	42 (38%)	
Ethnicity				
	White British	62 (89%)	100 (90%)	.75
	Non-White	8 (11%)	11 (10%)	
Occupation[1]:				
	Managerial/Professional	49 (70%)	69 (62%)	.33
	Other Occupation	21 (30%)	42 (38%)	
Advised to use food labels[2]				
	No	42 (60%)	84 (76%)	.03
	Yes	28 (40%)	27 (24%)	
Frequency of Internet Use[3]				
	Daily	63 (90%)	83 (74%)	.01
	Less than daily	7 (10%)	28 (26%)	
Ability to use the internet				
	Excellent or Very good	55 (79%)	66 (59%)	
	Good	10 (14%)	31 (28%)	.03
	Fair or Poor	5 (7%)	14 (13%)	
Confidence in using technology (7-point scale)[4] Mean (SD)		5.5 (1.6)	5.3 (1.5)	.20
Frequency of online shopping for food				
	At least once a week	10 (14%)	N/A	
	Monthly	20 (29%)	N/A	
	A few times a year	40 (57%)	N/A	N/A
	Never but planning on doing so	0	13 (12%)	
	Never	0	98 (88%)	
Reading of nutrition labels (in store)[5]				
	Frequently	38 (54%)	50 (45%)	.25
	Infrequently	32 (46%)	61 (55%)	
Influence of nutrition labels (i.e. in store) on purchase choices[5]				
	Frequently	37 (53%)	56 (50%)	
	Infrequently	33 (47%)	55 (50%)	.75

[1] Occupation was diachotomised as Managerial/Profession = Teacher, Nurse, Physiotherapist, Finance manager, Accountant, Solicitor, Civil engineer, or Other= Intermediate occupations including Secretary, personal assistant, clerical worker, call centre agent, nursery nurse. [2] Do you or a member of your household have a personal diet or medical condition where looking at food label information is advised? [3] Frequency of internet use was diachotomised as; 1= Daily, 0= 2-4 times a week, Less than once a week, Less than once a month. [4]Confidence evaluated using a 7-point scale where 1= not at all confident, 7 = extremely confident. [5] Frequently =Always/Often, Infrequently = Sometimes/Rarely/Never. $ Differences between online and non-online shoppers was assessed using Chi-squared tests for categorical variables or independent t-tests for continuous variables with 7-point scales. (Abbreviations: Uni. = University level including BSc., Post graduate qualifications, HNC= HNC/HND/Diploma qualifications.)

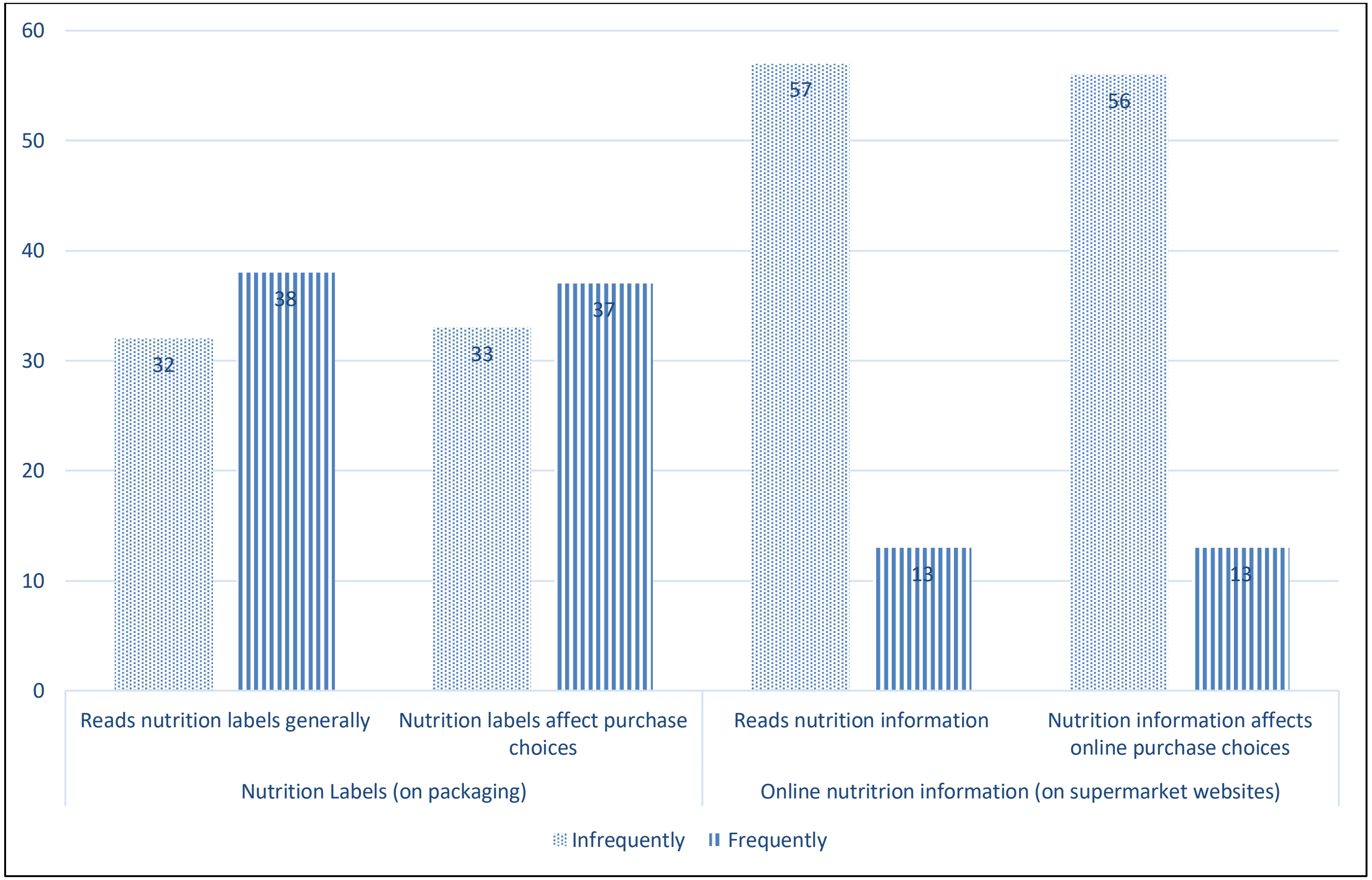


Figure 17 Number of online shoppers who reported frequent or infrequent reading, or use, of nutrition labels and online nutrition information

Table 28 Sociodemographic characteristics of older adult online shoppers, by frequent and infrequent use of online nutrition information

	n = 70	Reads product nutrition information (n=70)$			Online product information affects purchases (n=69)$		
	Total	**Infrequent n = 57**	**Frequent n = 13**	**P[1]**	**Infrequent n = 56**	**Frequent n = 13**	**P[1]**
Gender	**n(%)**	**n(%)**	**n(%)**		**n(%)**	**n(%)**	
Female	51 (73%)	42 (74%)	9 (69%)	.75	40 (71%)	10 (77%)	.69
Male	19 (27%)	15 (26%)	4 (31%)		16 (29%)	3 (23%)	
Age (years)							
50-60	52 (74%)	44 (77%)	8 (61%)	.5	43 (77%)	8 (62%)	.52
60-70	14 (14%)	10 (18%)	4 (31%)		10 (18%)	4 (31%)	
70+	4 (6%)	3 (5%)	1 (8%)		3 (5%)	1 (7%)	
Advised use[a]							
Yes	28 (40%)	37 (65%)	5 (38%)	.08	19 (34%)	8 (62%)	.06
No	42 (605)	20 (35%)	8 (62%)		37 (66%)	5 (38%)	
Ethnicity							
White British	49 (70%)	52 (91%)	10 (77%)	.14	51 (91%)	11 (85%)	.49
Not white British	21 (30%)	5 (9%)	3 (23%)		5 (9%)	2 (15%)	
Education[b]							
Higher education	49 (70%)	42 (74%)	7 (54%)	.16	41 (73%)	7 (54%)	.40
<Higher Education	21 (30%)	15 (26%)	6 (46%)		15 (27%)	5 (46%)	
Occupation[c]							
Managerial/professional	49 (70%)	41 (72%)	8 (62%)	.46	40 (71%)	9 (69%)	.88
Other occupation	21 (30%)	16 (28%)	5 (38%)		16 (29%)	4 (31%)	
Healthiness of diet[d]							
Good or better	52 (74%)	43 (75%)	9 (69%)	.64	41 (73%)	10 (77%)	.78
Fair or worse	18 (16%)	14 (25%)	4 (31%)		15 (27%)	3 (23%)	
General Health[e]							
Good or better	58 (71%)	47 (82%)	11 (85%)	.85	46 (82%)	11 (85%)	.83
Fair or worse	12 (29%)	10 (18%)	2 (15%)		10 (18%)	2 (15%)	

a Respondents answered yes or not to the question; "Do you or a member of your household have a personal diet or medical condition where looking at food label information is advised?" b Educational attainment was dichotomized as higher education (i.e. University level education) or less than higher education. c Occupation was dichotomized as Managerial and Professional occupations and Other Occupations (including unemployed, lower supervisory and intermediate). d Dietary healthiness was self-rated using the question item "How would you rate the healthiness of your diet" using a five point scale (i.e. "Excellent, Good, neither healthy nor unhealthy, fair , poor") which was dichotomised (i.e. 1= Excellent/Good, 0 = Neither, Fair, Poor) , e General healthiness was self-rated using the question item "How would you rate your general health?" using a five point scale (i.e. "Excellent, Good, neither healthy nor unhealthy, fair , poor") which was dichotomised (i.e. 1= Excellent/Good, 0 = Neither, Fair, Poor). $ Frequently = Always/Often, Infrequently = Sometimes/Rarely/never. [1] Difference within groups as assessed by Chi-squared tests or Fishers Exact test where cell values < 5.

Table 29 Personal involvement and nutrition knowledge characteristics of older adult online shoppers, by frequency of use of online nutrition information

Characteristic	Sample total N=70	Reads nutrition information online n = 70			Online nutrition information affects purchase choices n = 69		
		Infrequent	**Frequent**	**P[3]**	**Infrequent**	**Frequent**	**P[3]**
Personal involvement[1], Mean (SD)	46.1 (10.6)	43.8 (9.6)	56.3 (9.2)	< .001	43.8 (10.0)	54.9 (6.5)	.001
Nutrition Knowledge[2], Median *(IQR)*	11 (10,13)	11 (10,13)	12 (10,13)	.95	12 (10,13)	12 (10,13)	0.99

[1] Personal involvement with nutrition labels score was of a maximum of 70. [2] Nutrition knowledge quiz score is out of maximum of 13 [3] Difference within groups as assessed by independent t-tests or Mann- Whitney U tests. Statistically significant differences were assessed as $P< 0.05$. Abbreviations: SD = Standard Deviation, IQR= Interquartile Range.

Table 30 Characteristics of Think aloud session participants relating to online shopping and use of nutrition labels and online product nutrition information

Participant CODE	Gender	Age (yrs)	Education	Occupation	Frequency of Internet access	Ability to use the internet[2]	Confidence using technology[3]	Frequency of shopping online for groceries	Usual online supermarket	Advised to read labels?[1]	Frequency of influence of nutrition information on purchase choices	
											Labels (i.e. on pack)	Online
P1	M	64	A Levels	Profession.	Daily	Excellent	7	Monthly	Ocado	Yes	Sometimes	Sometimes
P2	F	55	HNC	Intermed.	Daily	Very Good	6	≥ once a week	Morrisons	No	Sometimes	Sometimes
P3	F	62	Uni.	Profession.	Daily	Good	6	A few times a year	Ocado	No	Sometimes	Never
P4	F	58	C & G	Profession.	Daily	Good	6	≥ once a week	Morrisons	Yes	Often	Often
P5	F	63	Uni.	Profession.	Daily	Very Good	5	Monthly	Ocado	Yes	Often	Often
P6	F	50	HNC	Profession.	Daily	Very Good	6	Monthly	Morrisons	Yes	Always	Sometimes
P7	F	60	HNC	Profession.	Daily	Excellent	6	Monthly	Morrisons	Yes	Sometimes	Sometimes
P8	F	66	GCSEs	Intermed.	Daily	Excellent	7	A few times a year	Morrisons	Yes	Always	Rarely

[1] Do you or a member of your household have a personal diet or medical condition where looking at food label information is advised? [2] Ability was evaluated using a five-point scale; Poor,, Fair, Good, Very good, Excellent. [3]Confidence evaluated using a 7-point scale where 1= not at all confident, 7 = extremely confident. Abbreviations: Gender; M= male, F = female. Uni. = University level including BSc., Post graduate qualifications, HNC= HNC/HND/Diploma qualifications, C&G = City and Guilds. Profession = Occupations including Professional and Managerial e.g. teacher, nurse, physiotherapist, finance manager, accountant, solicitor, civil engineer. Intermed.= Intermediate occupations including Secretary, personal assistant, clerical worker, call centre agent, nursery nurse.

5.5.4 Think aloud sessions: Participant characteristics

All eight participants were white British and most were female (n=7) aged between 55-66yrs old (Table 30). Most had professional-level occupations (n=6) and two had attained University-level education. All used the internet at least daily and their frequency of online shopping varied from weekly to a few times a year, with most (n=6) undertaking this monthly or at least once a week. The majority (n=6) of participants stated themselves or a family member had been advised to use food labels. Participants' usual online supermarket website was either Morrisons (n=5) or Ocado (n=3). Each participant's level of confidence in using technology was rated as at least "5" on a seven-point scale, where "7" was "extremely confident". Similarly, all participants rated their ability to use the internet as either "Good" or "Excellent".

5.5.5 Think aloud sessions: Themes identified

Three overarching emerging themes were identified using thematic analysis. These related to participants' use of supermarket websites and online product nutrition information, in the context of finding healthy products. Themes were; (1) Search efficiency; (2) Definition of healthy; (3) Information engagement. Themes and their corresponding sub-themes are outlined in Figure 18 and described below.

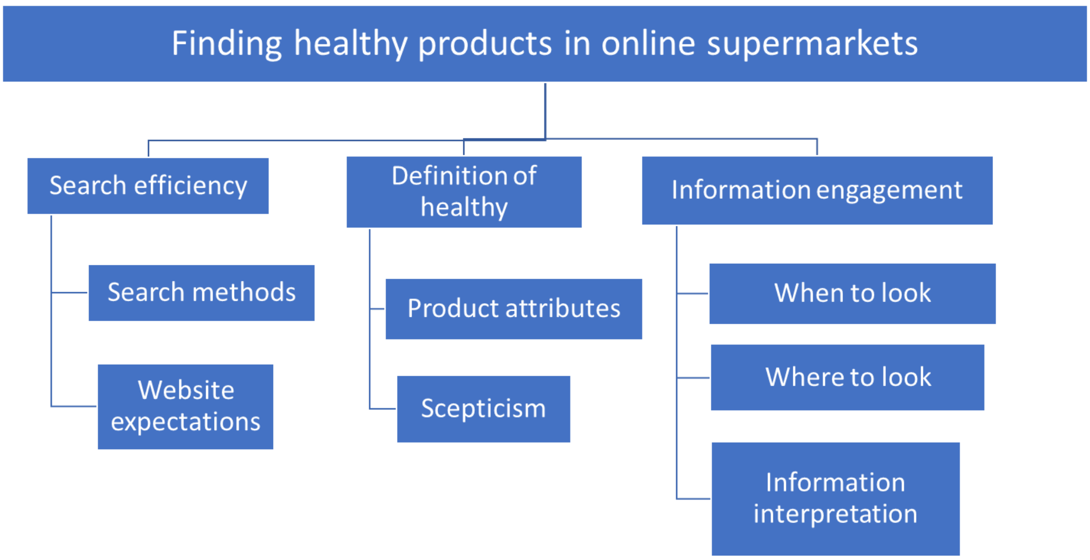


Figure 18 Themes relating to finding healthy products and use of nutrition information within supermarket websites

5.5.5.1 Theme 1: Search efficiency

Sub-theme 1.1 Search Methods

In response to the tasks, participants referred to their usual practices of navigating to products, including their previous experience and saved shopping lists.

> *"If it was just something I bought regularly (I) would actually just know where to go."(P8)*
>
> *"Go to orders, and then…. cos I have mine, er, like in lists, and er, so I'd use a previous order." (P2)*

In contrast, they used the search function (i.e. "find product" text box) to search for newer products.

> *"I just usually have my list and then just click in and out of that. I'd just put it into, if I didn't have it already added on to my favourites, I'd just put it on to search engine and just look." (P4)*

Participants' choice of website search methods was also considered in terms of their relative efficiencies in terms of the effort and time required when scanning long results lists. Participants expected that searching for a new product would lead to a long list of products which needed to be refined or else, "trawled" though.

> *" So… I think I would look probably again look at the (pause) again "find product" I think because after all I could spend all day looking at this (list)… I haven't purchased this before so it won't be on my previous shopping list."(P5)*
>
> *" If I want a specific kind, say if I just wanted the Heinz soup, I'd put in Heinz soup otherwise it will bring you up twenty thousand soups and you might not like any of them." (P1)*
>
> *"I might maybe just put Heinz tomato soup first to save time. Because I'm one (sic) about saving time I hate shopping so…I just want to get it done quickly and over with." (P2)*

Sub-theme 1.2 Website expectations

When tasked with finding "the healthiest" soup/ready meal, participants also stated they were unfamiliar with using the website for this purpose but expected the website could be used to list "healthy options", as an alternative to manual identification.

> *"It's not something I would normally do but I've seen this 'healthiest soups' on the left hand side. Or I would probably have to trawl through" (P7)*

“Well I would look for an option that the computer is geared up for, em, an option to put healthy.” (P6).

“Okay, well very often on the search criteria they have, er, the healthy option.” (P1)

One participant attempted to find healthy products by using the website function to sort products, which was unsuccessful.

“I’d look for this… it says sort by favourites. I’d look there to see if there was such a filter such as healthy. So, sort by favourites first, but I can see that there isn’t anything to say whether its healthy or not. oh okay and you go by… and that filter is price height low… So…going to be difficult. you have to look through.”(P2)

5.5.5.2 Theme 2: Defining healthy

Sub-theme 2.1 Product attributes

Participants used product attributes to refine a long list of products to find healthy products. Attributes used included “fresh” and “organic”.

“*Um, healthy. I’m thinking…. So I’d automatically look for a fresh soup. I would ignore all the tinned and packet-ed and things. And, erm, I might think, so I would then try and find organics.”* (P3)

Indeed, navigating to “fresh” products led one participant to find a list of “healthy options”, by chance:

“So probably fresh maybe? And then, that’s drop down there’s ready meals and then you’ve got healthy choices. So that’s how to do it. That brings up these.”(P7)

Other attributes that participants related with product healthfulness included price or brands they had prior knowledge and experience of.

“This is probably based on price.” (P3)

“See I’d find weightwatchers would be quite healthy because it’d be part of a slimming diet wouldn’t it. (gestures to the supermarket’s own brand “healthy range) It’s got reduced fat. And I know that’s their healthier option range because I’ve looked at it at home. Well, there’s probably more than one isn’t there, but I definitely know that that is and the weight watchers ones I know that they too are.”(P6)

As a result of an apparently unsuccessful attempt to locate the “healthy options” listing within the website, one participant rationalised that the listing of vegetarian products was in fact healthy due to the fact they did not contain meat.

“Well this one goes on about yeast free, vegetarian and etc. um. So because that (referring to healthy options) wouldn’t be there …I’d then put on the search bar “healthy soups”. Yeah, so, because it’s

not brought any healthy option soups up, all I've done is bring up all options with vegetables. Figuring that, well there's gonna be no meat in that. So, it might be marginally better than one rammed with er, meat."(P1)

Sub-theme 2.2 Scepticism

When exploring individual products to evaluate healthfulness, participants revealed their suspicions about product health marketing (i.e. branding or "low fat" nutrition claims).

"I'm looking here at the product description (reads)..."by choosing love life products you are improving the nutritional balance of your diet" so this is what it tells me…but do I really feel it does? So, I need to look in a bit more detail."(P5)

These included participants' concerns relating to their prior experience that marketing may not reflect the product's actual nutritional composition.

"The healthiest I'm thinking is loaded with sugar and salt. (P8).

"There can be vast differences... like full fat and low fat...I know there's lot more sugar in the low fat so I've intentionally switched to the full fat whereas at one time that (low-fat) would have been my overriding choice." (P4)

Participants' scepticism resulted in a perceived need to check the product's nutrition label.

"I know from experience that products that are labelled as healthy, less fat, when you really analyse them they are full of sugar, full of salt so it that healthy or not? Even though they are low in fat..and when you start to look at the labels and start to compare they're not really under the health category."(P2)

5.5.5.3 Theme 3: Information engagement

Sub-theme 3.1 When to look

In the context of online supermarket shopping, viewing online product nutrition information was reported as unusual for participants who stated they usually, or preferred to, examine product information when they were in-store.

(views nutrition information) "I wouldn't normally do that." (P1)

"Yeah so if I'm online shopping I'm doing it because I get home from work late and in late….not much time. I still do prefer to go into store to see the package and content to choose which I think I need, first. Rather than just a picture."(P6)

"Erm ...apart from going into store and reading the label...cos I do go into store as well I don't just shop on line... so if there's something in particular I might just search it out and look on the packaging." (P2)

Participants perceived there was also a need to consult individual product (i.e. nutrition) information to evaluate product healthiness following a failure to list "healthy option" products.

"Doesn't seem to be any healthy options so… so I would look at the, erm the nutrition value on the side of the packet. Well you'd have to click….you'd have to click and it would come up...there we are …you put the mouse over it." (P8)

Participants also felt it more necessary to view product nutrition information when considering which new products were meant to be purchased, for product comparisons, or specific product types (i.e. pizza).

"If it's a new product, just not one that I'm used to choosing or I've bought before, then to choose one I'd probably look at the product information. If it's one I've had previously then I'd just click and buy. I would have look at what its content was if I really were intent on buying one of them."(P4)

"Probably not for soup but for other items erm, I might look what the product information says, so maybe a pizza, I'd maybe want to see what it's constituent parts are (P3).

"Well it might be for two soups I weren't so sure on then….I usually tend to go….er i would look at a vegetable based one er rather than a creamy one, thinking that's more healthy….and then maybe just look at calorie er content…..and then I'd just go pick another one and ….do a comparator…you know I'd pick another soup and have a look at it." (P4)

Sub-theme 3.2 Where to find

Locating online product nutrition information on supermarket webpages (i.e. scrolling down the webpage) was an unfamiliar process for participants. One participant initially doubted the availability of this information following an attempt to locate this.

"I'd just click on that (product information window) (see Figure 2) and just see if anything comes up. Just tells you it is a product description. It just tells you it's one of your five a day and its vegetarian (reading) that's the only information it gives you. So it doesn't give you any salt content or sugar content so that something a bit restrictive really…it doesn't tell you there. (Hovers on photo) Arh, it's showing you the label a little bit. It's all green the traffic lights. You can just make it out...that there are four green and no reds. I think that's the best you're going to get, I think, online." (P2)

Participants located the information for the first time by chance.

> *"You want to look at the product information, and I don't actually know how you find it here. Er..some have it easily, you click on the, like, quick view…like that. But I just did that by chance like oh, let's just click on it and it'll bring a bigger picture up…it doesn't, it doesn't always have it." (P6)*

Participants often referred to short comings with their own website knowledge when attempting to view nutrition information or use this in product comparisons.

> *"I don't know how you'd...unless you compared it. I don't know how to do a comparison on Morrison's website…You can like click three or four products and put them side by side and compare which ones you want." (P7)*

In order to locate nutrition information, participants used their prior experience and online expectations of non-food product information provision (i.e. for clothes) in order to locate a product's nutrition information in product photographs.

> "…*Zoom into the packet, if I was buying a dress on Marks and Spencer you would zoom in and have a look at it. Look what it's made of, highlighting the product, … and have a look on here*."(P8*)*

However, participants' reliance on the product photograph for viewing nutrition information meant that when the expected front-of-pack traffic light panel was absent, this altered the basis of their comparative product health evaluation. This occurred when a gluten free logo appeared instead of front-of-pack nutrition labels within the same on-pack position (Figure 19).

> *(Hovering over a second product photo to find the traffic light signpost) "Chunky tomato soup… and it highlights… gluten free. They we are- if I was buying gluten free."(P4)*

Similarly, another participant's product comparisons were hindered when the corresponding traffic light information was not available on the comparator soup product photograph (Figure 20).

> *(*Hovers over the traffic light panel on photograph) "*Errm salt's only one gram…so I'd take that one off and look at Heinz (clicks on another product) . Arh, that doesn't tell you so I probably wouldn't buy that one cos I don't know what's in it."* (P3)

Sub-theme 3.3 Information Interpretation

When viewing online product nutrition information, participants expressed they would need to interpret this information using a personalised approach or with some prior knowledge.

> *"I'm doing a low carbohydrate diet. I would look at this, that's where I'd get my carbohydrate. If it's got lower than five then I'd think it's alright…I'd just have an eye on salt content...I must say though I don't know what level you're supposed to have."(P4)*

This included a participant's need to use their commercial weight management programme "calculator" to decide on healthiness.

> *"So as I scroll down it's given me the nutritional value. And being a weight watcher which I'm sure you can appreciate it is important to look what's it in it….I'm looking at the nutrition data...to make up my mind I suppose really I'd go off my weight watchers calculator again." (P5)*

Participants contrasted the need to interpret nutrition information with their confidence the available interpreting front-of-pack traffic light nutrition label colours, to evaluate individual product healthfulness.

> *"So that's what I'd look at (information found at the bottom of the product full details page)… You'd have to know what your daily intake recommendations were for all these and I don't know what they are. So I'd base it on the three green traffic lights."(P2)*

> *"It's whether you're familiar with food labelling. It's the green and amber so you know it's not got loads of the red labelling in so for me that's a good product choice."(P3)*

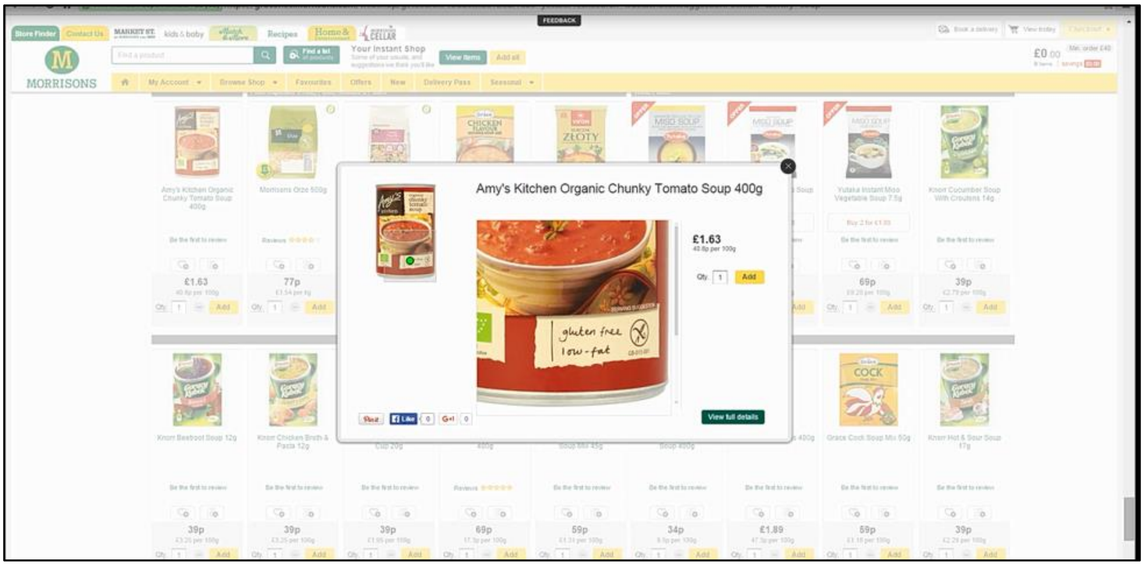
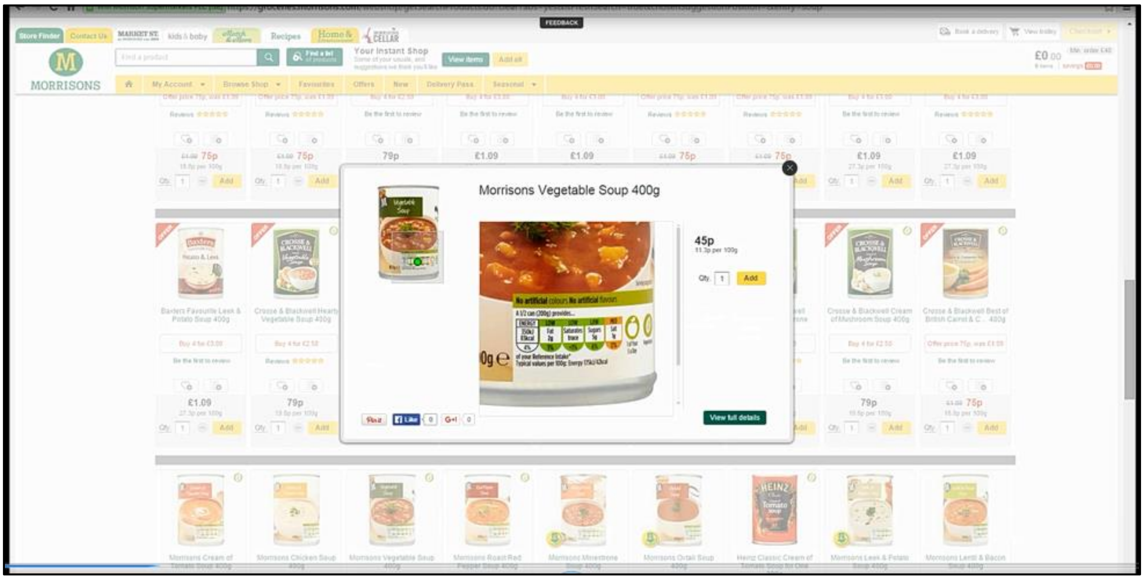


Figure 19 A supermarket website product information window showed with the product photograph hovered over to enlarge label



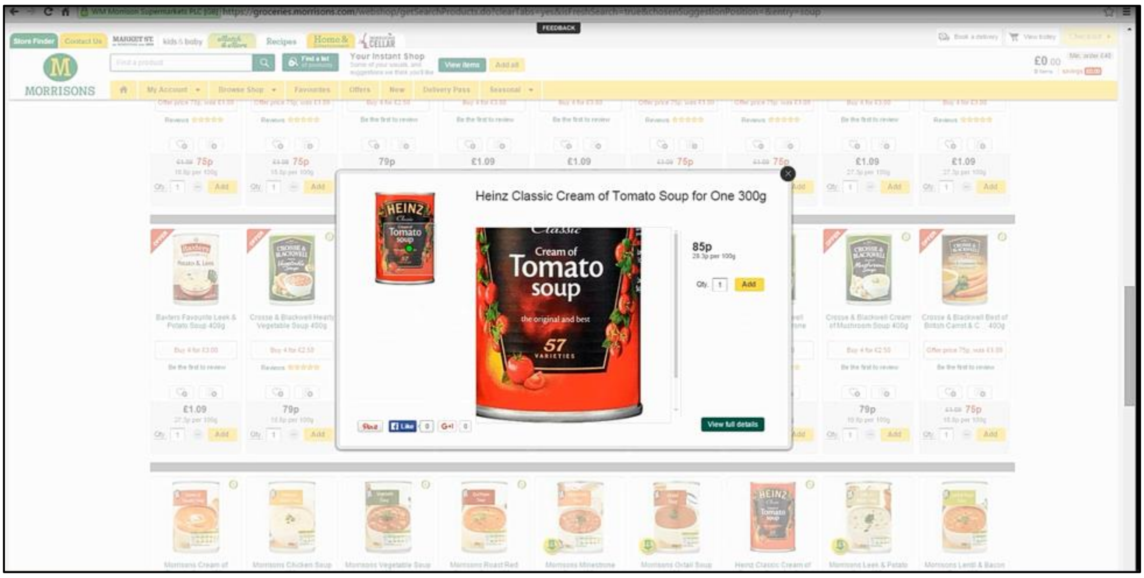


Figure 20 Two product information windows which were viewed by a participant sequentially.

The product photograph was hovered over with the cursor to magnify the traffic light nutrition label (top). Magnification of the second product photograph (bottom) in a similar location showed an absence of the front-of-pack nutrition label

5.6 Discussion

5.6.1 Summary of findings

This study aimed to explore older adults' use of online nutrition information within supermarket websites, in this case, when evaluating "healthy" products. Findings suggest that among online shoppers who responded to the survey, frequency of use of this online information was less than that reported for nutrition labels present on packaging. Although, frequency of use of online nutrition information was found to be related to their frequent self-reported use of labels (i.e. on packaging) and levels of personal involvement with this information. However, there was no link between frequency of use of online nutrition information and any other characteristics including educational attainment, gender, nutrition knowledge, or advised reading of food labels for health or diet reasons.

Explanations for this possible lack of engagement with product nutrition information in supermarket websites were then sought using individual concurrent Think aloud narratives from experienced older adult online shoppers tasked with finding healthy products in their usual online supermarket. Themes identified related to use of the supermarket website and online nutrition information. These were; search efficiency; definition of healthy; and information engagement. These themes and survey findings will now be discussed in relation to the emerging research. A wider discussion of these findings and their implications is presented in Chapter 8.

5.6.2 Searching for products using supermarket websites

Within supermarket websites, searching efficiently for products appeared to be an important influence on participants' engagement with product information. Searching for products on supermarket websites involved dealing with very long lists of products, which participants narrowed using "healthy options" or specific product attributes (i.e. "fresh"). These actions were perceived to save time and remove the need to evaluate each product's individual detailed information. Participants' reliance on the supermarket websites' automated product listings, which may negate the need to view or use product information, is an important finding. This is supported by recent research into consumer's online behaviour when grocery shopping which has been found to be focused on time-efficiencies with a tendency to view very few website pages (Anesbury et al., 2016) and to shop in the quickest possible way (Benn et al., 2015).

Participants' competence with the website functionality as well as their own assumptions and definitions about what was "healthy" also appeared to influence their selection and evaluation of products during the Think aloud tasks. For example, use of the website functionality to accurately list "healthy" products appeared to depend on participants' guess work or prior familiarly with this aspect of the supermarket website. An example of this was illustrated by one participant who attempted, unsuccessfully, to use the website "sort by" function to list products based on "healthy". Another participant was unable to locate a "healthy options" listing and relied instead on vegetarian options, presuming these would be "healthy". Consumers' ability to navigate websites when searching for products has also been emphasised as important for product selection in relatively younger adult online shoppers (Benn et al., 2015). The findings here appear to support other research which found that older adults may require further support to adequately navigate websites to find relevant (health-related) information (Miller and Bell, 2012; Wagner et al., 2014).

Participants' own assumptions and definitions of "healthy" products were often used to specify product attributes and types for use as online search proxies. These included "fresh", "vegetarian" or "organic" and were, in one case, based on price (the most expensive). Similar strategies have been reported in research observing that consumers may use product attributes, instead of nutrition information, when evaluating products in-store (Malam et al., 2009; Food Standards Agency, 2010; Health Canada, 2010). Also noted here were participants' references to their prior experience, or scepticism, when evaluating healthiness of food products. As part of this, they cited the need to look at food and nutrition labels as a way to "check" if the claims and marketing were correct. These findings are in line with other research whereby consumers are known to judge healthiness of food products based on a combination of factors, including previous experience with the nutrition content (Ronteltap et al., 2012). Participants' use of product attributes or listings to evaluate products online are therefore comparable to those findings of a study of 32 allergic adults aged 16-70 years old. This used similar Think aloud methods to show that even allergic consumers evaluated products using attributes and past experiences, rather than referring to detailed food label information (Barnett et al., 2013).

5.6.3 Engagement with nutrition information

Survey findings showed that nutrition information in online supermarkets was not reportedly used as frequently as that displayed on nutrition labels (on packaging). However, frequent use of this on-pack information appeared to be related to frequent use of this online information, among these older adults. Subsequently, analysis of Think aloud data has suggested that reasons for this may involve the search and navigation processes performed in supermarket websites, as described above. Findings also suggest that although participants perceived that viewing nutrition information was required to evaluate healthfulness, they reported they usually viewed this information whilst in-store, or only for new products, or specific product types. The latter are also commonly reported for use of nutrition labels whilst in-store (Grunert et al., 2010b; Campos et al., 2011). Opportunities for consumers to view nutrition labels in-store rather than online may also occur since many online shoppers also perform complementary in-store visits or minimise their purchase of new products via this channel (Chu et al., 2010).

The surveyed older online shoppers who reported being previously “advised” to use food labels were no more likely to report frequently using this online information than those who had not been advised. Similarly, actual (eye-tracked) viewing of online product nutrition information was also unrelated to participants’ dietary restrictions, among younger adults (Benn et al., 2015). Of the potentially related personal and nutrition-related characteristics evaluated here, only personal involvement with nutrition labels was related to more frequent use of online nutrition information in purchases, among online shoppers. This somewhat contrasts with earlier evidence from the survey of older adults which showed that greater levels of nutrition knowledge and dietary healthiness as well as being female, or advised to use labels, were associated with frequent use of nutrition labels in purchase choices (Chapter 4).

The Think aloud findings reported here may help to explain these findings from the online survey, and other research. For example, when tasked with selecting a “healthy” product, findings here suggest participants had difficulty knowing where to look when locating online product nutrition information within product information webpages. Locating this information was described by participants as based on their past-experience of non-food online shopping (i.e. for clothes) or viewing the product packaging, particularly when product photographs displayed front-of-pack traffic light labels. As such, it was a challenge for some participants to find (mandatory) nutrition table information, which appeared at the bottom of the product's webpage. This was noted by participants when front-of-pack nutrition labels were not present in product photographs. These findings now add to some recent consumer focus group insight which highlighted poor levels of awareness of the existence of nutrition information in online supermarkets, among consumers in Northern Ireland (Food Standards Agency, 2016). Together, these findings suggest that mandatory online nutrition information is not immediately obvious or easy for consumers to find and may not be noticed by consumers.

Recent work conducted around the same time as the current study has also reported nutrition information was not typically displayed on the search page on the majority of UK supermarkets websites (Stones, 2016). This author reported that whilst mandatory information was provided in all online supermarkets, this was normally located "below the fold" (i.e. requiring scrolling down the webpage). This was also true for those supermarket websites used by participants in the current study and appeared to lead one participant, who was initially not able to find a product's nutrition information, to assume that such information was not provided online. Indeed, Stones (2016) suggests that the current display of online nutrition information means that it is possible for consumers to purchase products without ever viewing nutrition information.

Furthermore, inconsistencies in the presentation of front-of-pack nutrition label information in online supermarkets were also highlighted by the current study's participants and in the research undertaken by Stones (2016). Inconsistent location, or the absence of, front-of-pack nutrition labels, including in product photographs, were both mentioned by participants. Such inconsistencies also appeared to impact on participants' between-products comparisons. This included when a front-of-pack (traffic-light) nutrition label was not displayed in product photographs and a (gluten-free) logo was found in a similar location on pack instead. Although voluntarily provided, front-of-pack information may be the only information accessed by consumers, so it is therefore important that it is available. Indeed, it has been suggested by experimental evidence that use of these types of labels on packages by consumers may result in less time examining any additional (i.e. back-of-pack) information for specific product types (Bix et al., 2015). Furthermore, the importance of a consistent location of (on-pack) nutrition information has also been highlighted by other researchers, to enable consumers' use of this information in product evaluations (Campos et al., 2011; Hieke and Taylor, 2012; Bialkova and van Trijp, 2010; Graham and Jeffery, 2012)

Evidence from the current study showed that when participants did attempt to use and interpret online nutrition information, they cited their own uncertainties about being able to do so. These included participants' use of their personalised approaches (i.e. low carbohydrate diets or weight management tools). In contrast, front-of-pack traffic light information was interpreted relatively confidently by participants to evaluate product healthfulness.

Overall, the findings of the current study show the potential for improvements to the provision and prominence of both mandatory (back-of-pack) and voluntary (front-of-pack) nutrition information. Greater exposure to and perception of this online nutrition information may be expected to better facilitate consumers' online product evaluations and comparisons with respect to nutrient content. This is in line with the conceptual framework of consumers' use of labels (Grunter and Wills, 2007). Product comparison is a key intended purpose of providing nutrition information, since this helps consumers to determine the existence of "healthier" product alternatives (Higginson et al., 2002b; NHS, 2014; Emrich et al., 2017). As indicated by the Think aloud findings here, consumers' conduct of product comparisons should also now be further investigated within online supermarkets. Overall, the current study now provides additional support for the recommendation that online supermarkets should increase the visibility, presentational consistency, and consumer awareness of the existence online product nutrition information (Stones, 2016; Buttriss, 2018) to enable consumers' accurate product evaluations in this retail channel.

5.6.4 Strengths and limitations of the study

This mixed methods study included an online survey, which evaluated use of nutrition information among older adult online shoppers. However, survey results cannot be assumed to reflect the general older adult population given that survey respondents were mostly well educated and female, with regular access to the internet and high levels of confidence in their use of technology. Survey findings reported here may therefore reflect a best-case scenario of older adult internet use and self-reported frequency of online food shopping. In addition, the small sample size, (n=70) may not have provided adequate power to detect differences between groups. As such, results should be interpreted with caution given the increased probability of type II error. The findings therefore warrant further investigation of consumer use of online nutrition information in a larger and more diverse sample of older adult consumers.

Furthermore, the use of online nutrition information was self-reported so it is also possible this could be over-estimated. Alternatively, this measure could also reflect how often these respondents shopped online for food and may therefore be lower estimates than the relative frequencies of use of this information (i.e. per purchase), in this setting. However, survey results focussing on the relative use of nutrition information vs labels are in-line with the low levels of objectively-measured attention paid to this information, compared to other product elements displayed online, in the eye-tracking study by Benn et al (2015). In addition, the current research did seek to contextualise the use of product nutrition information by these consumers by exploring use of this information within real-life supermarkets websites using Think aloud sessions. Overall, these findings should be considered to reflect an initial exploratory approach to investigating use of supermarket website and online nutrition information, by older adult consumers.

5.6.5 Use of Think aloud methodology

The Think aloud method was used to gather verbal data from individual participants concerning their use of nutrition information and supermarket websites, in a real-life context. Other researchers have also recently utilised this method, including within retrospective interviews to study consumers' use of online product information during accompanied website shops (Food Standards

Agency, 2016). Mixed methodologies which include Think aloud techniques have also been proposed to specifically explore older adult navigation in supermarket websites (Osman and Hwang, 2016), as well as technology-based food purchase decisions among consumers from remote communities (Tonkin et al., 2017). Furthermore, the relative efficiencies and reliability of the Think aloud method have been reported by Cowburn (2016) in her PhD thesis which favourably compared this method with video capture from consumers with wearable cameras. As part of the Front of Pack Labelling Impact on Consumer Choice (FLICC) study (University of Oxford), Cowburn (2016) conducted Think aloud sessions with a total of 31 participants to investigate and explain the low levels of use of these nutrition labels in consumer decision making, during real-life shopping in-store (Cowburn, 2016). Furthermore, other studies have also analysed Think aloud data by using thematic analysis as an approach with which to identify themes, as used in the current study (Barnett et al., 2013; Food Standards Agency, 2016; Cowburn, 2016; Osman and Hwang, 2016; Tonkin et al., 2017).

As opposed to retrospective interview techniques, concurrent Think aloud is considered to allow collection of more detailed insight from participants than retrospective interviews (Ericsson and Simon, 1993). However, providing a Think aloud concurrent narrative may have also imposed an extra cognitive load on participants when they were performing these complex tasks (Charters, 2003). This may have been a problem for participants who were not used to using this technology or unable to meet the required language skills. However, participants recruited in the current study were all experienced online shoppers and used their preferred usual supermarket website. In contrast, other work appears to have used novice online shoppers who had never shopped online or used the specific retailer website before (Benn et al., 2015). In this respect, participants in current study were considered likely to provide detailed insight into their use of online product information within a real-life online supermarket, which would address the exploratory research objective. In other words, without the possibility that levels of familiarity would impact on participants’ experience and use of their selected online supermarket website. Indeed, the role of familiarity in website use is currently being evaluated by other researchers (Osman and Hwang, 2016).

Participants' motivations to use nutrition information should also be acknowledged here. For example, survey respondents and Think aloud session participants were both self-selected and therefore likely to possess greater levels of interest in and motivation to use this information relative to the general older adult population (Cavaliere et al., 2017). In addition, Think aloud session tasks included the manipulation of interviewees' motivations and product selection "goals" by specifically instructing them to select the "healthiest" product (Higginson et al., 2002a). Such simulation of shopping tasks whilst "thinking aloud" has also been used in food choice research to allow exploration of how consumers engage with specific aspect of technology (Tonkin et al., 2017). Albeit not representative of real shopping behaviours, such tasks were specifically used here to provide insight into if and how nutrition information is used within the practical constraints of the online shopping environment. These tasks' instructions avoided specifically directing participants to use nutrition information and therefore influencing perceptions of information engagement within the context of the supermarket website. However, it should be acknowledged that such shopping tasks are known to stimulate best-case scenarios of engagement with these labels in-store via "goal-priming" (van der Laan et al., 2017; Cavaliere et al., 2017) and therefore may not reflect participants own purchase intentions. In the current study and other work, it is also acknowledged there is no correct "healthiest" product, as this would also vary with availability and product types across supermarket websites (Higginson et al., 2002a).

Only eight participants were purposively sampled and interviewed in the Think aloud study undertaken here. No further recruitment took place after August 2015 due to the researcher's commencement of maternity leave. However, the number of participants (n=8) was considered satisfactory for this exploratory research given that coding of text into nodes appeared similar across cases and these reflected themes defined here. As such, the sample size appeared sufficient to approach a likely "saturation" of data in terms of themes and sub-themes.

Data saturation is considered to be the point when "*researchers have heard or seen something so repeatedly that they can anticipate it*" (Sandelowski, 2008, p.2). Indeed, during the later interviews the researcher gained a clear sense of similarities between participant's approaches to the tasks and their use of the website and nutrition information. Participant's responses may have also been somewhat predictable given that tasks were prescriptive and participants' responses therefore repeated. Whilst, the concept and practical possibility of data saturation is also widely debated (Guest et al., 2006; Draper and Swift, 2011), guidance from Braun and Clarke (2013) on sample sizes can be compared to the size of the sample used in the current study (n=8). For example, these researchers suggest that around 10 interviews would be needed for a "small" study and between 10-30 for an entire PhD project, as used elsewhere (Higginson et al., 2002a; Braun and Clarke, 2013; Cowburn, 2016). In contrast, computer programme usability testing conducted using Think aloud "tests" with five participants has been shown to lead to identification of up to 85% of "issues" (Nielsen, 1994).

Finally, the insight obtained from Think aloud sessions here was limited to two supermarket websites. However, these were very similar in their presentation of product nutrition information and in terms of their functionality enabling navigation to "healthy options" and other product-type listings. In addition, although this study was conducted during the transition period of the implementation of the EU Regulation 1169/2011 for distance selling (i.e. online), it is important to note that both of these online retailers had previously implemented online nutrition information from 2014, in line with the information provision requirements for existing products.

5.6.6 The role of the researcher

The researcher can be considered a tool in qualitative research during both data collection and analysis (Braun and Clarke, 2006). For example, the data produced by the Think aloud sessions may reflect not just cognitive processes but the social setting, including the "reactivity" of the participant to the researcher (Reicks et al., 2003; Sasaki, 2008). Participants' reactivity or change in behaviour as a consequence of being observed is also possible here (McCambridge et al., 2014). The effect of reactivity on Think aloud data collection was minimised as follows; the researcher was not known to participants, no reference to nutrition information was made to participants during the study instructions; participants received prior training in Think aloud in line with best practice; the researcher explicitly stated that participants product selections were not judged (Barnett et al., 2013; Tonkin et al., 2017).

The reflexive role of the researcher should also be outlined here. She is a registered dietitian with experience of working in industry with consumer insight and nutrition labelling legislation. In addition, the researcher was more familiar with quantitative approaches and therefore sought training in NVivo software analysis and experience in qualitative research alongside Psychologists whilst undertaking the earlier pilot e-learning intervention in Chapter 3. Rigour and reliability were therefore considered and sought by involving several independent researchers in data analysis and research team members in theme development. In addition, transcripts were transcribed by the researcher as verbatim along with computer screen images to evidence meaning. These aspects are generally considered important to reduce the influence of pre-conceived ideas and beliefs during analysis (Draper and Swift, 2011).

5.7 Conclusion

Despite mandatory provision of product nutrition information in supermarket websites, older adult shoppers' use of this information appeared to be less frequent than their use of nutrition labels on product-packaging. Qualitative work undertaken here suggests that search strategies used by these consumers to find "healthy" products, including automated website listings, may reduce the need to engage with product nutrition information. Additional challenges surrounding the viewing of this information include difficulties locating online nutrition information, particularly that displayed mandatorily. Participants' reliance on (voluntarily provided) front-of-pack nutrition labels displayed in product photographs highlighted the impact that inconsistencies in the presentation of this information might have on their product evaluations. The use of online product nutrition information by these consumers might be improved by increasing the prominence and consistency of product nutrition information, therefore supporting the identification of healthy products in online supermarkets.

Chapter 6 Effect of educational interventions on understanding and use of nutrition labels: A systematic review.

6.1 Abstract

Background: The potential for nutrition labels to impact on consumers' health depends on their use of this information to inform their food choices. Consumers' understanding of nutrition labels is an important antecedent to use of this information, yet levels of understanding are known to vary with consumer age and education levels, or different label design formats. Labelling legislation requires consumer education on "how to use" nutrition labels, yet there is a lack of insight regarding the effect of such education on optimising consumers' understanding or use of this information. This review aimed to evaluate if nutrition label education can improve consumers' understanding and use of nutrition labels and to summarise the features of successful interventions.

Methods: Database searches were performed to identify published interventions which delivered education on nutrition labels and measured outcomes relating to aspects of nutrition label understanding or use.

Results: A total of 17 studies were selected for review, including nine randomised and eight pre-post intervention studies. Most studies (n=12) were conducted in the US. Study participants included school age children, older adults and those with diabetes, within a range of intervention types, including in-class group sessions and web-based education. Although measures were heterogenous, all studies reported a statistically significant improvement in one or more outcomes of participants' understanding or use of nutrition labels. Intervention features including educational content and delivery format as well as participants levels of general nutrition knowledge and health literacy warrant attention in future research.

Conclusion: Education can optimise understanding and use of nutrition labels and may therefore have the potential to improve the impact of this information on dietary health.

6.2 Introduction

The requirement for consumer education on nutrition labelling is stipulated in legislation which mandates this information on products in the US and EU (US Food and Drug Administration, 1995; EC, 2011). Recommendations that nutrition label education is provided also emanate from research reporting inequalities in consumers' understanding and use of nutrition labels and their disappointing effects on purchase choices (Cowburn and Stockley, 2005; Campos et al., 2011; Gregori et al., 2014; Volkova and Ni Mhurchu, 2015). However, there is a current lack of research into the effects of nutrition label education, including if such interventions can be expected to enhance consumer's understanding and use of nutrition labels. Consumer understanding of nutrition labels is considered a key antecedent to their use by consumers in purchase evaluation decisions (Grunert and Wills, 2007; Grunert et al., 2010b). Indeed, research evaluating different formats of nutrition labels also aims to improve the comprehensibility of this information for consumers (Malam et al., 2009; Gorton et al., 2009; Mejean et al., 2013b; Roberto and Khandpur, 2014; Ducrot et al., 2015). No review has yet evaluated the effect that educational interventions may have on consumers' understanding and use of nutrition labels. In line with research objective 4, this review aims to describe the effect of such interventions on nutrition label use and understanding. This study also aims to provide an examination of the features of these interventions to inform further research and intervention development in this area, as part of the current PhD project.

6.3 Methods

This review was undertaken in accordance with the PRISMA guidelines (Liberati et al., 2009).

6.3.1 Search strategy

The electronic databases Medline, PsychInfo and Cinal were searched for records published between 1994 to March 2015 (search 1) and again between April 2015 and July 2018 (search 2). Earliest publication dates were chosen as 1994 onwards to include evaluations of educational interventions which occurred following the US Nutrition Labelling and Education Act (US Food and Drug Administration, 1995). Search terms and strategies were created using key words from previous literature and database-specific subject headings to identify studies evaluating the effects of nutrition label education interventions on the outcomes of consumer use and understanding of this information. Search terms were combined using three elements of the research question (e.g. ‘nutrition label information’ or “nutrition facts panels” AND ‘educational intervention’ or “education program” AND ‘comprehension’, “understanding”, “use” or “knowledge”) (for an example see Table 31).

6.3.2 Selection of included studies and exclusion criteria

To ensure that selected studies reflected the aims of this review, abstracts were screened for articles in English reporting interventions which included nutrition label education either alone or as a component of a wider multi-component program. Those which reported outcomes which specifically included use or understanding of nutrition label information were identified. To provide an inclusive exploration of the available literature, study eligibility included all study designs and participant types (i.e. children, patients) and settings (i.e. community, geographic location, nutrition label type). No studies were excluded based on these aspects. Following the screening of abstracts by the researcher, full text articles were then obtained and assessed against the specific exclusion criteria by the researcher and supervisor (JD), independently, with subsequent discussion to resolve any conflicts. Specific exclusion criteria encompassed those studies which: (A) there were no outcomes concerning nutrition label use or understanding, (B) evaluated the “comprehensibility” of different label formats, (C) educated on aspects of “food labels” which did not include nutrition information such as allergens or ingredient information and (D) evaluated the implementation of labelling on products or “healthy eating” in-store campaigns (without educational sessions or the required outcome measures).

Table 31 Medline database search strategy

	Search Term		Search Term
1	nutrition* label*.	21	Health Promotion/
	Food Labeling/	22	(health adj3 promot*).mp. [
3	food label*.	23	(health adj2 educat*).mp
4	(nutrition* adj3 information).mp.	24	14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or "24".mp.
5	(nutrition* facts panel or nutrition* facts table).mp	25	cognition/ or awareness/ or comprehension/knowledge
6	food packag*.mp.	26	understand*.mp.
7	exp Nutritional Sciences/	27	perception.mp.
8	Nutritional Status/	28	comprehen*.mp
9	Nutrition Labels/	29	consumer*.mp.
10	Nutritive value/	30	health literacy.mp.
11	nutriti* value.mp.	31	nutrition literacy.mp.
12	food* value.mp.	32	behavio*.mp.
13	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12	33	behavio* change.mp.
14	health education.mp.	34	Consumer behavior/
15	Health Education/	35	Consumer behaviour/
16	education* intervention* program*.mp	36	Health behaviour/
17	nutrition education food label*.mp.	37	25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36
18	(nutrition* adj3 education).mp.	38	13 and 24 and 37
19	Patient Education as Topic/		
20	Health Knowledge, Attitudes, Practice/ or Program Evaluation/		

6.3.3 Data extraction and quality assessment

In line with the research aims, data extracted from the studies included participant and intervention program characteristics, as well as descriptions of and impact on, outcome measures concerning participants' use and understanding of nutrition label information. The data extraction form is shown in Appendix J. Included studies were appraised for quality by the first author in discussion with the research team using the Effective Public Health Practice Project (EPHPP) assessment tool for assessing risk of bias in intervention evaluations (Armijo-Olivo et al., 2012) (Table 32). Each of seven study characteristics including study design, participant selection and attrition were evaluated as either 'weak', 'moderate' or 'strong' based on the potential for bias and EPHPP ratings. Where quality EPHPP criteria aspects were not clearly reported, further information was sought from the study authors by email. Two authors were contacted concerning intervention content or evaluation measures to assist the data collection and quality appraisal process. No responses were received, and these items were therefore rated "weak/moderate" after discussion with the research team.

6.4 Results

6.4.1 Study selection, design and quality

Database searches returned 4,712 and 966 records, respectively (see Figure 21). Following duplicate removal and screening of abstracts, full texts (119 in total across both search timeframes) were examined in detail against the exclusion criteria. For example, a total of 41 studies (across searches 1 and 2) were excluded which reported aspects of nutrition label reading in their educational interventions but did not evaluate label use or understanding as outcomes (Figure 21). A total of 17 studies were retained for further analysis and data extraction. Study designs of the 17 selected studies included nine randomised studies which used control or comparator groups. The remaining eight studies used a pre post-intervention study design to evaluate the effect of the intervention on use or understanding (Chapman-Novakofski and Karduck, 2005; Hawthorne et al., 2006; Lindhorst et al., 2007; Katz et al., 2014; Dukeshire et al., 2014; Pettigrew et al., 2016; Garcia et al., 2017; Wolfe et al., 2017). The overall quality of the 17 studies was appraised as "moderate" for ten studies, five as "strong" and two as "weak". The latter ratings were due to acknowledged limitations concerning confounding or very low numbers of participants at follow-up in their rural communities and grocery stores (Lindhorst et al., 2007; Dukeshire et al., 2014) (Table 32). No studies were removed based on the EPHPP quality rating so that all 17 studies were retained for onward qualitative synthesis in this review. This aimed to provide an inclusive analysis of interventions undertaken in different settings.

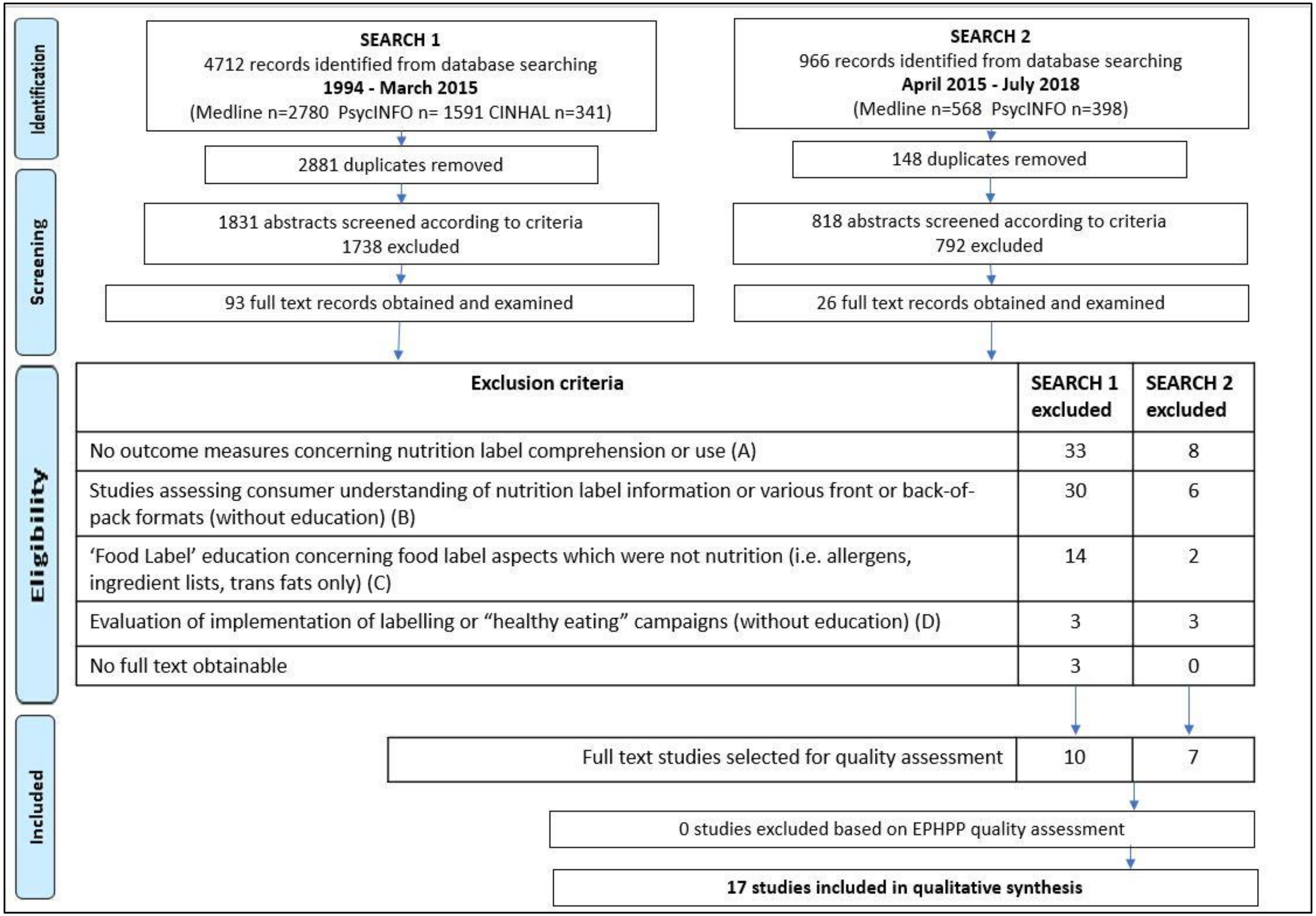


Figure 21 Study selection of articles included in the review

Table 32 Quality appraisal of the studies included in the review using EPHPP Criteria

Reference	Selection bias	Study design	Confounders	Blinding	Data collection	Withdrawals/ Dropouts	Intervention integrity	Overall
				Randomised studies				
Miller et al., 1999	Strong	Strong	Strong	Weak	Strong	Strong	Mod.	Strong
Miller et al., 2002	Strong	Strong	Strong	Weak	Strong	Strong	Mod.	Strong
Jay et al., 2009	Mod.	Strong	Strong	Weak	Strong	Strong	Mod.	Strong
Neuenschwander et al., 2013	Strong	Strong	Strong	Weak	Mod.	Strong	Mod.	Mod.
Pennings et al., 2014	Mod.	Mod.	Weak	Weak	Strong	Weak	Mod.	Mod.
Kollannoor-Samuel et al., 2016	Strong	Strong	Strong	Mod.	Mod.	Mod.	Mod.	Strong
Gavaravarapu et al., 2016	Strong	Mod.	Mod.	Mod.	Weak	Strong	Mod.	Mod.
Treu et al., 2017	Strong	Mod.	Mod.	Weak	Strong	Strong	Mod.	Mod.
Miller S et al., 2017b	Strong	Strong	Mod.	Mod.	Strong	Strong	Strong	Strong
				Cohort studies				
Chapman-Novakofski and Karduck, 2005	Mod.	Mod.	Mod.	Weak	Strong	Weak	Mod.	Mod.
Hawthorne et al., 2006	Mod.	Weak	Weak	Mod.	Mod.	Mod.	Mod.	Mod.
Lindhorst et al., 2007	Weak	Weak	Weak	Weak	Mod.	Mod.	Weak	Weak
Katz et al., 2014	Mod.	Weak	Weak	Mod.	Strong	Mod.	Mod.	Mod.
Dukeshire et al., 2014	Weak	Mod.	Weak	Weak	Weak	Weak	Mod.	Weak
Pettigrew et al., 2016	Strong	Mod.	Mod.	Mod.	Strong	Weak	Mod.	Mod.
Garcia et al., 2017	Strong	Mod.	Mod.	Mod.	Strong	Weak	Mod.	Mod.
Wolf et al., 2017	Strong	Mod.	Mod.	Mod.	Mod.	Weak	Mod.	Mod.

Abbreviations: Mod. = Moderate

6.4.2 Intervention participants and programs

The selected 17 studies included various numbers of participants ranging from 19 (Dukeshire et al., 2014) to 1,487 (Treu et al., 2017) which were >50% female and entirely female in one case (Miller et al., 1999) (Table 33). Ages of participants ranged from Third Grade (around 8 years) (Treu et al., 2017) to 75 years old (Miller et al., 2002; Dukeshire et al., 2014). Two studies recruited only older adults, specifically those with diabetes aged over 60, or 65 years (Miller et al., 2002; Chapman-Novakofski and Karduck, 2005). Participants included university students (Pennings et al., 2014; Miller et al., 2017b), school children or adolescents (Hawthorne et al., 2006; Katz et al., 2014; Gavaravarapu et al., 2016; Treu et al., 2017; Wolfe et al., 2017), disadvantaged or vulnerable adults (Lindhorst et al., 2007; Kollannoor-Samuel et al., 2016; Garcia et al., 2017) on existing education programs (Pettigrew et al., 2016), or low income adults (Neuenschwander et al., 2013), including some with low health literacy (Jay et al., 2009). Four studies were conducted with adults with diabetes (Miller et al., 1999; Miller et al., 2002; Chapman-Novakofski and Karduck, 2005; Kollannoor-Samuel et al., 2016). Most interventions took place in the US (n=12) prior to 2017 with the remaining from Canada (n=2), India, Australia and the UK.

Almost half of the interventions (n=7) focused on nutrition label education entirely in a one-off session (intervention type 1) (Hawthorne et al., 2006; Lindhorst et al., 2007; Jay et al., 2009; Katz et al., 2014; Dukeshire et al., 2014; Pennings et al., 2014; Miller et al., 2017) (Table 33). The duration of these sessions ranged from 10 to 120 minutes, with the shortest intervention involving a booklet viewing session of 10 minutes (Pennings et al., 2014). The remaining nine studies reported that nutrition label education was promoted as part of various healthy eating interventions (intervention type 2) (Miller et al., 1999; Miller et al., 2002; Chapman-Novakofski and Karduck, 2005; Neuenschwander et al., 2013; Pettigrew et al., 2016; Kollannoor-Samuel et al., 2016; Gavaravarapu et al., 2016; Garcia et al., 2017; Treu et al., 2017; Wolfe et al., 2017). These included weekly sessions delivered to groups in community or school settings (Miller et al., 1999; Miller et al., 2002; Neuenschwander et al., 2013; Pettigrew et al., 2016; Gavaravarapu et al., 2016; Garcia et al., 2017; Wolfe et al., 2017) or monthly (Chapman-Novakofski and Karduck, 2005), with participants in one study receiving individual, intensive, home-based visit sessions as part of a 12 month intervention (Kollannoor-Samuel et al., 2016). Across both intervention types 1 and 2, delivery formats included in-class teaching and interventions conducted entirely (Dukeshire et al., 2014), or partly, in a supermarket (Miller et al., 2002; Kollannoor-Samuel et al., 2016; Treu et al., 2017). Two studies described interventions which were conducted with participants on individual computers, described as web-based (Neuenschwander et al., 2013; Miller et al., 2017b).

Table 33 Descriptions of educational interventions, including participants, settings and underpinning theories

First author, year	Sample characteristics	Sample size	Intervention programme: description, aims and delivery format	Intervention Type	Setting and Country	Duration and session type	Theory underpinning intervention
Miller 1999	Women with Type 2 diabetes.40-60yrs old.	40	Nutrition labelling education programme to facilitate the application of information on the food label to meet patient's needs. Delivered in-person by dietitians	2	Community centres US	9 weekly GS	TML
Miller 2002	Older Adults with Type 2 diabetes. 53% Women.≥65yrs old.	93	Nutrition labelling education programme to improve food label knowledge and skills in diabetes management. Delivered in-person by dietitians.	2	Outpatients US	10 weekly GS (each 1.5hrs)	SCT. IP
Chapman Novakofski 2005	Older adults with diabetes. Mean age 63yrs.73% Female.	239	*Dining with Diabetes*: Diabetes education program about healthy eating and food label components. Group taught sessions delivered in person.	2	Community-based US	3 monthly GS, 2hrs each.	SoC SCT
Hawthorne 2006	Young adolescents. Aged 11-14yrs.47% Female.	34	How to read and use a nutrition facts label education program. Delivered by a registered dietitian.	1	NS. US	1 GS of 1 hr	NS
Jay 2009	Low income adult patients. Mean age 50 yrs. 73% Female.	42	Intervention to improve nutrition label comprehension. Brief interactive multi-media video and pocket card. Tutor delivered by tutor.	1	Healthcare centre US	1 GS 45 minutes total.	NS
Lindhorst 2007	Adults. Aged 18->65yrs.81% Female.	259	*Healthy Eating is in Store for You* – a nutrition labelling education program aiming to help consumers make food choices promoting healthy weight. Delivered by community health officers.	1	Community-based Canada	1 session	NS
Neuenschwander 2013	Low income US adults Aged 18-50 yrs. 90% Female.	123	Web-based nutrition education program on healthy eating including nutrition label reading.	2	Home computer/ community centre US	3 GS or online of 30-40 mins	KEL
Dukeshire 2014	Adults. Aged 31-75yrs.>90% Female.	19	An in-store Nutrition Label Education Program designed to teach how to read nutrition facts panel. Delivered by a registered dietitian using a lecture with materials followed by a store tour	1	Grocery Store Canada	A 2 hour GS	NS
Pennings 2014	Undergraduate students. Aged 17-24yrs.63% females	32	*Thumbs Up Healthy Eating* Nutrition Education booklet designed to promote attention focus on nutrition labels on product packaging.	1	University US	A 10 minute session.	IP
Katz 2014	5th grade school children. Age NS. 58% Female.	212	*Nutrition Detectives* educational program on how to read food labels aimed at developing food-literacy skills. Taught by school teacher within class (presentation and practical)	1	School class US	1 session of 45 mins	NS

First author, year	Sample characteristics	Sample size	Intervention programme: description, aims and delivery format.	Intervention type	Setting and Country	Duration and session type.	Theory underpinning intervention
Pettigrew, 2016	Disadvantaged adults. Age NS.76% Female	927*	*FOODcents* nutrition education program for disadvantaged adults: aims to improve household food expenditure according to the health eating pyramid, includes food label reading. Delivered face-to-face with cooking sessions and supermarket tours.	2	Community-based Australia	GS of 1-2hrs or up to 8 sessions.	P&P.
Gavaravarapu, 2016	Indian school children .Aged 12-15 yrs. Females: NS	175	*READ-B4-U-EAT* multicomponent school module to promote use of the food label information and informed food choices. Delivered using videos, handouts and presentations, by teachers.	2	School India	4 GS sessions of 45 minutes	SCT
Kollannoor-Samuel 2016	Latinos with Type II diabetes. Median age 57yrs.73% Female.	203*	Diabetes among Latinos Best Practices Trial (DIALBEST) on food labels and Glycaemic control. Includes nutrition education and how to interpret food labels. Delivered with individuals by Community Health Workers.	2	Home-based (and store visit) US	17 home-based sessions over a 12month period.	NS
Garcia 2017	Vulnerable adults. Aged >45yrs 68% Female	62*	*Eat Better Feel Better* community-based cooking program aimed at tackling barriers to cooking and healthy eating. Delivered by community-trained chefs.	2	Community-based UK	6 weekly GS of 2 hrs.	NS
Wolfe 2017	School children 3rd-5th and 6th-8th Grades.~50% Female.	1,334	*Choose Health: Food, Fun, and Fitness Youth Curriculum* (part of SNAP-Ed) aimed at enhancing knowledge and skills building. Incudes label reading. Delivered by Community Health Educators.	2	School, clubs, summer camp US	6 weekly lessons 45-90 minutes each.	SCT EL
Treu 2017	Third Grade School Children .Mean age 8.7yrs.52% Female.	1487	*Nutrition Detectives* and *ABC for Fitness* programs (Standard Intervention), alongside family, home, and supermarket sessions (Enhanced Intervention).	2	School US	90min In-class and 30 min booster after 3 months	NS
Miller S 2017b	Undergraduate students. Mean age 20.7 yrs.60% Female.	140	Web-based label reading training tool to improve individuals' ability to use labels to select more healthful foods. Training tasks required individuals to compare 3x 24 pairs of nutrition labels	1	University US	One session of 60-90 minutes	Skill

Abbreviations: NS=Not stated. SCT=Social Cognitive Theory, TML= Theory of Meaningful Learning, SoC=Stages of Change, Skill= skills acquisition, KEL=Kolb's Experiential Learning, EL=Experiential Learning, P&P= Precede &Proceed, GS = Group session. *Sample size lower at follow up, see text for details.

6.4.3 Effect on understanding of nutrition labels

A total of eleven studies which evaluated participants' understanding of nutrition labels reported statistically significant pre-post intervention increases in this outcome (Hawthorne et al., 2006; Katz et al., 2014; Dukeshire et al., 2014; Pettigrew et al., 2016), or compared to the comparison group (Miller et al., 1999; Miller et al., 2002; Chapman-Novakofski and Karduck, 2005; Jay et al., 2009; Gavaravarapu et al., 2016; Miller et al., 2017b; Treu et al., 2017) (Table 34). However, lack of a control group meant that alternative explanations for improvement in participant understanding could not be ruled out. In addition, comparability of these interventions' impact on participants' label understanding was limited given that much variation existed between studies in question items used to evaluate understanding of nutrition labels. For example, some studies conducted assessments of participants' objective understanding of nutrition labels with multiple quiz questions assessing label "comprehension" or ability to interpret and compare labels using serving size, %DV and nutrient content information (Hawthorne et al., 2006; Jay et al., 2009). Perceived understanding of nutrition labels, specifically participants' agreement that they knew "how to use" them was assessed in one study (Chapman-Novakofski and Karduck, 2005).In contrast, other studies assessed understanding using only a few question items which aimed to assess understanding of nutrition information alongside food label components (i.e. ingredients, quality logos, cooking instructions etc.) (Lindhorst et al., 2007; Dukeshire et al., 2014; Pettigrew et al., 2016; Gavaravarapu et al., 2016; Garcia et al., 2017). Two studies evaluated participants' understanding of the nutrition label elements of the overall "food label" using a single question. For example, one asked: "*In 100g of this product how many grams of sugar are there?*" (Pettigrew et al., 2016). Another assessed increases in "knowledge of the nutrition label" using a single questionnaire item asking 12-15 year old school students if nutrition information was "present" on a food label (Gavaravarapu et al., 2016). The validity and reliability of these mainly, "researcher developed" instruments was not consistently evident across studies, further limiting the interpretation of results.

Two studies used a validated multi-item "food label literacy" instrument to evaluate school students' ability to use nutrition labels and make healthful food choices (Katz et al., 2014; Treu et al., 2017). Both showed significant pre post-test improvements among the school children undertaking the intervention, including compared to the control school groups (Treu et al., 2017). Furthermore, various aspects of both factual and applied knowledge and understanding of nutrition label data were evaluated in two studies with participants with diabetes undertaking multiple sessions as part of programmes aimed at improving food label skills and diabetes managements (Miller et al., 1999; Miller et al., 2002). Participants in both these studies significantly increased their levels of declarative (i.e. factual) and procedural (i.e. applied) knowledge of nutrition labels from pre to post-intervention, as compared to the control groups. In addition, one study also assessed improvements in participants' own (written) decision-making rationale for theoretical food purchases (Miller et al., 2002). The use of these measures in these studies highlights the potential for education to improve participants' understanding of nutrition label information and to enable accurate use of this information, particularly when comparing products or making food choices in the context of diabetes management.

6.4.4 Effect on usage of nutrition labels

There were 13 studies which reported the impact of their interventions on nutrition label "use", all of which showed significant improvements in one or more measures of this outcome (Table 34). However, measures of use of nutrition labels may not have been reflective of actual behaviours given that they comprised mainly of self-reported pre and post-intervention questionnaire items such as "*How often do you read nutrition labels?*" (Neuenschwander et al., 2013; Pettigrew et al., 2016; Kollannoor-Samuel et al., 2016; Gavaravarapu et al., 2016; Wolfe et al., 2017). In addition, one UK study described "objectively measured" nutrition label reading by using tick boxes besides images of nutrition labels for participants to indicate at pre and post-intervention which UK label components were checked (i.e. fat, sugar, calories) (Garcia et al., 2017). In contrast, objective assessment of actual viewing of labels was evaluated in only one study which found a significant increase in eye-gaze time (by 1.3 seconds) in those viewing nutrition labels (on computer screens) compared to the control group, following a brief leaflet-viewing intervention (Pennings et al., 2014). In addition, levels of self-confidence in using labels, including for specified tasks (i.e. "*I can use nutrition labels to check sugar content*") were evaluated and found to improve significantly following intervention in five studies (Miller et al., 1999; Miller et al., 2002;

Dukeshire et al., 2014; Garcia et al., 2017, Chapman-Novakofski and Karduck, 2005). Similarly, participants' "perceived importance" of reviewing nutrition information before purchases was also shown to improve in one study (Lindhorst et al., 2007).

One study with school children in India used five questions to assess use of specific components of nutrition labels. These included: "*Do you see the sugar content in sparkling beverages?"* and "*Do you see the salt content when buying snacks*?" (Gavaravarapu et al., 2016). However, only childrens' responses to the latter question were significantly improved in the intervention, compared to the control group.

Three studies evaluated use of nutrition labels at various follow-up time points following interventions which included nutrition label education as a component within a wider intervention promoting healthy lifestyles and behaviour change (Pettigrew et al., 2016; Kollannoor-Samuel et al., 2016; Garcia et al., 2017). This included after 6 weeks follow-up with 114 disadvantaged Australian adults (Pettigrew et al., 2016), and after 3-4 months with 17 vulnerable Scottish adults (Garcia et al., 2017). Although the numbers of participants at follow-up were reduced compared to post-intervention in all three studies and therefore may be prone to bias, results from these suggest (self-reported) use of nutrition labels were still somewhat increased at these time points (Pettigrew et al., 2016; Kollannoor-Samuel et al., 2016; Garcia et al., 2017). Promisingly, this included after 6 months follow-up in the randomised study which reported significantly greater use of food labels in the intervention compared to the control group following 12 month multiple home-based sessions (Kollannoor-Samuel et al., 2016). In this study, evaluation of participants' glycaemic control and dietary intakes was also undertaken. Such measures enabled analysis suggesting that improvements in food label use and diet quality mediated significant improvements in glycaemic control among the intervention, compared to the control participants (Kollannoor-Samuel et al., 2016).

6.4.5 Design features of effective interventions

6.4.5.1 Intervention types and components

Type 2 interventions were categorised here as multi-component programs encompassing nutrition label education alongside other "healthy eating" aspects, including behavioural components such as cooking and lifestyle advice (Neuenschwander et al., 2013; Pettigrew et al., 2016; Gavaravarapu et al., 2016; Garcia et al., 2017; Treu et al., 2017; Wolfe et al., 2017). Type 2 interventions also included those with nutrition label education which was delivered in the context of diabetic glycaemic management (Miller et al., 1999; Miller et al., 2002; Chapman-Novakofski and Karduck, 2005; Kollannoor-Samuel et al., 2016). Some type 2 interventions were designed around theoretical models of behaviour change such as “Social Cognitive Theory” and, “Stages of Change”(Miller et al., 2002; Chapman-Novakofski and Karduck, 2005; Gavaravarapu et al., 2016) (Table 33). In addition, activities and outcome measures related to nutrition label use appeared to reflect the desire to promote positive improvements in participant characteristics of relevance to the SCT theory (i.e. outcome expectations, self-efficacy and behavioural capacity such as knowledge and skills) (Miller et al., 2002; Chapman-Novakofski and Karduck, 2005; Lindhorst et al., 2007; Dukeshire et al., 2014; Garcia et al., 2017).

In terms of nutrition label education, underpinning theories across both intervention types 1 and 2 included theories of Kolb’s experiential learning (Miller et al., 1999; Chapman-Novakofski and Karduck, 2005; Neuenschwander et al., 2013; Wolfe et al., 2017), information processing (Miller et al., 2002; Pennings et al., 2014) and skill acquisition (Miller et al., 2017b). Based on the studies evaluated here, both intervention types 1 and 2 appeared effective at increasing use and understanding of nutrition labels by participants. However, evidence of lasting follow-up effects was only gathered and found in three studies which were all multi-component type 2 interventions.

6.4.5.2 Delivery Format

Most of the interventions were delivered in-person by instructors among groups, with the exception of three conducted individually with participants during home visits or leaflet viewing (Pennings et al., 2014; Kollannoor-Samuel et al., 2016) using web-based (online) education (Neuenschwander et al., 2013; Miller et al., 2017b) (Table 33). In terms of the effect of online education, two studies reviewed here provide some mixed insight into the influence of this delivery format on the effectiveness of the intervention. In one study, comparison of a web-based education intervention with an in-person taught comparator group was conducted with low-income participants. For this, both groups received 3 sessions of a healthy eating education program including “Nutrition Facts label reading” (Neuenschwander et al., 2013). Details of the content of learning materials used here were, unfortunately, not fully described. This study reported pre-post intervention gains in both groups for all nutrition-related behaviour outcomes such as self-reported fruit intake and nutrition knowledge and these included for the question “*When shopping, do you use nutrition facts labels to decide what food to buy*?”. However, in contrast to the other outcomes, greater pre-post intervention gains in this use of nutrition labels were found for the in-class taught participants compared to web-based group.

In contrast, the second web-based study suggests that this delivery format may be effective in improving ability to use nutrition labels. For this, undergraduate participants undertook repeated computerised “training with feedback” whilst working through several pairs of nutrition labels to identify the “correct healthy choice” (Miller et al., 2017b). Although no control group was used here, participant’s accurate use of nutrition label information significantly increased from pre to post intervention here with this practice, as well decreasing the time taken to evaluate labels.

6.4.5.3 Needs of the target audience

Six interventions were described as devised, or adapted, to meet the needs of participants (Chapman-Novakofski and Karduck, 2005; Jay et al., 2009; Pettigrew et al., 2016; Kollannoor-Samuel et al., 2016; Garcia et al., 2017; Wolfe et al., 2017). For example, the FOODcents curriculum was developed according to the precede-proceed programme planning model. These authors highlighted the need to work with specific (e.g. low-income) target groups to identify knowledge gaps and other barriers to engage in recommended behaviours, before developing content to address these. Specific gaps and barriers to achieve a healthy diet were identified as cooking skills, limited food budget, knowledge of the diet-disease relationship and use food labelling (Pettigrew et al., 2016). Two studies stated food label education was included in their intervention given that prior research evidence showed specific “knowledge gaps” or common misconceptions concerning food labels. These included patients with diabetes (Miller et al., 1999; Miller et al., 2002) or based on prior educational research with Latino populations on this topic area (Kollannoor-Samuel et al., 2016).

In other studies, intervention design incorporating participants' own needs included adaptation of the language used to teach (Jay et al., 2009; Kollannoor-Samuel et al., 2016) or undertaking hands-on practical tasks to increase engagement and learning (Jay et al., 2009; Garcia et al., 2017). Appropriately tailored learning materials were also described in three studies aimed at children (Katz et al., 2014; Treu et al., 2017; Wolfe et al., 2017). In one study, an eight-minute multi-media video was specifically incorporated into the intervention to explain how to use a colour card tool to interpret Nutrition Facts Panels with the aim of improving comprehension of this information in patients with low health literacy (Jay et al., 2009). This was successful in improving nutrition label comprehension test scores in the intervention as opposed to the control group (who received monochrome reading materials). However, this intervention appeared ineffective at increasing comprehension of US Nutrition Facts Panels within the small sub-group of outpatients (n=7) identified as having low health literacy (Jay et al., 2009).

6.4.5.4 Content of learning materials

Several of the interventions provided detailed explanations of the meaning of specific numerical elements of the presented nutrition label information, such as nutrient content of a serving and contribution to the percent "Daily Values" (%DV). Where detailed in the studies, this included particular emphasis on %DV (Hawthorne et al., 2006; Jay et al., 2009; Katz et al., 2014; Dukeshire et al., 2014), serving size (Kollannoor-Samuel et al., 2016) and nutrient content "per serving" (Miller et al., 1999; Miller et al., 2002; Gavaravarapu et al., 2016; Miller et al., 2017b). Instruction on "how to use" nutrition labels to make healthful choices was incorporated into nearly all studies, except the booklet viewing intervention by Pennings et al (2014). Such education was described as involving detailed exploration of nutrition label components (Miller et al., 1999; Miller et al., 2002; Hawthorne et al., 2006), including in those interventions encouraging school children to become food information "detectives" when examining labels (Katz et al., 2014; Treu et al., 2017). In two studies, aspects of "declared" and "procedural" knowledge of nutrition labels was emphasised by showing participants nutrition information and then "modelling the process of comparing brands" (Miller et al., 1999; Miller et al., 2002). In contrast, learning materials provided more basic guidance on how to interpret colour-coded front-of-pack nutrition labels in the UK (Garcia et al., 2017).

In addition to instruction on the features of, and “how to use”, nutrition labels these interventions can also be seen to also promote aspects of more general nutrition knowledge (i.e. of the definition of nutrient and energy and diet-health relationships). For example, the inclusion of a nutrition knowledge component was found to enhance the effect of web-based nutrition label training on participants’ accurate product comparisons (Miller et al., 2017). Elements of general healthy eating nutrition knowledge which incorporated the US food pyramid or UK healthy eating guidance were also included in other studies, but the effect of these not specifically evaluated (Pettigrew et al., 2016; Garcia et al., 2017).

Table 34 **Summary of the effect of the interventions on study outcomes of "use" and "understanding" of nutrition labels**

Reference first author	Study design, follow up (control group)	Nutrition label USE	Nutrition Label USE	Nutrition Label Understanding	Nutrition Label Understanding
		Outcome measure	**Impact**	**Outcome measure**	**Impact**
Miller 2002	Randomised controlled trial. Pre post-test. (Control group: no contact other than mailed questionnaire)	Confidence in using food labels. i.e. "*I can choose foods high in fibre at the supermarket*"	Significantly increased in experimental, not control group (p<.001)	Nutrition and diabetes knowledge related to the food label: Total, procedural and declarative and decision-making skills.	Procedural, declarative and total knowledge scores and decision-making skills increased significantly for intervention group but not for control group (all p<.0001).
Miller 1997	Pre-post-test control group design. (Control group: no contact other than mailed questionnaire).	Confidence in skills using the food label. i.e. "*Select a product low in fat*"	Significantly increased in experimental, not control group (p<.01)	Nutrition and food label related knowledge: Total, procedural and declarative.	Both total, procedural and declarative knowledge were significantly increased in experimental, not control group (p<.01).
Jay 2009	Randomised (controlled) trial, Pre post-test. (Control group: received black and white reading materials only)	Confidence in "nutrition" knowledge.	No significant difference between groups.	Nutrition label knowledge comprehension quiz score (%), including accurate interpretation of percent daily values, serving size information.	Comprehension quiz score pre-post gains were significantly greater for the intervention group than the control group (p<0.05). Sub group analysis of (n=7) participants with low health literacy found no significant increase for either the intervention or control group.
Chapman Novakofski 2005	Pre post- intervention tests. (no control)	Confidence in ability to use labels	Significant pre post-test improvement (p< .0001).	Knowledge questionnaire questions included the nutrition label items (exact details NS)	Knowledge scores were significantly better post, compared to pre-test (p=.001). Post hoc analysis found knowledge scores were a significant factor for response to "do you agree you know how to use food labels" (p = .22)
Dukeshire 2014	Pre post-intervention survey and one month follow up (n=3). (no control)	Self-confidence, awareness and ability to use nutrition labels	Self-confidence performing all seven activities were significantly increased post-test (p<0.01).	Self-reported knowledge of the NFP. Knowledge assessed using two items (serving size and definition of the term "percent daily value").	Increase in number of participants answering %DV question correct (15.8% to 57.9%). Smaller increase in number of participants correct in terms of serving size (26.3% to 36.8%).
Pettigrew 2016	Sample comprised 54% of the FOODcent centres, which includes different program durations. Pre post- intervention survey and six week online follow up (n=97). (no control)	Reading of the nutrition information panel (self-reported)	Significantly increased at six week follow up (p<.001).	Knowledge of interpreting food labels using 3 questions including one item specifically on nutrition labels: "*In 100g of this product how many grams of sugar are there*?"	Higher proportion of correct responses in post-session surveys. No significant differences by SES.

Reference first author	Study design, follow up (control group)	Nutrition label USE	Nutrition Label USE	Nutrition Label Understanding	Nutrition Label Understanding
		Outcome measure	**Impact**	**Outcome measure**	**Impact**
Gavararapu 2016	Intervention group and comparison group using pre post-intervention questionnaires. (Comparison group received a lecture about food labels.)	Use of nutrition labels evaluated with 5 questionnaire items (self-reported) i.e. "*Do you read the sugar content when buying chocolate*?"	1 of 5 items significantly improved in intervention compared to comparison group ($p< .05$). I.e. *"Do you see the salt content when buying snacks?"*	Knowledge of nutrition label assessed using item "*is nutrition information present on this label*"?	Significantly improvement in intervention compared to control group ($p<.05$)
Neuenschwander 2013	Randomised block equivalence (Comparator group received in-person taught session).	Frequency of use of labels when shopping (self-reported). '*When shopping do you use nutrition labels to decide what food to buy?*'	Both groups significantly increased at post intervention. (In all other measures the web-based group performed better than the comparator.)	NP	MP
Pennings 2014	Randomised controlled, pre post-test. (Control group viewed a word puzzle).	Eye gaze time on areas of computer screen images of nutrition labels on cereal box packaging.	Participants in the experimental group gazed significant longer at nutrition labels during post-test compared to the pre-test ($p<.001$) and at post-test compared to the control group ($p< .001$).	NP	NP
Kollannoor-Samuel 2016	Block randomised to either intervention or control groups which were evaluated at baseline, 3,6,12,18 months. (Control group received standard care.)	Frequency of use of food labels (self-reported).	Food Label use significantly higher in the intervention (vs control) groups at 3, 12 and 18 months ($p>.01$).	NP	NP
Lindhorst 2007	Pre-post-intervention questionnaire with a total of 18 workshops across the country and 3 month follow up. (n=35) (No control)	Nutrition label attitudes and behaviours (self-reported). i.e. "Is *it important to you to review the nutrition information before buying that food"*?	Data on 35 participants only available at 3 month follow up. Increased proportions of participants selecting higher responses.	NP	NP
Garcia 2017	Single group repeated measures. Pre and post intervention and 3-4 month follow up (n=17). (No control)	(a) Confidence reading food label (self-reported). (b) Objectively measured food label reading (using tick boxes)	(a) Significantly increased from baseline to post-intervention ($p< .001$) (b) Significantly increased from baseline to post intervention and follow up.	NP	NP

Reference first author	Study design, follow up (control group)	Nutrition label USE	Nutrition Label USE	Nutrition Label Understanding	Nutrition Label Understanding
		Outcome measure	**Impact**	**Outcome measure**	**Impact**
Wolfe 2017	2 sub-samples, across age groups and settings evaluated using pre-post surveys (which featured nutrition label items) (No control)	Reading of nutrition information (self-reported) i.e. "*I read nutrition facts labels on food packages*"	Significantly increased post-survey (*p*<.001)	NP	NP
Treu 2017	Quasi-experimental 3 group design, where schools were randomised on district. Pre post-tests. (Control group received normal curriculum and no pre or post tests)	NP	NP	Food Literacy and Label Nutrition Knowledge (FLLANK) test to evaluate knowledge of healthful food choices.	Both groups increased FLLANK scores compared to baseline values after first and booster sessions (*p*<.001). No significant difference in this improvement between the two intervention groups.
Miller S 2017b	Randomised to 2 groups. Prior knowledge group received short presentation. (Basic group did not)	NP	NP	Accuracy (of selecting correct answer in training tasks)	Accuracy increased with practise, across each of the three training blocks (*p*<.001). In block 3, the odds of a correct answer for the prior-knowledge group were 79% higher than those in the basic group (*p*=.02). Pre-test levels of nutrition label numeracy and significantly predicted accuracy.
Hawthorrn 2006	Single group pre-post-intervention tests (No control)	NP	NP	A Nutrition Facts Label knowledge pre and post-test developed by author (calculating %DV with differing serving sizes and defining DV).	Overall test score improved significantly pre-post-test (p<0.0001). From a mean score of 6.6 ± 2.2 SD (i.e.~55%) to 8.3 ± 2SD (i.e.~70%). Correct answers to the questions concerning the definition of %DV also improved significantly (p=0.03) from 38% to 74%, as did correct answers to question concerning serving size modification calculations (*p*=0.003). No difference in boys or girls scores.
Katz 2014	School classes across 5 schools, used pre -post-intervention -tests. (No control)	NP	NP	Food label literacy (quiz) evaluating ability to distinguish between healthy and unhealthy foods using the Nutrition Facts panel.	Quiz scores increased significantly pre-post test of 16.2% (ranging from 4.3%-23.6% among schools) (p<.001). Girls score improved significantly more than boys (*p*= 0.04)

Abbreviations: NS=Not stated. NP = Not Performed.

6.5 Discussion

6.5.1 Summary of results and critique

The purpose of this review was to systematically examine the effect of educational interventions on outcomes concerning participants' understanding and use of nutrition labels. Following identification of studies which met the inclusion criteria, 17 studies were reviewed which evaluated understanding (n=4), use (n=6), or both use and understanding (n=7) of nutrition labels as part of interventions which included nutrition label education. All 17 reported a statistically significant effect on improvements in one or both of these outcomes. Studies varied in intervention type, delivery formats, or setting and were conducted among children, disadvantaged adults and older adult patient groups.

Critical considerations which may impact on the validity of the results include that the evidence synthesised here was obtained from studies of varying design (i.e. pre post-intervention as well as randomised two group designs). As such, levels of quality of the studies included in the review varied, including study design types without control groups and some with small numbers of participants (or sub-groups). In addition, measures of use of labels were mainly self-reported (not actual) and assessment of participants' understanding of nutrition labels were inconsistent across all studies, with only a minority reporting that instruments validity had previously been assessed. The available evidence suggests that nutrition label education has the potential to improve participants' understanding and / or use of this information and highlights the further possibility of influencing food choices. Although not the specific aim of this research, studies with randomised controlled study designs which were conducted among patients with diabetes did suggest that nutrition label education may improve nutrition label understanding, which can then enable accurate use of this information when making food choices in the context of diabetes management (Miller et al., 1999; Miller et al., 2002). Furthermore, increases in nutrition label use were also related to improvement in participants' dietary intakes and diabetic glycaemic control (Kollannoor-Samuel et al., 2016).

6.5.2 Findings in context of the literature

6.5.2.1 Content of learning materials

Features of effective educational interventions have been narratively synthesised here. These include assessment of target audience needs by utilising the prior research regarding "food labels" and knowledge gaps in patients with diabetes (Miller et al., 1999; Miller et al., 2002; Kollannoor-Samuel et al., 2016). In addition, content of learning materials used in many of the interventions appeared to include a focus on several elements of the Nutrition Facts Panel components (i.e. %DV, serving sizes) as well as how to use this information. The inclusion of these elements of nutrition labels may reflect that consumers are thought to find it most difficult to use specific quantitative information (Cowburn and Stockley, 2005; Campos et al., 2011). Indeed, nutrition label education which targets label elements thought to be understood the least has also been recommended by US researchers who concluded that: "*labelling education can reap the greatest benefits by focussing on those aspects of nutrition labelling that are not fully understandable and useable without consumer education*" (Byrd-Bredbenner et al., 2001, p.277). This prior research had suggested that there are elements of the US Nutrition Facts Panel which are "inherently educational" whereas more interpretive (i.e. %DV) elements require explanation in order for consumers to use this information to plan dietary intakes (Byrd-Bredbenner et al., 2001).

However, only a few studies reviewed here detailed the rational for their focus on specific elements of nutrition label elements (Miller et al., 1999; Miller et al., 2002; Miller et al., 2017). These rationales included recognition that consumers often performed but lacked knowledge of what constituted "an important nutrient difference" during product comparisons (Miller et al., 2017b). A further criticism of the included studies is that the development of the interventions reviewed here did not appear to cite, or be underpinned by, the extensive wider evidence base concerning consumer use of nutrition labels, including for their country's specific labelling formats (see Chapter 1). Educational learning objectives which are specific to both the type of nutrition label as well as the needs of the targeted consumers, may therefore both be an important feature of interventions aimed at increasing participant's understanding of the complex information on nutrition labels.

In addition, many of the reviewed interventions were conducted to support healthy eating behaviour change and therefore included nutrition label education alongside additional components on nutrition knowledge and healthy eating recommendations (intervention type 2). These aspects may also be important in enabling participant understanding or use of nutrition label information. Indeed, levels of nutrition knowledge are known to support nutrition label reading (Miller and Cassady, 2015), as well as understanding of nutrition labels (Grunert et al., 2010b), including as shown earlier among UK older adults (Chapter 4). However, this review also shows there is potential for even very brief one-off educational sessions which are focussed entirely on nutrition labels (intervention type 1) to impact on understanding and use of nutrition labels across a variety of population types (Hawthorne et al., 2006; Jay et al., 2009, Miller et al., 2017b, Lindhorst et al., 2007, Dukeshire et al., 2014). Even so, within these, the addition of nutrition knowledge components may enhance the effect of training on nutrition label reading skills (accuracy) (Miller et al., 2017b). Furthermore, previous experimental studies in the US have shown the need for prior knowledge on aspects of nutrition to enable consumer use of specific food and nutrition label components (i.e. on trans fats, or %DV) (Fuan Li et al., 2000; Howlett et al., 2008; Pletzke et al., 2010). The success of the interventions reviewed here in increasing use and understanding of nutrition labels may therefore reflect current perspectives on theory-based nutrition education interventions. These are generally considered more efficacious in terms of behaviour change when both skills and knowledge are included (Murimi et al., 2017).

6.5.2.2 Education delivery format

The mixed evidence on the effect of web-based education or training on use/understanding of nutrition labels was limited in this review to community settings (Neuenschwander et al., 2013) or experimental “training” with undergraduates (Miller et al., 2017b). It is possible that, for nutrition label education, face-to-face contact with instructors or peers further supports learning by providing opportunities for participants to ask specific personalised questions and to check their own assumptions and learning (Neuenschwander et al., 2013; Murimi et al., 2017). Such interactions are thought to be important in the success of other nutrition education research on portion size estimations (Grechus and Brown, 2000; Ayala, 2006). Face-to-face learning may also be of particular importance for participants who possess lower levels of literacy or educational attainment (Murphy et al., 1996; Gibbs and Chapman-Novakofski, 2012). However, other research shows there is potential for internet-based interventions to effect dietary behaviour changes in adults, albeit in studies without an emphasis on nutrition label education (Wantland et al., 2004; Park et al., 2008; Poelman et al., 2013).

In terms of media and resource types, one study reviewed here suggests that compared to reading materials, a multi-media video intervention did not help significantly enhance nutrition label comprehension in (a small number of) individuals with low health literacy (Jay et al., 2009). In contrast, instruction using a video has been previously shown to help participants retain more nutrition education messages than those instructed via lecture/poster approaches (Byrd-Bredbenner et al., 1988). Overall, the optimal setting and delivery formats of nutrition label education is not yet clear but might include a combination of in-person teaching and message reinforcement via media/video (Byrd-Bredbenner et al., 1988; Jay et al., 2009; Neuenschwander et al., 2013), with materials tailored to participants' needs.

6.5.2.3 Participant and instructor characteristics

It is also possible that participants' own perceptions and personal and health-related motivations to use nutrition labels could impact on the efficacy of the intervention in terms of outcomes of understanding and use of nutrition labels. Indeed, personal and health-related motivations are well known to impact on consumers' frequency of use of this information (Visschers et al., 2010; Campos et al., 2011; Miller et al., 2015). Whilst measures of personal motivations relating to nutrition labels were largely unevaluated in the studies reviewed here, patients with diabetes or participants' readiness to undertake behavioural changes were a particular focus of three of the reviewed studies (Miller et al., 1999; Miller et al., 2002; Chapman-Novakofski and Karduck, 2005). These studies also included older adults and as such, the success of these interventions may also be due to participants' ageing or health-related motivations and diabetic health-concerns, factors also known to drive nutrition label use (Miller and Cassady, 2012).

In addition, participants' perceptions of the role of the instructor (i.e. dietitian, teacher or trained health officer) in the delivery of nutrition label education was not explored within the interventions reviewed here. However, four interventions were delivered by a dietitian (Miller et al., 1999; Miller et al., 2002; Hawthorne et al., 2006; Dukeshire et al., 2014) and in one case by health officers who were trained by dietitians (Kollannoor-Samuel et al., 2016). The role of this facilitator could be an important factor in promoting learning and engagement as a "catalyst for change" as indicated by a previous study undertaken by a nurse practitioner (Murphy et al., 1996). With respect to the current PhD, other research has shown that community-practicing dietitians are instrumental in providing credible nutrition education to facilitate healthy eating in older adults (Manafò et al., 2013). Furthermore, contact with healthcare professionals has recently been highlighted as a part of the framework underpinning nutrition education interventions for older adults (Sahyoun et al., 2004).

6.5.3 Strengths and limitations of the review and included studies

The strengths of this review include a comprehensive search strategy and systematic selection process, undertaken on two consecutive occasions. This strategy aimed to ensure that the most up to date publications were included and that the exclusion criteria was consistently applied. However, it is also possible that some relevant articles were not included in the review due to the number of databases searched. In addition, no unpublished grey literature was known nor searched and as such the potential risk of publication bias should be noted. Furthermore, statistical meta-analysis of the effects of these interventions was not possible due to heterogeneity in study designs and specific outcome measures. Theses aspects may have limited the comparability of study findings, as further discussed below.

In terms of the outcome of nutrition label understanding, a limitation which potentially impacts on the interpretation of results is the considerable heterogeneity in the type and number of questions asked at pre and post-intervention to evaluate this characteristic. For example, "food label literacy" was measured to assess label understanding in two studies, which appeared to reflect nutrition label understanding as an intersection between nutrition and food literacy (Katz et al., 2014; Treu et al., 2017). Briefly, "Food Literacy" can be considered to reflect the practical knowledge and skills with which to choose and prepare food (Velardo, 2015; Krause et al., 2018). Nutrition literacy, on the other hand, is defined as "the degree to which people have the capacity to obtain, process, and understand basic information about health (and nutrition)" (Zoellner et al., 2009; Velardo, 2015). The extent to which nutrition label understanding, rather than health, nutrition, or food literacy is being measured in these studies is therefore unclear as the potential relationships between these characteristics emerge (Malloy-Weir and Cooper, 2016).

Another criticism of the included studies is that all used pre and post-test measures, yet it is not clear to what extent this repeated questioning influenced participants' understanding and therefore the validity of the results. This may be particularly important in those non-randomised studies which did not feature a control group. It is possible that a participant's completion of pre-intervention questionnaires or quizzes (before the education sessions) may have supported their own learning by increasing self-awareness about which aspects they did and did not understand. However, prior research has described the use of an experimental (4-group) between-subjects study design to check for the effect of exposure to the pre-test during education specifically on trans fats (Pletzke et al., 2010). These authors found no significant effect of their pre-test on participants' knowledge of trans fats. Nonetheless, it should be noted that five of the studies reviewed here included descriptions of pre and post-intervention quiz instruments which appeared to suggest these were identical (Chapman-Novakofski and Karduck, 2005; Dukeshire et al., 2014; Gavaravarapu et al., 2016; Hawthorne et al., 2006; Jay et al., 2009). Therefore, the role of undertaking such quizzes in the learning process, as well as participants' self-awareness of their own understanding may both deserve consideration in future interventions.

Finally, usage of nutrition labels was mainly self-reported with indicators including confidence and frequency of use, or reading, of this information. As a result, these measures are likely to be biased or over-reported particularly in the intervention context, including when participants are subject to pre and post-intervention testing. In addition, not all studies assessed both use and understanding of outcomes. In two studies, where use, but not understanding, was assessed, this hindered full appreciation of the educational impact of the interventions on participants' understanding (Neuenschwander et al., 2013; Pennings et al., 2014). Such insight would have been particularly valuable given findings which indicated online education was found to impact less favourably on intended use of nutrition labels than in-person taught classes (Neuenschwander et al., 2013).

6.5.4 Findings in the context of the PhD project

This review was global, and the included studies spanned two decades, yet only five were conducted in countries outside the US. There is demonstrable potential for future research in this area in other countries, including those which use nutrition label formats are different from the US Nutrition Facts Panels. Time-frame differences in the implementation of labelling legislation which stipulates mandatory nutrition labelling (as well as consumer education) between the US (1994), compared to UK (2014), may have led to the disparities in the volume of research conducted in this area of nutrition label education. Evidence here indicates it is possible that the UK “lags” behind the US in terms of consumer nutrition label education. There are also likely differences in healthcare culture, provision and availability of nutrition label education which may now exist between these countries. These differences could therefore impact on consumer use and understanding of nutrition information in these countries, as well as the impact of these labels on health and food choice. The possibility of between-country differences in the effect of labels on consumers has also been highlighted by researchers in terms the implementation of various front-of-pack labels (Hersey et al., 2013).

Overall, the scope for developing and evaluating a UK label-specific intervention as proposed in the current PhD project, can be seen. In addition, the recent changes to label format during the implementation of mandatory nutrition labelling in the UK is another reason to evaluate the effect of education on consumer use and understanding of this information. Indeed, the limited research on educational interventions focussing on UK nutrition labels found here includes a lack of studies which are focussed on UK back-of-pack or other mandatory nutrition label elements. Only one study reviewed here was conducted in the UK but the learning materials used appeared to be focussed only on the basic use of voluntary front-of-pack traffic lights (Garcia et al., 2017).

Learnings from US studies, which have been shown to promote label understanding can now be adapted for use with UK nutrition labels. However, the development of content of such learning materials requires specific considerations. These include the differences in displayed information and terminology between UK nutrition labels and US Nutrition Facts Panels. For example, declaration of nutrient content data “per serving” in addition to “per

100g” as well as “Reference Intake (RI)” terminology are used on UK labels, with “daily values (DV)” and “per serving” information declared in the US (Kliemann et al., 2018) (Chapter 1, Figure 4). It is therefore important to note that the educational content of future UK interventions will need to be guided by current legislation on specific nutrition label formats and elements.

In relation to the focus of this PhD, older adults’, including those with diabetes, participated in the nutrition label education interventions reviewed here (Miller et al., 1999; Miller et al., 2002; Chapman-Novakofski and Karduck, 2005; Garcia et al., 2017). The positive effects of these suggests there is currently further scope to conduct research in this area with UK older adults. In particular this is warranted given that in the UK it is possible that older adults’ understanding of specific elements of the current UK nutrition labels may benefit from this education (Chapter 4). In addition, further insight into the effect of label education on community-based older adults, rather than in-patient environments, would help to explore if this approach is effective in encouraging greater use and impact of nutrition information among these consumers.

Finally, the review highlighted the need for strong evaluation of interventions, particularly the need for pre and post–intervention assessment of label understanding and use which would ideally include valid instruments and objective measures, including at follow-up time points (Contento et al., 2002). The study design of intervention evaluations also appears to be an issue in this area given that there were no control groups used by eight of the reviewed studies. Reasons for this include participants’ data collection “burden” or feasibility issues in schools or community-based settings which precluded the employment of randomised controlled groups. Finally, there is also a need to base the development and evaluation of interventions on models of learning and behaviour change, in order to support participants’ nutrition label usage behaviours, via understanding.

6.6 Conclusion

Interventions which are based on, or include, content educating about nutrition labels can been seen to have a positive impact on participants' use and / or understanding of this complex numerical information. Research findings are limited by study design and to a small number of mostly US studies, but these do include different ages and disadvantaged groups as well as older adults. Common aspects of successful interventions which improved participants' understanding of nutrition labels included a focus on specific elements of information such as "serving size" and "%DV". These elements have previously been reported as difficult for consumers to understand and use. Practically, inclusion of behavioural and additional contextual general nutrition knowledge components, which focus on dietary recommendations and healthy eating, may also help further improve participants' own understanding and use of nutrition labels. Intervention features including educational content and delivery format as well as participants' levels of general nutrition knowledge and health literacy warrant attention in future research. This review provides further insight on which to develop and evaluate a pilot intervention targeting use and understanding of current UK nutrition labels in older adults and community-based consumers (Chapter 7).

Chapter 7 Development and pilot evaluation of an educational intervention designed to improve understanding of current UK nutrition labels in older adult community service-users

7.1 Abstract

Background: New, mandatory nutrition labels were introduced in the UK from 2014 and are intended to help consumers' make healthier food choices. A key antecedent to consumers' use of this information is their understanding which is known to vary according to label format and decline with age. To help consumers to understand and use nutrition labels, education is required in labelling legislation although evidence is lacking on if this can support UK consumers to understand and use this information. The aim of this study was to develop and evaluate a pilot educational intervention which targeted older adults' understanding of current UK nutrition labels. **Methods***:* Intervention development and session learning objectives were based on earlier research into older adults' levels of understanding of specific elements of current UK back and front-of-pack nutrition labels. The potential effect of the educational intervention on participants' understanding of nutrition labels and related characteristics was assessed at pre and post-intervention using questionnaires and quiz questions. **Results:** Following ethical approval, a cohort of 31 community service-users (median age 56 yrs) consented to participate in a one-hour education session advertised as about "food labels". The session was led by a dietitian and included hands-on tasks and a short video. Level of understanding of nutrition labels were low at pre-intervention (mean quiz score out of five = 1.7, SD 1.8). A post-intervention understanding appeared to improve (mean score = 3.2 SD 1.7) at post-intervention (MD=1.4, 95% CI: 2.1, 0.8) as did participants' confidence in use of nutrition labels to make healthier food choices (using a 7-point scale, MD = 1.0, 95% CI: 0.5 to 1.6). **Conclusions**: This pilot study shows the development and potential of a brief education session to support improvements in understanding of current UK nutrition labels in older adult community service-users. Future UK research is required, at scale, to confirm the effects of such education on participants' nutrition label use and dietary intakes.

7.2 Introduction

For nutrition labels to impact on purchase choices they must first be understood and used by consumers during product evaluations (Grunert and Wills, 2007). Previous chapters have shown that specific elements of the new UK nutrition labels are not well understood by older adults, including “Reference Intakes” and corresponding label values which appear on both front and back-of-pack nutrition labels (Chapter 4). In addition, greater objective understanding of nutrition labels was not a determinant of frequent label use in purchases, yet these consumers’ self-rated (subjective) understanding and increasing levels of nutrition knowledge and personal involvement with nutrition label appeared to predict such frequent label use. These earlier findings suggested that those older adults, including those who claimed to frequently use nutrition information in their purchase choices, may benefit from nutrition label education on the current UK nutrition labels.

A review of the limited evidence reporting the effect of nutrition label education interventions has shown the potential for nutrition label education to impact on participants’ understanding and use of nutrition labels (Chapter 6). This included US older adults and participants with diabetes. However, the review found a lack of research specifically relating to improving UK consumers understanding and use of UK nutrition labels, including in community-based older adults. In addition, despite the mandatory implementation of current nutrition labels in the UK, there appears to be a present lack of consumer-facing educational materials concerning how to use this information as identified earlier (Chapter 3). In line with research objective 5, this chapter will describe the development and pilot evaluation of a new educational intervention which aimed to improve understanding and use of these nutrition labels among older UK adults.

7.2.1 Objectives of the Pilot Study

This pilot study was intended to allow the development of novel nutrition label education intervention and to assess the feasibility of its implementation in this community setting and the measures used to evaluate the potential effect on participants’ understanding and use of labels. This pilot study is intended to inform the future development of a larger, randomised design study in order to allow the more definitive evaluation of the effects of the intervention on older adults’ use and understanding of UK nutrition labels (Thabane et al., 2010).

7.3 Methods

7.3.1 Target audience and goals of the educational intervention

The educational intervention developed here was targeted at older adults aged 50 years or older. These adults are considered to be nutritionally “at risk” “(Ducrot et al., 2015) and may require advice or support to meet their health needs via dietary adjustments (NHS, 2017). Older adults are also an under-researched group in terms of their understanding of UK nutrition labels and the subsequent impact that increased understanding of this information might have on label behaviours, diet or food choices (Chapter 1). In addition, previous research has also showed that consumers’ understanding of various types of nutrition labels may decline with age (Campos et al., 2011; Grunert et al., 2010b; Macon et al., 2004; Miller et al., 2017a, 2010; Soederberg Miller, 2014). Similar finding among UK older adults aged 50 yrs and older were reported concerning the current UK nutrition labels as part of this PhD thesis (Chapter 4).

Specifically, this earlier research found that those who use this information frequently are likely to be highly personally involved (motivated) or previously advised to look at food labels. However, among these older adult consumers there was some indication of disparities in levels of objective understanding of this information according to education, gender, age, levels of nutrition knowledge and if reading of food labels had been previously “advised”. As such, efforts to improve understanding of specific elements of current UK nutrition labels and personal characteristics related to label use, may support improvements in these consumers’ understanding and future use of this information. Overall, the development and evaluation of new UK nutrition label education targeted at older adults is therefore warranted.

The aim of the educational intervention was to improve older adults’ understanding of UK back and front-of-pack nutrition labels and promote indicators and characteristics related to use this information in real-life food choices.

7.3.2 Development of the educational intervention

7.3.2.1 Guiding principles

The design and planning aspects of this new nutrition label education intervention were based on the publicly available Guide for Effective Nutrition Interventions and Education (GENIE) tool which has been validated for this purpose (Hand et al., 2015). This tool highlights the nine areas which require consideration during nutrition education intervention development, including program goals and framework, setting, educational content/materials and evaluation. All nine GENIE categories were considered during the development of this education intervention (see Table 35). Included is the need to base the development of the educational session content and evaluation on a framework devised to guide the design of nutrition education interventions for older adults, proposed by Sahyoun et al (2004) (Figure 22).

Specifically, this framework indicated the need for interventions to include both social and environmental context as well as individual level aspects of these, including contact with health professionals. Delivery formats which were group-based and in-person (i.e. class-based) were favoured here. This format enabled the delivery of simple and practical messages and hands on activities with a focus on behaviour modification, based on theoretical models (Sahyoun et al., 2004). In addition, the previous systematic review of the literature in this area of nutrition label education (Chapter 6) had suggested that in-person (group-based) delivery is common, and potentially more favourable than web-based methods, in the delivery of nutrition label education. It has also been suggested that face-to-face contact with instructors or peers may support learning in this area by providing opportunities to ask questions and “check” assumptions (Neuenschwander et al., 2013; Murimi et al., 2017).

The use of this framework all highlighted that individuals are integral to their social and physical environments, including personal circumstances, wider family or community and the food retail environment (i.e. where nutrition labels are found). As such, placing the intervention in context of the wider consumer environment, there was a need to encompass existing public health initiatives including the recent NHS Change4Life Campaign which encourages “food swaps” (NHS Change4life, 2018a). Indeed, the current Change4Life campaign advises the basic use of front-of-pack traffic light label “colours” but does not currently specifically educate on the current and mandatory UK nutrition labels (NHS Change4life, 2018b).

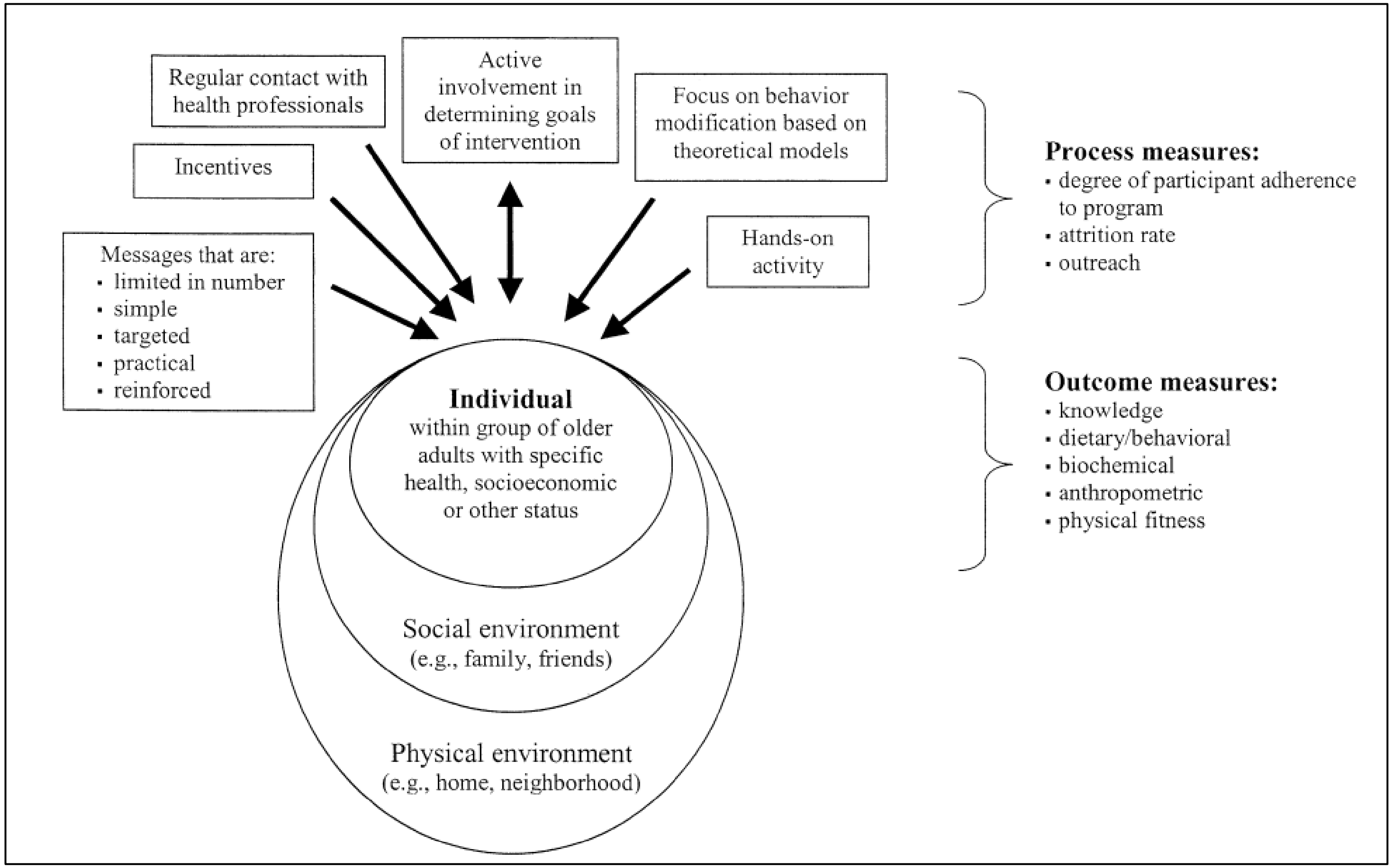


Figure 22 The framework used for designing the nutrition education intervention for older adults (from Sahyoun et al., 2004)

Table 35 Overview of the development of the education intervention based on the Guide for Effective Nutrition Interventions and Education (GENIE) criteria

GENIE category	Educational intervention development
1. Programme description and importance	A nutrition education session for older adults targeting their understanding and use of current UK nutrition labels, which have been mandatorily displayed on food products since 2014. This education responds to the need to support older adults with diet and health into older age, including the need to use of nutrition labels to make healthy food choices. These aspects support wider national public health initiatives such as the NHS Change4Life campaign.
2. Programme goal	To improve older adults' actual and perceived understanding of current UK nutrition labels and promote their use of this information in real-life food choices. The ambition to increase understanding of nutrition labels is based on the conceptual framework by Grunert and Wills (2007) in which this characteristic is an antecedent to consumer use in purchase decisions.
3. Program Framework	A framework for nutrition education intervention with older adults (Sahyoun et al., 2004) was used to inform the development of the intervention (Figure 21).
4. Programme Setting, Recruitment and retention plan	Setting: Community centre hosting older adult social and education classes in Leeds, UK. Participants were recruited from those service-users attending the centre. For the pilot intervention, recruitment of service-users took place via posters and via informal in-class announcements by the centre co-ordinator. To promote retention at the midday sessions a lunch was provided. In addition, a £5 supermarket voucher was provided to participants at the end of the session.
5. Instructional methods	In line with theories of learning and behaviour change, a combination of demonstration, hands-on activities, group discussion and video were used to promote learning in line with pre-determined learning objectives and motivate behaviour change among participants. Sessions were delivered by a registered dietitian.
6. Programme Content	Specific learning objectives were informed by the prior research into elements of the nutrition labels which were found to be poorly understood in adults aged over 50 years. Content and learning materials were also based on the NHS webpage and Change4Life materials concerning front-of-pack food labels as well messaging provided for use with consumers by the IGD and UK Department of Health. Included in the session was a (general) nutrition knowledge component, specifically to raise awareness of "daily allowances" (Reference Intakes) of key nutrients of public health concern and their effect on health.
7. Evaluation	Evaluation of this pilot intervention took place in July 2018 and included a pre and post-intervention assessment of understanding and self-reported use of nutrition labels in line with intervention goals.
8. Program materials	A short presentation delivered by the instructor; Packaging from several real-life food products; transparent demonstration pots containing "Reference Intake" amounts of fat, sugar etc; a brief (6 minute) video re-iterating the messaging in-line with learning objectives (screened at the end of the session).
9. Sustainability	The session outline and objectives as well as short video are now available for disseminating for public use and further evaluation on a larger scale, with other populations.

7.3.2.2 Funding

Funding was initially sought to support the development and evaluation of the pilot intervention from *LeedsACTS!*. This organisation supports the activities of third sector organisations based in Leeds by offering seed corn funding for academic projects which aimed to benefit communities and service-users. As such, the researcher contacted a Leeds-based community centre as well as Leeds City Council Health Improvement Team in order to develop and evaluate a series of education classes on healthy eating and nutrition labels with around 100 older adult service users from around the city. The proposal to conduct and evaluate this intervention was costed at £1,700 including travel, room hire, participant incentives, refreshments and production of promotional and resource materials for use with the wider Leeds Public Health Resource library. Although this funding bid was not successful, alternative PhD research funding of £250 was agreed by Leeds Trinity University to cover the costs of a smaller scale pilot intervention evaluation conducted at the same community centre.

7.3.2.3 Setting

The setting of the intervention was the Feel Good Factor community centre, located in the suburb of Chapeltown, Leeds, UK (Figure 23). The centre is funded by Leeds City Council and third sector charity organisations and employs four members of staff. Approximately 80 older adult and low-income service-users were known to voluntarily attend sessions at the centre on a daily or weekly basis. Services provided included social and housing advice, financial and personal administrative support as well as adult education classes. Each week, four older adult education sessions were hosted by the centre which included classes in art, computing, finance and lifestyle or mental health. The socio demographics and characteristics of centre services-users were varied but known to include low-income older adults and those who lived and worked locally. The pilot educational intervention was designed with the setting in mind since the centre co-ordinator was previously known to the researcher during their work together on the prior collaborative seed corn funding proposal. This setting was also selected to recruit community-based, rather than in-patient, older adults.

7.3.2.4 Rationale for group sessions

Group sessions offer a means to reduce costs and time compared to individual tuition and education (Meck Higgins and Clarke Barkley, 2004). Group education sessions were also those most commonly used in interventions delivering nutrition label education, as described in the prior review of this area (Chapter 6). In addition, the setting was well equipped to run group education sessions, and group-based discursive classes were familiar to service-users, as reported by the centre co-ordinator. The setting also enabled a large room set-up which encompassed a circular table and seating for demonstrations as well as a screen to show video or website material (Figure 23). The intervention was therefore developed in relation to the available room space, anticipated group size and the available (1 hour) time slots. For example, the largest room available at the centre was able to comfortably accommodate 15-20 people. As such, it was decided to deliver a one-hour intervention and to include as many participants as possible by repeating this session on several occasions. This decision also reflected the available funding as well as the review findings that single session, group-based, nutrition label education may be effective at improving understanding of nutrition labels (Chapter 6) (Hawthorne et al., 2006; Jay et al., 2009).

7.3.2.5 Underpinning theories of learning and behaviour change

Participants' understanding of nutrition labels was targeted for improvement in this pilot intervention. As such, specific theories used to underpin the promotion of learning and improved understanding and use of nutrition labels are described next. These are also detailed for each activity in the education session, within Table 36.

Kolb's experiential learning theory was found to underpin successful interventions which impacted on understanding of nutrition label information, as previously reviewed (Chapter 6). In addition, the researcher was familiar with promoting understanding of nutrition via lecturing in higher education using this theory. As such, the Kolb's theory of experiential learning was used to inform intervention content and learning activities (Kolb, 1984). In line with this theory, participant's active learning was facilitated by using a mixture of practical, hands-on activities and instructor feedback. Similar approaches were also recommended by the centre co-ordinator from her prior experience of delivering adult education classes with service-users. In line with Kolb's theory, learning activities were devised to incorporate aspects including sensory experiential learning, conceptualisation (i.e. of “Reference Intakes” or “daily allowances”) with opportunities to reflect during discussion and to consolidate knowledge by watching a video (Table 36). The advantage of using Kolb’s approach is that it also attempts to promote learning among participants of various learning styles (i.e. activist, reflector) (Kolb, 1984). This approach has been described as inclusive, including within interventions with older adults as well as among those of lower educational attainment (Sahyoun et al., 2004; Whatnall et al., 2018).

Behaviour change techniques are often incorporated into effective brief interventions which target dietary behaviours (Whatnall et al., 2018), including for older adults (Sahyoun et al., 2004). Similarly, the interventions featuring nutrition label education reviewed earlier (Chapter 6) have also sought to include activities promoting positive improvement in participant characteristics of relevance to the use of nutrition labels via aspects of Social Cognitive Theory (SCT). These include participants’ outcome expectations, self-efficacy and behavioural capacity such as knowledge and skills (Chapman-Novakofski and Karduck, 2005; Dukeshire et al., 2014; Garcia et al., 2017; Lindhorst et al., 2007; Miller et al., 2002). For example, the acquisition of skills related to use of nutrition label information within product comparisons was previously described in relation to SCT behavioural capabilities in an earlier intervention with older adults with diabetes (Miller et al., 2002). To therefore help underpin the label behaviour aspects of the education session, SCT was selected for use. The SCT theory postulates that behaviour is influenced by the constant integration of the environment and the personal characteristics of an individual (Bandura, 1986; McAlister et al., 2008). This aspect aimed facilitate the promotion of participant’s personal motivations, their confidence in understanding and self-belief in their ability to use nutrition labels to make healthier food choices.

7.3.2.6 Learning material content and learning objectives

To achieve the goals of the educational intervention of increasing understanding of current UK nutrition labels in older adults, specific learning objectives were developed to guide the educational session. These were based mainly on the findings of earlier research into specific elements of UK nutrition labels which were found to be poorly understood in adults aged over 50 years (Chapter 4). These included understanding the meaning of “Reference Intakes (RI)” terminology and associated values, including the “RI” for fat or the nutrient amounts and “%RI” provided “per serving” of the food.

The need to explain detailed aspects of nutrition labels which were problematic for consumers to understand was highlighted in the earlier review (Chapter 6). For example, there appeared a need to include educational content reflecting the common difficulties encountered by consumers using nutrition labels which were broadly described as use of serving size and “percent daily values” (%DV) as based on US evidence (Byrd-Bredbenner et al., 2001; Campos et al., 2011; Cowburn and Stockley, 2005). Indeed, these components were commonly included in several of the reviewed effective intervention studies, where they were specific to the US Nutrition Facts Panel (Dukeshire et al., 2014; Jay et al., 2009; Miller et al., 2002) (Chapter 6). Therefore, specific elements of current UK nutrition labels to be explained within the education intervention were included into learning objectives. These included enabling the identification of “per 100g” and “per serving” information declared on back-of-pack nutrition labels, as well as an appreciation of the meaning of “Reference Intakes” and “%RI” information.

The inclusion of the latter was also supported by the recently issued recommendations from the UK Department of Health and the Institute of Grocery Distributors (IGD) relating to consumer communication messages on the “RI” label elements of front-of-pack voluntary nutrition labels (Department of Health, 2016b; IGD, 2018). These messages were used inform intervention learning objectives and content explaining “%RI” as well as how to use front-of-pack labels. Specific recommendations on how consumers can use voluntary front-of-pack labels and %RI information include:

(1) When choosing between similar products try to go for more green and ambers, and fewer reds to help you eat a healthier diet

(2) While the colours provide at-a-glance information, the %RI information will give you a little more detail about how much an average adult's daily intake limit of each nutrient is in a portion and will help you put it in the context of a healthy balanced diet

(3) The %RI also enables you to make more accurate comparisons between equal portions of products. You can use the details RI information to help you choose between products which have the same colour per 100g/ml of the same portion sizes.

(Source: Department of Health, 2016b)

The concept of "Reference intakes" as proportions of daily values or "allowances" was also introduced within the education session by using transparent pots containing amounts of "Reference Intakes" for fat, sugar etc (Figure 23). The idea for this came from the diagrams used in the US FDA website concerning "Percentage Daily Values" (%DV) displayed on Nutrition Fats Panels (Center for Food Safety and Applied Nutrition, FDA, 2015), as described in Chapter 3. In addition, to memorably define the meaning of "Reference Intake" terminology for participants the term "daily allowance" is featured in the consumer communiation tool kit materials available from the IGD (IGD, 2018).

This aspect of intervention development also incorporated the concept of general nutrition knowledge and healthy eating into the education session. For example, the role of nutrition in health was visually emphasised in relation to "daily allowances" of key nutrients. Specifically, this component sought to relate the concept of "daily allowances" of key nutrients (salt, saturates fat, sugar) to health and a healthy diet. This was also considered important given earlier work linking the characteristic of such general nutrition knowledge with increased levels of nutrition label understanding and use (Grunert et al., 2010b; Miller et al., 2017b; Miller and Cassady, 2015), including among the surveyed UK older adults (Chapter 4). This element was also considered to support the diet/health "outcome expectations" aspect of the underpinning Social Cognitive Theory of behavioural change. In addition, creating awareness and knowledge of these aspects of nutrition for health and use of nutrition labels are also aligned with the key messages in the recent UK Change4Life campaign (NHS Change4life, 2018a, p. 4).

Three learning objectives were therefore determined by the researcher, mindful of what was realistic given the session time available. These were: (1) Be able to identify back and front-of-pack label data on nutrient and energy content “per serving” and “per 100g”; (2) Be aware of the meaning of the terminology “Reference Intakes” and corresponding label data; (3) Appreciate the front and back-of-pack elements which help evaluate product healthiness in-line with a healthy diet (i.e. traffic light colours and % RI).

An outline of the session activities and their corresponding learning objectives is provided in Table 36.

7.3.2.7 Video

A short video which aimed to cover all three pre-determined learning objectives was created by the researcher. The decision to create a video arose from the need to re-iterate the covered concepts and learning objectives at the end of the session (Kolb, 1984). In addition, showing a multi-media (video) as a means to reinforce key messages has been successfully used in community-based nutrition education in the US aimed at increasing understanding of nutrition or nutrition labels (Byrd-Bredbenner et al., 1988; Jay et al., 2009).

The video was developed using images of nutrition labels accompanied by voice-over narration of the accompanying text, as shown beside animation indicating specific elements of nutrition labels (i.e. “Reference Intake” values, or “per serving” sizes) (Figure 24). Also included was advice on how to use traffic light colours as well as %RI and” per serving” and “per 100g” information to compare products and evaluate a product’s healthfulness. Imagery and messaging in the video were partly based on messages provided within the publicly available “marking tool kit” for health professionals communicating front-of-pack nutrition labels, with their permission (IGD, 2018). Video development was undertaken using the subscription software Powtoons^{TM} with kind permission a research team at the University of Leeds. The video lasted 6 minutes and was shown at the end of the session. It is available here: https://www.powtoon.com/online-presentation/epzQJVBaqj4/nutrition-labels-how-to-use-them/?mode=movie

Table 36 Outline of the content and activities of the one-hour education session aligned to specific learning objectives and theoretical models of learning and behaviour change

Objective	Activity	Theoretical concept and definitions	
		Kolb's Theory of Experiential learning	**SCT Social Cognitive Model**
Introduction and data collection	Information sheet (also provided in advance) and consent form completion. Pre-intervention questionnaire completed.		
Familiarising with nutrition label information LO1, LO3	Individual participants were each handed their own food product package and asked to find "*How much salt is there in one serving of your product?*" Correctly identifying this information on either front of back-of-pack nutrition labels was discussed with the instructor and individual participants in group. *Is this amount of salt too much*? Instructor asked for show of hands. Facilitation of group discussion on traffic light colours and % Reference Intakes on front and back-of-pack.	Experiential learning i.e. using existing knowledge within a concrete "experience" (task). Reflection on task performance enabled by facilitator.	Promotion of knowledge and skills (behavioural capabilities)
LO1 **LO2**	Short talk by the instructor about the per 100g and per serving information (back-of-pack label shown on the NHS website). Amounts of nutrients which are considered "low" and "high" per 100g/serving were listed. The meaning of "Reference intakes" in terms of "daily allowances". Demonstration visualising these RI amounts using nutrient pots. Health relationships described briefly. Total and free sugars amounts described.	Reflection and conceptualisation	Further promotion of behavioural capabilities. Outcome expectations related to health.
LO3	Participants asked: *What do you think – is your product healthy?* Use of front-of-pack colours and % RI discussed. Portion size and consumption amounts discussed with relation to "per 100g" and "per serving" information	Active experimentation	Enabling self-efficacy and perceived confidence to perform a behaviour.
LO1, LO2, LO3	Short video shown reiterating LO1, 2 and 3	Reflective learning (and conceptualisation)	Promotion of knowledge and skills (behavioural capabilities)
Close and data collection	Participants thanked and invited to complete post-intervention questionnaire. Voucher provided.		
Overall aspects: Social support	Intervention conducted in small groups. Friends and family members welcomed. Opportunities throughout to interact with instructor. The UK Change4Life national healthy living initiative introduced.	Incorporation of elements likely to appeal to most active or reflective learning styles	Social support (peers, family, instructor and society)

Session learning objectives (LO1) Be able to identify back and front-of-pack label data on nutrient and energy content per serving and per 100g; (LO2) Be aware of the meaning of the terminology "Reference Intakes" and corresponding label data (LO3) Appreciate the front and back-of-pack elements which help evaluate product health in line with a healthy diet (i.e. traffic light colours and %RI).

Figure 23 Intervention setting and session materials (top left, the room set up; bottom right the FeelGood Factor Community Centre, Leeds; top right, nutrient "allowance" pots; bottom left, food packaging for group activities)

Figure 24 Screen capture examples from the video shown in the education session

7.3.3 Study design

The possibility of a randomised two group design was discussed with the centre co-ordinator. This was considered unfeasible due to the logistics of the setting and service-users' attendance. Specifically, service-users attended the centre voluntarily and unpredictably. Furthermore, study participant's travel costs could not be covered by the available funding. In addition, service-users' knowledge of other users and the centre's ongoing class activities were assumed to be likely to impact on their learning experiences, particularly if participants were allocated to either a control or intervention groups. This was also possible due to the lay out of the centre which encompassed the centre's main entrance within the largest room, meaning that all visitors walked through this area. As such, it was felt that specific attendance by service-users at either a control or intervention group session might not be guaranteed and therefore presented the potential for cross-contamination of education between groups.

A single arm pre post-intervention study design was therefore used to evaluate the potential effect of the intervention (Thiese, 2014). This was a pragmatic decision due to the logistical reasons outlined above given the nature of the community setting. This type of study design was used by around half of the interventions, reviewed previously (Chapter 6), which also acknowledged the difficulties of randomising participants within community and school settings.

7.3.4 Outcome measures

The need for outcome measures to evaluate the potential effect of the intervention on relevant participant characteristics (i.e. knowledge and skills etc). are also described in the earlier intervention framework (Sahyoun et al., 2004). To evaluate outcomes, pre and post-intervention questionnaires were compiled by the researcher to measure participants' nutrition label understanding (the primary outcome) as well as characteristics related to use of this information when making healthy food choices. Pre and post-intervention questionnaires are shown in Appendix M and described below.

7.3.4.1 Evaluation of objective understanding of current UK nutrition labels

To assess individual participants' potential objective understanding of nutrition label terminology and associated label data, pre and post-intervention quizzes were developed (Appendix M). Each quiz included five open-answer questions which required participants to write in the correct answer from their viewing of the provided back-of-pack nutrition label. The label was taken from real-life product artwork, as kindly provided by a retailer and declared both mandatory (i.e. per 100g information) and commonly provided supplementary information (i.e. "per serving" and "Reference Intakes (RI)" information). Corresponding to the session learning objectives, three questions concerned the meaning of Reference terminology and related values. These reflected the questions used in the prior online survey of older adults which were adapted from previous studies assessing label understanding (Grunert et al., 2010b; Levy et al., 2000) and rationalised in Chapter 2, section 2.2.4.

The remaining quiz questions required participants to identify the nutrient content, or "%RI" provided by, "per serving". These items were based on those multiple-choice questions used to assess understanding as featured in the validated questionnaire by Mackinson et al (2010) (Chapter 2). The use of multiple-choice question items was not considered necessary here due to the questionnaire being completed in-person rather than online. Such question types were also avoided to reduce the possibility that providing several answer options could facilitate correct quiz responses. Similarly, open answer question types were also used in pre and post-tests to evaluate the educational interventions reviewed in Chapter 6 (Hawthorne et al., 2006; Jay et al., 2009; Miller et al., 2002). However, in this review, concerns were highlighted about the effects of pre-intervention quizzes on participant's learning or memory at post-intervention (Chapter 6). To minimise these potential effects, pre-intervention quiz questions were made different from post-intervention quiz questions by altering both the type of nutrient and nutrition label which participants were questioned about.

Before use, the quizzes were assessed for content validity by nutritionists and academics experienced in nutrition education. The quizzes were also informally tested with five older adults (aged over 50 yrs) who worked in non-academic roles at Leeds Trinity University and gave verbal feedback to the research whilst completing the quizzes. For all five adults, the time taken to answer the questions was less than 3 minutes. Feedback from these individuals included grammar and readability (i.e. word order) improvements, which were incorporated. No other changes to question content or type were made.

Answers from these older adults were also used to help create a pre-defined marking criterion (Table 37). This criterion was devised by the researcher and supervisor (JD) who were both familiar with the development and use of objective marking criteria for assessment in higher education. The use of a marking criteria to score open-ended questions was also described in one previous study which evaluated participants' nutrition label understanding with open text box questions (Miller et al., 2002). For example, for the question "What does the term "Reference Intakes" mean to you?", an answer involving "daily allowance" or "amounts per day" was marked as correct, whereas "not sure" or "foods for reference" was marked incorrect (see Table 37). Following the intervention, questions were marked as correct (score = 1), or incorrect (score = 0), by the researcher and supervisor (JD), the latter of which was not involved in the delivery of the intervention. Participants' overall quiz score was the total number of correct answers out of a maximum of five.

Table 37 Marking criteria for pre and post-intervention nutrition label quiz

Pre/post-test question	Marking Criteria	
Quiz	**Correct**	**Incorrect**
Q1. How much salt/ sugar (in grams) is in a serving of this food?	Pre-test (salt) = 0.4g Post Test (sugar) = 5.8g Also accepted numbers alone, without units (i.e. g/grams)	Not Sure or "NS"
Q2. What does the term "Reference Intake" mean to you?	Daily allowance, recommended limits, daily amounts, amounts per day or words of this meaning	Foods for reference, Not Sure or "NS"
Q3. What is the Reference Intake for fat/sugar, as given on the label above?	Pre-test RI for fat = 70g Post-test RI for sugar = 90g	Not Sure or "NS"
Q4. What percentage (%) of your Reference Intake for fat/sugar is provided by one serving of this food?	Pre-test %RI for fat = 1% Post-test RI for sugar = 6%	Not Sure or "NS" or amount of nutrient in grams
Q5. How much of the Reference Intake for fat/sugar should you aim to consume each day?	Pre-test answers accepted: "70g" , "less than 70g", "less than 100%" or "100%" Post-test answers accepted: "90g", "less than 90g", "100%" or "less than 100%"	Not Sure or "NS" or other number which is not correct

7.3.4.2 Evaluation of personal characteristics related to nutrition label use

Secondary outcomes included self-rated understanding of nutrition labels and levels of self confidence in using this information to make healthy food choices. Both used a seven-point scale (i.e. 1= I do not understand it at all, 7 = I understand it perfectly; and 1= Not at all confident, 7 = I'm very confident, respectively). In addition, participants' personal motivation to engage with nutrition labels (personal involvement with nutrition labels) was evaluated using the ten-item inventory adapted from previous studies as described previously in Chapter 2 and reported in Chapters 4 and 5 (Celsi and Olson, 1988; Xie et al., 2015; Zaichkowsky, 2013). Briefly, inventory items included personal interest in, the need for, relevance and importance of nutrition labels. Each inventory item was evaluated using a seven-point scale (i.e. 1= unimportant, 7= important). Respondent's level of personal involvement with nutrition labels was calculated as a score out of a maximum of 70 (minimum 10) by summing scale responses for each inventory item.

Self-reported use of nutrition labels was also evaluated by two items concerning the frequency of reading nutrition labels and their influence on purchases (Mackison et al., 2010). For example, the pre-test asked; "*Thinking about the last six months, how often have you read nutrition information on food labels?"*. At post-intervention this item was worded: *"Following the session, how often do you think you will read nutrition information on food labels?".* Both items used a five-point worded frequency scale (i.e. Never, Rarely, Sometimes, Often, Always). The pre-intervention questionnaire, to be completed before the session began, also included an initial definition of nutrition labels which aimed to distinguish these from other aspects of food label information (i.e. ingredients, allergens).

As described earlier for the online survey (Chapter 2), the pre-intervention questionnaire items also included participants' socio demographics. These included their age, educational attainment, ethnicity and whether participants, or a member of their household, "have a medical condition where looking at food labels is advised".

7.3.5 Participants and recruitment

Prior to commencing, the study received ethical approval from the Leeds Trinity University's School of Health and Social Sciences Ethics Committee (reference SHH-2018-002) (Appendix K). Participants were recruited by posters and informal announcements which advertised the sessions to community centre service-users. Given the community centre's open access policy, participation in the session was not restricted by any additional eligibility criteria (i.e. age, relation to other family members also in the group), other than arriving for the session prior to its commencement and being willing to participate. However, to maximise recruitment of older adults the centre co-ordinator also verbally promoted the sessions within older adult computer and art education classes in the week preceding the sessions and handed out study information sheets. In addition, session timings were planned to correspond with the end or start times of other older-adult education sessions offered by at the centre. As such, participants would be able to attend one of the intervention sessions without them having to incur additional travel costs. In addition, the sessions were also aimed to be scheduled around lunch time which would encourage service-users to attend for the provided free lunch.

Recruitment was conducted in May, June and July 2018 by inviting service-users to attend one, of three, available sessions on “food labels” to be run in June and July 2018. These recruitment adverts also stated the session was run by a registered dietitian and provided a free lunch and a £5 supermarket voucher. Following their arrival at the sessions, the study was explained to participants who were also provided with an information sheet (Appendix L). Before the sessions started, informed written consent was obtained from each participant.

7.3.6 Sample size

This pilot study was not designed to be powered to detect differences in outcomes of interest, nor examine the definite effect of the intervention on sub-groups. However, the earlier study with undergraduate students (Chapter 3) suggests that 30 participants per group was likely to possess a power of 80% to detect a between group difference of 1.5 correct quiz questions at the 0.05 significance level (MD=1.5, 95% CI: 0.2, 2.8). Whilst indicative, it should be noted that this earlier pilot study (Chapter 3) used only post-course quiz scores (i.e. not pre post-course changes) and also used a different number and type of quiz questions to evaluate nutrition label understanding. A target for recruitment of 30 participants was therefore pragmatically decided for the current pilot study.

7.3.7 Procedure

The pilot educational intervention was scheduled to be delivered on a total of three separate occasions at the community centre, during June and July 2018. Each session lasted approximately 1 hr and was undertaken in the same room at the community centre. In keeping with the session plan illustrated in Table 36, participants were first asked to read the provided information sheets and formally consent to participate before being given the pre-intervention questionnaire to complete prior to the start of the session. Instructions to participants included being sure to complete the questionnaire individually and writing “not sure” if leaving answer-boxes uncompleted. Following the session, the post-intervention questionnaire was handed out for completion. Participants were then invited to help themselves to lunch and were given the £5 supermarket voucher incentive as they handed the post-intervention questionnaire back to the instructor.

7.3.8 Data Analysis

7.3.8.1 Statistical analysis

Continuous variables were quiz score (i.e. objective understanding), personal involvement with nutrition labels, or those measured with a 7-point numerical scales such as participants' self-rated understanding of and confidence using nutrition labels to choose healthy foods. These were first tested for normality using histograms and indicators of skewness and kurtosis. All were found to be satisfactorily normally distributed and were therefore described using mean and standard deviations (SD). In addition, items which used a 5-point Likert scale to assess self-reported frequency of use of nutrition labels (i.e. reading and effect on purchases) were coded as follows: Never = 1, Rarely = 2, Sometimes = 3, Often = 4, Always = 5. These ordinal variables were considered non-parametric and described using the median and interquartile range (IQR).

Descriptive data (i.e. means and SD or medians and IQR) are provided on the above variables at pre and post-intervention. To provide insight into the potential effect of the intervention on participants' nutrition label understanding and related characteristics, differences between pre and post-intervention measures were also analysed using paired t-tests for continuous variables, or the Wilcoxon signed rank test for ordinal variables. Results are reported as the mean difference (MD) and 95% confidence intervention of these (95% CI). In addition, Chi-squared (Fisher's exact) tests were used to compare proportions of correct answers for each pre/post quiz question. For these, a statistical significance level of $p < 0.05$ was used. All analyses were undertaken using IBM SPSS Statistics software Version 21.

Whilst the study was not powered for any sub-group analyses, trends in differences in outcomes within specific sub-groups are highlighted. Sub-groups were first dichotomised (i.e. advised vs non-advised or educational attainment: higher education or less than higher education). Post-hoc analyses within these two sub-groups was performed using independent t-tests for parametric variables (i.e. quiz score, self-rated-confidence in understanding).

7.4 Results

7.4.1 Sample characteristics

A total of 31 participants consented and attended the education sessions. Data from one participant was not obtained because their pre and post-intervention questionnaires were only partially completed. Participant numbers at each session varied, with 6, 11 and 14 participants attending each of the three sessions, respectively. Participants were of various ethnicities, mostly aged over 50 yrs (63%) (aged ranged from 37 to 78 yrs), female (83%) and with lower than university educational attainment (n = 20, 80%) (Table 38). Around half (53%) indicated that themselves or a household member had been advised to use food labels. Prior to the intervention, 50% (n=15) of participants reported they had read nutrition labels “frequently” (i.e. either “always” or “often”). Slightly fewer (43%) reported that this information had influenced their purchase choices as frequently (Table 38).

Post-hoc analysis indicated that proportions of those who were “frequent” and “infrequent” users of this information (i.e. in purchase choices) were not different between sub-groups of participants, based on advisory use of food labels or educational attainment (Table 39). For example, whether participants stated they had been advised to read food labels or not, did not appear to be associated with their reported frequency of reading (or influence on purchases) of nutrition labels at pre-intervention ($\chi^2(1) = 0.475$, $p = 0.49$).

Table 38 Characteristics of participants in the pilot intervention study (n=30)

Characteristic	n	% of participants
Gender		
Female	25	83
Male	5	17
Age (years)		
35-39	4	13
40-49	7	23
50-59	5	18
60-69	10	33
70+yrs	4	13
Ethnicity		
White/White British	16	53
Asian/Asian British	6	20
Black/Black British	4	13
Mixed or Other	4	13
Education[1]		
Higher Education (i.e. University/HND/Diploma)	10	33
<Higher Education	16	54
None	4	13
Advised to use food labels?[2]		
Yes	16	53
No	14	47
Frequency of reading of nutrition labels[3]		
Infrequent readers	15	50
Frequent readers	15	50
Frequency of use of nutrition labels during purchases[3]		
Infrequent users	17	57
Frequent users	13	43

[1] Higher Education = University level including HNC/HND/Diploma qualifications, < Higher education = NVQ/GNVQ, O Levels/GCSEs/CSE, AS/A Levels, City and Guilds Technical or Trade Certificate. [2] Do you or a member of your household have a diet or medical conditions where looking at food label information is advised? [3] Grouped by response to the pre-course questions “How often do read nutrition labels?” or “How often do nutrition labels affect your purchase choices?” (Frequent users = Always/Often, Infrequent users = Sometimes/Rarely/Never)

Table 39 Participant characteristics at pre-intervention, by frequent or infrequent label use during purchases

	Frequent users [a] (n=13)	Infrequent users [a] (n=17)
Advised to use food labels? [b]		
Yes (n=14)	10	6
No (n=16)	7	7
Educational attainment [c]		
Higher Education (n=10)	7	3
< Higher Education (n=20)	10	10
Ethnicity		
White British (n=16)	7	9
Non-white British (n=14)	10	4
Age group		
<50 years old (n=11)	6	5
≥50 years old (n= 19)	11	8

[a] Grouped by response to the pre-course question "How often do nutrition labels affect your purchase choices?" Frequent users = Always/Often, Infrequent users = Sometimes/Rarely/never [b] Do you or a member of your household have a diet or medical condition where looking at food label information is advised? [c] Higher Education = University level including HNC/HND/Diploma qualifications, < Higher education = NVQ/GNVQ, O Levels/GCSEs/CSE, AS/A Levels, City and Guilds Technical or Trade Certificate.
[1] Differences between proportions as analysed by Chi-square or Fisher's exact test

7.4.2 Objective understanding of nutrition labels

At pre-intervention, individual quiz questions which were answered correctly by the greatest number of participants included identifying the number of grams of salt in a serving on the displayed nutrition label (n=14, 47%) or locating the percentage of reference intake (%RI) provided by a serving (n=11, 37%) (Table 40). Similar number of participants were able to identify the "Reference intake for fat" (i.e. as 70g as stated on the example nutrition label) (n=11, 37%). However, fewer participants were able to correctly define the term "Reference Intakes" (n=8, 27%). The quiz question answered correctly by the fewest participants concerned how much of the "Reference Intake" value for fat should be consumed in a day (n=5, 17%). Following the intervention, the proportion of participants who were able to correctly answer each quiz question increased, but this increase was significant for only one question i.e. identification of the "Reference Intake" value for fat (or at post-test, sugar) as shown on the label (Table 40).

Table 40 Number of participants who correctly answered each question at pre and post-intervention (n=30).

Quiz question	Participants answering correctly				
	Pre-test		**Post -test**		
	n	**%**	**n**	**%**	**P[1]**
Q1. How much salt/ sugar (in grams) is in a serving of this food?	14	47	20	67	0.05
Q2. What does the term "Reference Intake" mean to you?	8	27	20	67	0.21
Q3. What is the Reference Intake for fat/sugar, as given on the label above?	11	37	13	43	0.002
Q4. What percentage (%) of your Reference Intake for fat/sugar is provided by one serving of this food?	13	43	22	73	0.09
Q5. How much of the Reference Intake for fat/sugar should you aim to consume each day?	5	17	20	67	0.64

[1] Significant difference between proportions of correct answers to individual quiz questions assessed by Fisher's exact test

Prior to the intervention, overall mean quiz scores were low among intervention participants, with less than two of the five quiz questions being answered correctly (1.7, SD 1.8). Following the intervention, participants' mean total quiz score (i.e. out of maximum of 5) significantly improved to over three out of five (3.2 SD 1.7), (MD=1.4, 95% CI: -2.1, -0.8) (see Table 41).

Post-hoc sub-group analysis highlighted a potential trend in mean pre-intervention quiz scores where those who had been advised to read food labels (n=16) scored lower on the quiz (mean= 0.8, SD 1.3) compared to those who had not been "advised" (n=14) (mean = 2.7, SD 1.8) (MD = 0.7, 95% CI: 0.78,3). In addition, those with higher educational attainment may have also scored higher on the pre-intervention quiz (n=10) (mean = 3.2, SD 1.5) compared to those with lower than university education (n=20) (mean = 0.95, SD = 1.5) (MD = -2.25, 95%CI: -3.4, -1.1). Furthermore, at post-intervention, those with higher educational attainment also scored higher on the quiz (mean score = 4.7, SD 0.5) than those with lower educational attainment (mean score = 2.4, SD 1.6) (MD = -2.3, 95% CI: -3.4, -1.2). However, there was no longer an apparent difference in quiz scores between participants who were advised (mean = 2.6, SD 1.9) to read food labels compared to those who were not (mean = 3.8, SD 1.4) (MD = 1.2, 95% CI: -0.091, 2.4).

Table 41 Outcome measures concerning understanding and usage of nutrition labels at pre and post-intervention

			Change from pre to post-intervention
n=30	**Pre-intervention**	**Post-Intervention**	**Mean difference (95% CI)**
Quiz score[1], **Mean (SD)**	1.7 (1.8)	3.2 (1.8)	-1.4 (-2.1, -0.8)
Self-rated understanding of nutrition labels [2] , **Mean (SD)**	4.73 (1.7)	5.4 (1.2)	0.7 (0.2,1.2)
[3] Self confidence in ability to use nutrition labels to make healthy choices, **Mean (SD)**	4.8 (1.7)	5.8 (1.2)	1.0 (0.5,1.6)
[4] Personal involvement with nutrition labels, **Mean (SD)**	49.0 (18)	58.6 (13.3)	9.6 (15.9, 3.3)
[5] Frequency of reading of nutrition labels. **Median (IQR)**	3.5 (2.75, 4)	4 (4, 5)	-1.0 (-2, 0)
[6] Frequency of impact of nutrition label on purchase choices, **Median (IQR)**	3 (2, 4)	3 (2, 4)	-1 (-2, 0)

[1] Pre and post quiz scores were out of a total of 5. [2] Self-rated understanding of nutrition labels assessed using a 7-point scale (i.e. I do not understand it at all, 7= I understand it perfectly). [3] Self confidence in ability to use nutrition labels to make healthy food choices assessed using a 7-point scale (i.e. 1= Not at all confidence, 7 = I'm very confident). [4] Personal Involvement with nutrition labels assessed using a 10-item inventory where overall score ranged from minimum 10 to 70 (maximum). [5] Frequency of reading of nutrition labels assessed with the frequency scale (1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always), [6] Frequency of impact of nutrition label on purchase choices assessed with the frequency scale (1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always). [7] Differences between pre and post-intervention outcome measures analysed using paired t-tests for all outcomes except use of nutrition labels which used Wilcoxon signed-rank tests). Abbreviations: SD = Standard Deviation, IQR = Inter Quartile Range

7.4.3 Self-rated understanding and confidence in use of nutrition labels to make healthy choices

At pre-intervention, participants' mean level of self-rated understanding of nutrition labels was moderately high using a 7-point scale (i.e.1 = Do not understand, 7= I understand completely) (mean= 4.7, SD 1.7) (Table 41). Similarly, self confidence in ability to use this information to make healthy food choices was also moderately high (mean= 4.8, SD = 1.7) (7-point scale; 1= Not at all confident, 7 = I'm very confident) (see Table 41). Following the intervention, mean levels of self-rated understanding of nutrition label information rose (mean = 5.4, SD 1.2) (MD = 0.7, 95% CI: 0.2, 1.2). Likewise, participants' mean level of confidence in using nutrition labels to make healthier food choices also improved at post-intervention by an average of one point (MD = 1.0, 95% CI: 0.5, 1.6).

Post-hoc analysis suggested similar mean levels of self-rated rated understanding among participants according to if they had been "advised" to read food labels (n=16) (Mean = 4.6 (SD 1.4) or not "advised" (n=14) (Mean = 4.9, SD 1.7). Similar scores were observed among those of University of higher educational attainment (n=10) (Mean = 4.5, SD 1.4) and those of lower than university attainment (n=20) (Mean = 4.8, SD 1.9). However, those who were "advised" to read food label did not appear to improve their self-rated understanding of nutrition label from pre to post-intervention (MD = -0.7, 95%CI: -1.9, 0.5). A similar trend was noted for those who had lower educational attainment (MD= -0.6 95% CI: -1.3, 0.1). However, there were no significant differences in pre-post gains in self-rated understanding of nutrition labels within the educational attainment (i.e. between sub-groups changes in pre-post differences MD = 0.3, 95% CI: -0.8, 1.5) or according to "advisory" food label reading (MD = 0.03 95% CI: -1.1,1.07).

7.4.4 Personal involvement with nutrition labels

Personal involvement with nutrition labels was measured using a ten-item inventory where each item was scored from 1-7, so that the minimum and maximum scores were 10 and 70. Mean overall scores for this characteristic were calculated as the sum of all inventory items. At pre-intervention, mean scores for this characteristic were moderately high (mean = 49.0, SD 18) (Table 42). Inventory items which scored highest at pre-intervention were; “importance”, “need”, “value” (Table 42). Except “interest” “need” and “value”, the mean scores of all nine remaining inventory items significantly increased from pre to post-intervention. Following the session, participants’ personal involvement with nutrition labels significantly increased (mean = 58.6 SD 13) (MD= 9.6, 95% CI: 15.9, 3.3).

Table 42 Mean scores for items within the personal involvement with nutrition labels inventory, at pre and post intervention (n=30)

Personal involvement inventory item	Mean (SD)		Mean difference	95% CI	
(1-7 scale)	Pre	Post		Lower	Upper
Importance	6.1 (1.4)	6.7 (0.5)	0.6	1.1	0.1
Interest	5.3 (2.2)	5.7 (1.7)	0.5	1.5	0.4
Relevance	5.0 (2.4)	6.3 (1.6)	1.3	2.1	0.5
Exciting	3.7 (2.4)	4.7 (2.3)	1.0	1.8	0.2
Meaning to me	4.9 (2.4)	6.0 (1.8)	1.10	1.9	0.3
Appeal	4.0 (2.3)	5.3 (2.0)	1.2	2.0	0.4
Fascination	4.1 (2.4)	5.3 (2.0)	1.2	2.0	0.4
Value	5.5 (2.2)	6.3 (1.6)	0.8	1.5	0.02
Involvement	4.4 (2.4)	5.7 (1.9)	1.3	2.2	0.4
Need	6.0 (2.1)	6.5 (1.2)	0.6	1.3	0.2
Overall personal involvement with nutrition labels	49.0 (18.0)	58.6 (13.3)	9.6	3.3	15.9

[1] Differences between pre and post-intervention scores assessed using paired t-tests.

7.4.5 Potential effect of the intervention on future use of labels

Frequency of use of nutrition labels was measured using the 5-point Likert scale to measure frequency of use (i.e. Never = 1, Always = 5). At pre-intervention, median values of frequency of reading of nutrition labels (median 3.5, IQR = 2.75,4) and influence on purchase choices (median = 3, IQR = 2,4) were moderately high (Table 41). Participants' self-reported frequencies of reading and (intended) impact of labels on purchase choices increased significantly from pre to post-intervention, reflecting greater intended frequency of reading nutrition labels and anticipated use in future purchase choices following the course (see Table 41).

Correspondingly, following the session, 93% of participants reported they would frequently read nutrition labels and 83% claimed their future purchase choices would be frequently influenced by this information (i.e. "always" or "often"). In comparison at pre-intervention, 50% (n=15) of participants indicated they frequently read nutrition labels and 43% (n=13) said that this information frequently influenced their purchase choices.

7.4.6 Session feedback and perceived usefulness

Participant's comments about the session were invited in an open text box at the end of the post-intervention questionnaire. These were all positive and included "useful" "interesting" "helpful", "involving" and "informative". Other comments stated, "this is the first time I have really looked at labels" and "well needed for people like me who do not understand labelling". Following the session, spontaneous verbal feedback to the session facilitator (the researcher) was also positive and enquired if ongoing future sessions were planned at the same location. Two written suggestions of improvement provided on the post-intervention questionnaire were to have a "longer session" or "more sessions". One participant also commented on the group size (i.e. in the largest of the three classes containing 14 participants) and that there was a "bit too much noise going on". Participants' mean post-intervention rating for the usefulness of the session in helping them to understand nutrition labels was 6.2 (SD 0.9) (i.e. out of maximum of 7).

7.4.7 Intervention feasibility in the setting

The co-ordination and management of the sessions at this particular community centre were found to be feasible and relatively easy to organise, given the pre-existing working relationship which enabled effective collaboration between centre co-ordinator and the researcher. The costs of running the three sessions, albeit without a fee for facilitation by the instructor, also fell within the small budget constraints (£250). Service users were willing and happy to be recruited and those who attended appeared interested and pleased with this session.

However, the particular setting constrained the recruitment of participants according to an ideal eligibility criterion (i.e. older adults aged 50 yrs only). In addition, the setting's layout and room facilities did not easily enable a randomised two group study design and meant that less robust methods of evaluation were used.

7.5 Discussion

7.5.1 Overview and main findings

This study has described the development and pilot evaluation of a short educational intervention designed to improve understanding of current UK nutrition labels in older adult community service-users. Older adults were of interest here since the earlier research in UK older adults showed that objective understanding of current UK nutrition labels may vary with older adults' age, gender, education, whether respondents had been advised to use food labels and their levels of nutrition knowledge (Chapter 4). However, not all participants recruited in this particular setting were older adults and as such it may be more feasible to conduct a larger scale randomised study which is restricted to this age group within other community centres around Leeds. The intervention was, however, developed in collaboration with the centre co-ordinator, which may have helped recruitment and the positive feedback on the "usefulness" of the session, as rated by participants.

In addition, this pilot study suggests the intervention potentially increased levels of objective understanding of current UK nutrition labels among older adult and community service-users. The potential effects of the session on participants nutrition label understanding and usage characteristics may have been due to the incorporation of specific educational learning objectives which were based earlier work which highlighted lower levels of understanding of specific elements of labels including terminology and associated label data. Secondary outcomes including self-rated understanding and confidence in use of this information when choosing healthy foods also appeared to improve from pre to post-intervention in these participants. Levels of personal involvement with nutrition labels, a characteristic not yet assessed in the limited literature on this characteristic as well as nutrition label education, also showed potential increases in across intervention participants.

This discussion section will go on to discuss the potential effects of the intervention on participants' understanding of current UK nutrition labels and self-report usage characteristics. This study's limitations and findings in terms of the existing research on nutrition label education will also be discussed here. A wider discussion of this chapter's findings and implications in context of the wider PhD project are presented in Chapter 8.

7.5.2 Potential effects on participants' understanding of nutrition labels

The need to educate service-users about nutrition labels was clearly indicated by the pre-intervention assessment of levels of participants' label understanding. This found less than half of participants were able to locate (replay) basic label data (i.e. for quiz questions concerning the location of "per serving" nutrient values, or "%RI" contributions). Furthermore, only around a quarter could define the current terminology "Reference Intakes" and corresponding values despite being provided with a current UK back-of-pack nutrition label. In contrast, around half (54%) of survey respondents selected the correct definition of this label terminology in the multiple-choice question quiz (Chapter 4). At pre-intervention, the mean number of correctly answered quiz questions was less than two (1.8) out of a possible five. The quiz questions with the lowest number of correct responses (17%) related to how much of the "Reference Intake" value for fat should be consumed in one day. In contrast, previous research with UK consumers found that consumer understanding of the "GDA" for fat "means that an average adult should eat no more than 70g of fat a day" was generally "good" and correctly selected by 83% of consumers (Grunert et al., 2010b). Overall, the current findings suggest it is possible to expect positive results in improved understanding of UK nutrition labels even with a brief single session intervention as developed here.

Although the present study was not powered to detect difference within subgroups, post-hoc analysis suggests there is potential for some disparities in participants' initial levels of understanding of nutrition labels according to level of education and whether participants had been advised to read food labels. This agrees with prior findings from a larger sample of adults aged 50 yrs+ where lower levels of objective understanding of current UK nutrition labels were found amongst those with non-university level education attainment, or if they had been "advised" to use food labels (Chapter 4). Among the intervention participants here, participants who had been "advised" were found to perform worse in the pre-intervention quiz than those who had not been. However, the intervention may have been somewhat effective at reducing these pre-existing inequalities in understanding of nutrition labels according to whether participants had been advised to use this information. For example, the gap in nutrition label understanding (quiz score) between those who had, and had not been, advised to read food labels appeared to be reduced at post-intervention. There was also no difference in pre post-intervention gains in levels of objectively evaluated understanding of nutrition labels between those with higher or lower levels of educational attainment. However, it should still be noted that those participants with higher levels of educational attainment appeared to score consistently significantly higher in the quiz, than those with lower levels, at both pre and post-intervention.

In addition, self-rated understanding of nutrition labels also appeared to increase among participants, following the session. However, no significant increases in mean self-rated (subjective) understanding of this information were found among smaller sub-groups of infrequent label users, those with lower educational attainment, or who had been advised to look at food labels. Although data interpretation is limited here with such small subgroup analysis, it is suggested there is potential for disparities in how well certain types of participants perceived they understood labels following their participation in the session. This might be an important finding given the impact of self-rated understanding on driving frequent label use in the earlier Chapter 4 and is further discussed in chapter 8, sections 8.4.1 and 8.5.2.

7.5.3 Potential effects on participant characteristics relating to label use

Intervention participants' levels of confidence in using nutrition labels "to make healthy food choices" was significantly increased at post-intervention. Indeed, improvements in participants' confidence in using nutrition labels to choose foods "high in fibre" or "low in fat" was a commonly reported positive outcome of similar short interventions targeting nutrition label use and understanding (Chapman-Novakofski and Karduck, 2005; Dukeshire et al., 2014; Jay et al., 2009; Lindhorst et al., 2007). The current findings suggest there is potential for the single session intervention developed here to increase consumers' levels of confidence in their use of nutrition labels, an effect seen in seen in comparatively longer interventions (Garcia et al., 2017; Miller et al., 2002, 1999; Wolfe et al., 2017).

Levels of personal involvement with nutrition labels were evaluated among participants to reflect their personal motivations to engage with this information (Moorman, 1990). However, participants' overall levels of personal involvement with nutrition labels were found to significantly increase following the educational intervention. These are potentially interesting findings given that motivation to engage with this information is considered a "bottle neck" for use of nutrition labels (Grunert et al., 2012). This study is a new contribution to the existing literature on personal involvement with nutrition labels, which does not yet encompass the potential of educational intervention to influence consumers' levels of this characteristic (Xie et al., 2015; Mulder et al., 2018). This will be discussed further in Chapter 8, sections 8.4.1 and 8.5.3.

Overall, participants' self-reported (i.e. future) reading of nutrition labels and use of this information during purchase choices potentially increased from pre to post-intervention. However, it should be noted that participants' (future) use of nutrition labels was self-reported and measured directly after the intervention took place, without any opportunity for participants to implement their intentions during a follow up period. No "follow-up" stage was included here, during which participants could be contacted following the intervention. Therefore, no information on whether participants retained their levels of nutrition label understanding, or self-reported frequency of use, was obtained. This would have been an additional contribution to the literature (review in Chapter 6) which appears to have only measured understanding immediately after the intervention yet suggests nutrition label use increased in those participants followed-up after 3-6 months post intervention (Garcia et al., 2017), or compared to control group participants (Kollannoor-Samuel et al., 2016).

Nonetheless, findings of the current study do reflect other studies which also found that brief interventions are also likely to increase self-reported (intended) use of nutrition labels as measured at post-intervention (Dukeshire et al., 2014; Lindhorst et al., 2007). Furthermore, a potential long-term effect of nutrition label education has been suggested in research with US older adult females. Specifically, those who had previously received "instruction" in the topic of nutrition labels were found to possess "improved attitudes and label reading skills" compared to those who had not, some years later (Byrd-Bredbenner and Kiefer, 2001). It is recommended that measures which reflect actual label use and associated effects on dietary behaviours should be used in future work evaluating these characteristics following this intervention.

7.5.4 Limitations

This pilot study did not include a control group and therefore any changes to outcomes including nutrition label understanding and use may not yet be definitively attributed to the educational intervention. This limitation hindered the identification of any alternative explanations for the relatively short-term improvements in participants' understanding of nutrition labels. These include a possible "learning" effect due to the use of pre and post-intervention quiz questionnaires directly before and after the session. However, the pre and post-intervention quizzes were different and used different label types and questions to reduce any possible learning effect or participant's reliance on memory. In this respect, the use of different pre and post–intervention versions of the nutrition label understanding quiz contrasts with those measures reported in other interventions reviewed in Chapter 6. These appeared to report using identical quiz instruments at both pre and post-test (Chapman-Novakofski and Karduck, 2005; Dukeshire et al., 2014; Gavaravarapu et al., 2016; Hawthorne et al., 2006; Jay et al., 2009). In addition, the marking criteria used in the present study to assess participant's open answer quiz responses is also a strength of this study, as used in one similar study in the US (Miller et al., 2002).

The use of a control group was considered unfeasible in this setting given the available space and the possibility of contamination between groups of service-users. This resource limitation of the intervention and setting therefore led to the pragmatic decision to prioritise the recruiting of as many participants as possible within a pre post-intervention study design. Similar issues were described in other interventions studies without control groups, including those featuring nutrition label education (Hawthorne et al., 2006; Katz et al., 2014) (Chapter 6), nutrition knowledge (Rustad and Smith, 2013) or behaviour change in older adults (Hermann et al., 2000). Recruitment strategies used here did enable data collection from a sample which comprised of mostly older adult participants aged over 50ys. However, it is acknowledged that this study was not designed to detect differences in the effect of this intervention between sub-groups. Results of the post-hoc sub-group analyses should be interpreted here with caution, including according to educational attainment levels or whether they had been "advised" to use labels. Further research with larger samples is warranted and would specifically explore the effect of nutrition label education on specific participant types. A sufficiently powered randomised controlled study design would more definitively assess the effect of the intervention on participants' understanding of nutrition labels and related outcomes.

A strength of this study, intervention participants did include older adults from diverse education and ethnic backgrounds, who are often under-represented in research interventions. These individuals are an important focus of nutrition label education since previous work has suggested that individuals of specific socio-demographics, including those of older ages and lower educational attainment, may use and understand nutrition labels less well than those from other backgrounds (Campos et al., 2011; Macon et al., 2004; Sinclair et al., 2013). This includes findings from the earlier survey of older adults where age and educational attainment were both found to similarly influence levels of objective understanding of the current UK nutrition labels (Chapter 4). Furthermore, prior research suggests that label use may be one factor explaining differences in food choice between high and low income populations (Pérez-Escamilla and Haldeman, 2002). However, recruitment of intervention participants in the present study meant that these were self-selected, likely interested individuals, who may have specific reasons for wanting to know more about nutrition labels. Indeed, 53% of participants reported that themselves or a family member had been "advised" to read food labels. These characteristics may help explain the promising potential effects of the short intervention participants levels of personal involvement with nutrition labels (i.e. enduring motivation to engage with this information) and anticipated use nutrition labels during purchase choices following the session. However, this work does provide an initial insight into the effect of nutrition label education in a diverse community-based sample, as recommended by other researchers in this area (Jay et al., 2009; Macon et al., 2004; McArthur et al., 2001; Pérez-Escamilla and Haldeman, 2002; Satia et al., 2005). Future research should ideally aim to recruit more widely, from various community settings and attempt to use objective measures of nutrition label use (i.e. in-store) to assess how the intervention may affect participants' actual label use, including at follow up points post intervention.

One further limitation of this study is the discrepancies in ages and other socio-demographics between the community service-users who participated in the intervention and those older adults who responded to the online survey (Chapter 4). Due to the community centre inclusion policy, recruitment of intervention participants was not limited to those aged 50 years old or older. As such, not all (63%) intervention participants were aged 50 years or older and most were of lower educational attainment (80%) and non-white British ethnicity (46%). This is a potential concern since the education session learning objectives were based on assessment of nutrition label understanding as performed using the online survey of older adults aged 50 years or older who were mostly female (73%), of white British ethnicity (90%) and high educational attainment (65%). For example, it is possible that those intervention participants with lower educational attainment may have had additional needs concerning their understanding of nutrition labels, including specific health literacy considerations (Jay et al., 2009; Meck Higgins and Clarke Barkley, 2004). Further intervention development and tailoring of learning materials, or additional written materials, is therefore recommended in future work, discussed in Chapter 8, sections 8.5.5 and 8.8.

7.6 Conclusion

This study contributes to the limited UK evidence-base concerning the effects of nutrition label education on understanding and use of this information. The basis for and development of the education session content and learning objectives have been described and informed by earlier review evidence (Chapter 6). Specifically, development of intervention learning objectives was underpinned by earlier insight into the needs of older adults relating to their understanding of specific elements of the current UK nutrition labels (Chapter 4). The evaluation of the pilot intervention has demonstrated the potential of this brief education session to improve older adult and community-service users' understanding of the nutrition label terminology and information elements currently displayed on products. In addition, personal motivation characteristics and those related to label use also appeared to improve following the intervention. Future intervention development and larger scale evaluation is now required to confirm the effects on various types of participants' nutrition labels use and their dietary intakes, via improvements in understanding of the current UK nutrition labels.

Chapter 8 Discussion

8.1 Overview of the PhD work and study aims

The project's aims were based on gaps identified in the research literature relating to older adults' use and understanding of the current UK back and front-of-pack nutrition labels (Chapter 1). This PhD project first aimed to evaluate understanding and use of current UK nutrition labels, as well as potentially related characteristics amongst older adults aged 50 years or older. To do so, online data collection tools were developed to measure objective understanding and self-reported use of this information. This work involved reviewing the existing literature which has assessed these characteristics (Chapter 2). In addition, data collection tools were developed and piloted in a basic education intervention conducted in the Virtual Learning Environment (VLE) with undergraduate students (Chapter 3). Data analysis and feedback from this pilot study were then used to inform the development of the online survey of older adults, developed to evaluate understanding and use of current UK nutrition labels by older adults aged 50 yrs or over (Chapter 4). The survey also aimed to evaluate older adult consumers' engagement with recently mandated online nutrition information and used a qualitative approach to further explore the use of this information within supermarket websites (Chapter 5).

The next aim of the PhD project was to review the features and effectiveness of nutrition label education interventions which specifically reported outcomes including participants' use or understanding of this information (Chapter 6). The review provided insight on a variety of previous educational intervention and, together with the findings of the online survey of older adults, was then used to inform the development and evaluation of a classroom-based pilot community education intervention targeting older adults' understanding of current UK nutrition labels (Chapter 7).

This chapter first provides a brief summary of the findings from studies reported and briefly discussed within Chapters 4, 5, 6 and 7 (also see Figure 25), in line with the three parts of the PhD story structure previously outlined above (and within Chapter 1, section 1.8). Findings and their implications will then be discussed in relation to the current research, including the evidence in this area which has emerged since 2015. The strengths and limitations of the research will also be considered, in addition to those aforementioned in the individual Chapters. Finally, this chapter will describe areas for future research.

8.2 Summary of main findings

8.2.1 Use and understanding of current UK nutrition labels among older adults

Among older adult survey respondents (n=181), those who reported nutrition labels frequently affected their purchase choices (51%) were more likely to be female, report greater dietary healthiness, or indicate that they or a household member had been previously advised to look at food labels for a diet or medical condition. Respondents' overall levels of objective understanding of current UK nutrition labels were found to be moderately high. However, findings suggested specific difficulties understanding the meaning of the current label terminology "Reference Intakes" and corresponding values and identifying "per serving" information (Chapter 4). Some disparities in objective understanding of this information were found among respondents according to gender, age, educational attainment and if respondents had been advised to read food labels for health or dietary reasons. Frequent influence of nutrition labels on purchase choices was predicted by increasing self-rated understanding of labels as well as general nutrition knowledge scores and personal motivation to engage with this information (personal involvement with nutrition labels). However, levels of objective understanding were not associated with frequency of use of this information, suggesting that those who use this information frequently during purchases may not entirely understand it.

8.2.2 Engagement with product nutrition information in supermarket websites

Data collected using the online survey showed that older adult online shoppers (n=70) reported using nutrition information in this setting less frequently than for nutrition labels (declared on-pack) (Chapter 5). Characteristics associated with frequent use of online nutrition information included frequency of use of on-pack nutrition labels and increasing personal involvement with this information. In contrast, other characteristics which were associated with use of nutrition labels on-pack, including respondents' levels of nutrition knowledge or whether that had been previously advised to look at this information, were not associated with frequent use of nutrition information online. Exploration of how these consumers use nutrition information within supermarket websites was undertaken using ‘Think aloud’ narratives from eight older adult online shoppers, who were tasked with selecting healthy products within their usual online supermarket (Chapter 5). Thematic analysis of verbal data identified three themes relating to use of supermarket websites and online nutrition information. These were: search efficiency; definitions of healthy; and engagement with information. For example, website searches and product attributes (i.e. “fresh”, “organic”) were used to identify “healthy” products with limited engagement with nutrition information. In addition, such information may also have been difficult for participants to locate and was inconsistently presented within product photographs. The latter appeared to impact on participants’ nutritional evaluations during between-product comparisons.

8.2.3 The effects of nutrition label education on understanding and use of labels

The systematic literature review of the effect of nutrition label education on participants’ label understanding and use showed the potential for short (single session) interventions to impact on these outcomes across a variety of intervention types and participant demographics, including ages (Chapter 6). This review also showed a clear gap in the evidence relating to interventions conducted in the UK which had incorporated and evaluated nutrition label education and its impact on consumers’ understanding or use of this information, including in older adults. Subsequently, a group-based in-person pilot nutrition label education intervention was developed and evaluated with a single arm pre-post-intervention design with community centre service-users (n=30) in a suburban area of Leeds, UK (Chapter 7). A potentially positive effect of the intervention was shown on participants’ levels of objective understanding of current nutrition labels and their levels of confidence in use of this information when making healthier food choices. There were also some indications that the intervention may have reduced initial disparities in levels of understanding according to whether participants had been advised to read food labels, or their level of educational attainment. Intervention feasibility was discussed, incorporating logistical issues and participant feedback.

Chapter title	Description	Main findings summary
Chapter 4 Characteristics associated with use and understanding of nutrition label information in older adults	Results from an online survey (n=181) reporting levels of understanding and use of nutrition labels and associated characteristics amongst older adults.	Frequent use of nutrition labels more likely by females, those who had been advised to use food labels and those with greater self-reported dietary healthiness. Frequent use was predicted by increasing nutrition knowledge, self-rated understanding and personal motivations to engage with labels, but not objective understanding. Objective understanding varied according to gender, age, educational attainment, advised label use and levels of nutrition knowledge.
Chapter 5 Online grocery shopping: Exploring the use of online product nutrition information by older adult shoppers.	Mixed methods study incorporating analysis of online survey items relating to online shoppers use of nutrition information in supermarket websites. Analysis of 'Think aloud' verbal data obtained from online shoppers tasked to find "healthy" products.	Less frequent use of online product nutrition information amongst online shoppers (n=70), compared to on-pack labels. Frequency of use associated with personal motivation to engage with nutrition information. Participants' use of the supermarket website search functionalities, as well as the prominence and consistency of online product nutrition information, may influence engagement with this information in evaluations of "healthy" products.
Chapter 6 Effects of educational interventions on nutrition label understanding and use: a systematic review	Qualitative analysis of 17 global studies evaluating nutrition label education and outcomes including use and/or understanding of nutrition labels in a variety of populations	Positive effect educational interventions on use and/or understanding of nutrition labels. Studies include single or multicomponent interventions encompassing nutrition label education In-class delivery most popular. Limited UK evidence found.
Chapter 7 Development and piloting of a nutrition label education intervention designed to improve understanding of current UK nutrition labels in older adult community service-users	The rationale for the development of the pilot educational intervention and its objectives. Single arm pre post intervention study design used to evaluate the effect on objective understanding and characteristics related to label use among community-centre service users	Overall increases in objective understanding of this information and characteristics related to use (i.e. confidence in use of labels to make healthier food choices, personal motivations). Indicates the potential to reduce in disparities in understanding of nutrition labels according to educational attainment and whether participants were advised use of food labels.

Figure 25 Overview of the findings of Chapters 4, 5, 6 and 7

8.3 Original contributions to the evidence base

8.3.1 What was already known on this topic

- Nutrition labels are required to be understood and used by consumers to affect their food choices and health.
- Older adults may use and understand this information at levels which are different to younger consumers.
- Product information, including nutrition information, was viewed minimally by shoppers using a UK online supermarket website (one study).
- Nutrition label education to help improve consumers' ability to use this information is stipulated in labelling legislation and research recommendations.

8.3.2 What this PhD thesis adds

- Older adults' reported use of current UK nutrition labels during purchases is linked with their nutrition knowledge, personal motivations and subjective, but not objective, understanding of this information.
- Specific elements of the current UK nutrition labels currently declared under recent EU Regulations, including "Reference Intakes" (RI), were not widely understood across surveyed older adults.
- Explanations for the lower use of online product nutrition information by older adult consumers, compared to labels, include their use of product search functionalities and the presentation of this information within UK supermarket websites.
- The available global evidence suggests that nutrition label education can positively affect consumers' use and understanding of this information, but there is a lack of research with UK consumers and labels.
- A brief educational session may potentially improve understanding of current UK nutrition labels and specific label elements (i.e. RI), among older adults and community service-users.

8.4 Older adult use and understanding of current UK nutrition labels

8.4.1 Characteristics related to use and understanding

Following the brief discussion of findings of the older adult survey (Chapter 4, section 4.5) these may now be further discussed in relation to the current literature and the overarching PhD project. Although limited by a small number of respondents, survey findings did indicate that older adult characteristics which were associated with frequent use of nutrition labels in purchase choices included being female or possessing greater levels of self-reported dietary healthiness, compared to infrequent users. These consumer characteristics are also consistently associated with label use in other populations, including in recent research conducted in the US and with younger adults (Campos et al., 2011; Christoph et al., 2018; Christoph and An, 2018; Nabec, 2017). In addition, increasing levels of nutrition knowledge were also associated with frequent use of this information, as also highlighted in other populations (Drichoutis et al., 2005; Grunert et al., 2010b; Grunert and Wills, 2007; Hieke and Taylor, 2012; Miller and Cassady, 2015, 2012). Furthermore, those older adults who had been "advised" to use food labels were more likely to be frequent label users than those who had not been advised to do so. This finding now contributes to those obtained with US survey data which suggest that use of nutrition labels is likely to increase with diagnosis of chronic disease (An, 2016; Post et al., 2010).

Existing evidence has already demonstrated that consumer use and understanding of nutrition labels may be influenced by age or vary with specific presentation formats. This provided the motivation to conduct the present research with older adults and the current UK nutrition labels, both of which had not featured in the research to date. With regards to objective understanding of the current UK nutrition labels, disparities between socio demographics (i.e. with gender, education, age and "advice" to use food labels) were indicated among older adult survey respondents (Chapter 4). Declines in levels of objective understanding of nutrition labels with increasing age, or respondents' decreasing educational attainment levels, were also similar to previous evidence from cross-sectional studies with wider age ranges concerning other label types (Ducrot et al., 2015; Macon et al., 2004; Malam et al., 2009; Sinclair et al., 2013). In addition, increasing levels of nutrition knowledge (i.e. of healthy eating) was also associated with better objective understanding of the current UK labels in older adults surveyed here. The positive relationships found here between label understanding, use and nutrition knowledge were in-line with the conceptual framework described in Chapter 1 (Drichoutis et al., 2005; Grunert et al., 2010b; Miller and Cassady, 2015). These findings now contribute to the existing evidence base in which a lack of insight into these specific characteristics among older adults has previously been highlighted (Kasapila and Shaarani, 2016; Miller and Cassady, 2015).

However, an unexpected survey finding here was the lack of relationship between levels of objective understanding and older adults' frequency of use of nutrition labels. This finding conflicted with the majority of the available evidence in this area, which has usually connected greater levels of use of this information with increased understanding in other populations (Ducrot et al., 2015; Koen et al., 2018; Levy and Fein, 1998; Sinclair et al., 2013), including in older adults of advancing age (Byrd-Bredbenner and Kiefer, 2001; Macon et al., 2004). For example, the PhD survey findings suggested that males were more likely to score higher in terms of objective understanding, despite being less likely to frequently use this information during purchases, compared to females. It is therefore possible that those UK older adults who claim to use labels most frequently may not entirely understand this information. A similar lack of association between use and understanding of nutrition labels has also been reported in younger US adults in one other study (Sharif et al., 2014).

Furthermore, it is concern that both the survey (Chapter 4) and pre-intervention findings (Chapter 7) consistently suggested that those who were "advised" to read food labels possessed lower levels of objective understanding of this information, compared to those who had not been "advised". It is possible that those older adults who have been advised to use nutrition labels may be disadvantaged in terms of their level of understanding of this information. This was a surprising and apparently novel finding and suggests it is possible that those adults who have been advised to use this information had not been adequately informed or educated about how to do so. In contrast, these older adults may be very personally motivated to use nutrition labels. Indeed, among surveyed older adults, those who had been "advised" possessed significantly higher levels of personal involvement (i.e. motivation to engage) with this information compared to those who had not been. This finding is in line with the influence of "motivation" on consumers' label use, according to the conceptual framework (Grunert and Wills, 2007). Such insight now also contributes to the research area of personal involvement with nutrition labels by specifically evaluating this characteristic in UK older adults, rather than younger US consumers (Chandon and Wansink, 2007; Moorman, 1990; Xie et al., 2015).

In addition, this research on UK older adults also showed that personal involvement with nutrition labels was not related to these consumers' objective understanding of this information. This is a new contribution to the area of personal involvement with nutrition labels in terms of older adults and label understanding. These findings reflect the limited available evidence in younger adults, which also suggests a role for increasing personal involvement with nutrition labels in determining nutrition label use, rather than actual label comprehension or participant's ability to accurately identify healthy food choices (Chandon and Wansink, 2007; Mulders et al., 2018). Specifically, levels of such personal involvement were recently found to be unrelated to younger adults' "nutrition label reading numeracy" in experimental research (Mulders et al., 2018). These authors have proposed that consumer characteristics determining understanding of nutrition labels, such as nutrition knowledge, may therefore be different from those underpinning use of this information, such as personal motivations (Mulders et al., 2018). In this respect the findings of the PhD in older adults regarding the association of nutrition knowledge, rather than personal involvement, with objective understanding of current UK nutrition labels, are somewhat similar. Likewise, differences in consumer characteristics which drive "use" (mainly motivations) or "understanding" of nutrition labels (mainly nutrition knowledge, age, education) were reported previously in a large cross-sectional study focussed on UK front-of-pack nutrition labels (Grunert et al., 2010b).

However, it should be noted that in the current PhD the older adult survey respondents' levels of nutrition knowledge were associated with both use and understanding of nutrition labels. Similarly, experimental work has suggested that a combination of (pre-existing) nutrition knowledge and personal motivation may be important in enabling accurate use of the US Nutrition Facts Panels in older adults. Specifically, these characteristics were both found to play a role in determining participants' attention to and interpretation of nutrition label data in healthy product comparisons (Miller and Cassady, 2012; Soederberg Miller, 2014). Overall, the current PhD work now contributes new insight into the role of older adults' nutrition knowledge and personal involvement with nutrition labels, in supporting older adults' use of nutrition labels and/or objective understanding of this information.

Another key finding of the thesis is the suggestion that older adults' subjective (i.e. self-rated) understanding of nutrition labels may not be aligned with their objective understanding of this information (i.e. as assessed using the survey quiz) (Chapter 4). This reflects the potential disconnect between actual and assumed understanding of US Nutrition Facts Panels found among young adults (Sharf et al., 2012). Likewise, other insight has also suggested that European consumers' "perceived" understanding may not be aligned to their actual understanding of various label types or elements (Feunekes et al., 2008; Gregori et al., 2014). This includes in a pan-European survey of 7,550 consumers which found that self-reported understanding was higher than that tested for several aspects of nutrition labels relating to "per portion" and "per 100g" information. In addition, 77% of these consumers claimed proper understanding of the term "GDA" whereas only 30% possessed actual understanding of this term (Gregori et al., 2014). In the current survey of older adults, levels of self-rated (subjective) understanding of nutrition labels did not vary according to whether respondents had been "advised" to read food labels. As such, these older adult consumers may have not been aware of their actual understanding of specific label elements. This finding is potentially important since increasing self-rated, rather than objective understanding, was found to predict frequent label use in purchase choices in the older adults surveyed here.

These potentially different associations between older adults' subjective and objective understanding of nutrition labels and their frequency of use of this information provide a new contribution to the existing literature in this area. They also support the research focus on evaluating consumers' perceptions (i.e. of label comprehensibility) as a key influence on their use of various label formats in other populations (Feunekes et al., 2008; Gregori et al., 2014; Grunert and Wills, 2007; Limbu et al., 2019; Malam et al., 2009; Méjean et al., 2013a). However, the need to additionally evaluate actual, objective understanding is also highlighted by these findings. This is important given that levels of consumers' subjective or objective understanding have been used differentially within policy recommendations on the adoption of specific front-of-pack nutrition label formats (Ducrot et al., 2015; Gregori et al., 2014; Grunert and Wills, 2007; Kleef and Dagevos, 2015; Malam et al., 2009; Mejean et al., 2013b; Méjean et al., 2013a).

Overall, the implications of these findings include the need for nutrition label education to help reduce the inequalities in nutrition label understanding according to level of nutrition knowledge, educational attainment levels or personal motivations, including whether they have been “advised” to view this information for diet or medical conditions. Indeed, recent research has identified high levels of patients’ motivations to use nutrition labels following medical diagnosis of (pre) diabetes, compared to those without a diagnosis (An, 2016). These researchers have also suggested that the “point of diagnosis” may present a “teachable moment” in which to offer nutrition label education and “promote understanding about how to use this information” (An, 2016). In addition, findings here suggest that education may also help to support those older adults who claim to use labels frequently in their purchases and (subjectively) understand them yet may not entirely (objectively) understand specific elements of the current UK nutrition labels.

The specific elements of the current UK nutrition labels which were not widely understood by older adults are discussed next. These include “Reference Intakes (RI)” and “per serving” information.

8.4.2 Understanding of specific elements of current UK nutrition labels and implications: Reference Intakes

New evidence provided by this PhD thesis concerns elements of the current UK nutrition labels which were found to be relatively poorly understood among both older adult survey respondents and community intervention participants at pre-intervention. These elements include the meaning of “Reference Intakes (RI)” and associated values (i.e. RI for fat, %RI). The “Reference Intake (RI)” elements are an important supplementary component of UK back and front-of-pack nutrition labels. These values reflect the population Dietary Reference Values (DRVs) and are intended to allow “*comparison of the nutritional values of food products and can help to convey the relative significance of the food as a source of energy and nutrients in the context of the daily diet*” (European Food Safety Authority, 2009). As such, these values appear within nutrition labels on most UK food and drink products (European Food Information Council, 2018; Department of Health, 2016b).

Levels of consumer understanding of the meaning of “Reference Intakes (RI)” terminology and values can be compared with previous research findings concerning the “%DV” on US Nutrition Facts Panels and the “GDA” terminology used on previous UK nutrition labels. These were discussed in detail in Chapter 4 (see section 4.5.4). For example, previous levels of UK consumers’ understanding of “GDA” terminology was considered generally “good” and correctly defined by 61% of consumers of various ages (Grunert et al., 2010b). Survey findings suggest that slightly less (54%) of the surveyed older adults could correctly define the meaning of “Reference Intakes”. However, this may not be surprising given that this term has appeared on UK food labels relatively recently from 2013. According to the conceptual framework, consumers’ exposure to and familiarity with label formats may also influence their use and understanding of this information in product evaluations (Grunert et al., 2010b; Grunert and Wills, 2007). It is therefore possible that the new “Reference Intake” terminology will become more familiar to consumers and understood by them over time with continued consumer exposure.

However, the current pilot community nutrition label education intervention undertaken here was conducted more recently in 2018 (Chapter 7) and also demonstrated a similar lack of understanding of the meaning of “Reference Intakes” terminology amongst participants at pre-intervention. It is therefore possible that the “Reference Intakes” elements of UK nutrition labels may not be as “inherently” comprehensible to consumers as other aspects, even after exposure over time. Researchers have previously reported low levels of consumer understanding of, or ability to use, the “%DV” elements of the US Nutrition Facts Panels, even among consumers who were familiar with and exposed to these labels (Byrd-Bredbenner et al., 2001; Fuan Li et al., 2000; Levy and Fein, 1998; Levy et al., 2000). These researchers have specifically recommended that prior knowledge, or nutrition label education, is required in order to render such “%DV” US label elements effective at informing consumers’ food choices (Byrd-Bredbenner et al., 2001; Fuan Li et al., 2000; Levy et al., 2000).

The findings of the current study therefore warrant the inclusion of the meaning of “Reference intakes” in nutrition label education, as will be discussed later.

8.4.3 Understanding of “per serving” nutrient content information

Findings of the current work also show that some consumers may have difficulties correctly locating basic label data declaring nutrient content “per serving”. Correct identification of this information for salt, declared on back-of-pack nutrition labels, was performed accurately by 69% of surveyed older adults and 47% of pre-intervention participants. Since locating (i.e. replay of) basic label data is thought to be a straight forward task for consumers to perform with nutrition labels, these results among UK older adults were somewhat surprising. In contrast, a prior review of European evidence suggested that “most consumers believe they can understand and are able to replay information presented in the nutrition label” (Grunert and Wills, 2007). However, other recent evidence from consumers across various countries appears to show their poor understanding and lack of use of serving size and associated nutrient content information, including on US Nutrition Facts Panels (Bucher et al., 2018; Faulkner et al., 2012; Zhang et al., 2016).

In the UK, consumers may have difficulty when locating “per serving” label data due to the mandatory declaration of nutrient content “per 100g” which usually appears in an adjacent column on the nutrition label (Department of Health, 2016a; Kerr et al., 2015) (see Figure 4). In contrast, front-of-pack nutrition labels mainly provide “per serving” information only, which may explain why more survey respondents were able to locate “per serving” nutrient information on these. Both elements (i.e. “per 100g” and “per serving”) of label information may be important in supporting consumers’ identification of healthier product choices in experimental conditions. For example, the provision of information “per serving” on nutrition labels, particularly for foods which are unlikely to be eaten in amounts of 100g, may support (younger) consumers’ evaluation of product healthfulness using pre-2014 UK front-of-pack (i.e. GDA) nutrition labels (Raats et al., 2015). In other research, the inclusion of “per 100g” as a “fixed baseline” may also support healthier overall food choices, compared to when the baseline varies by providing only “per serving” information (Hieke and Newman, 2015; van Herpen et al., 2014; Visschers and Siegrist, 2009). Promoting understanding and use of both “per 100g” and “per serving” may now therefore be considered to help support older adults’ use of UK nutrition labels.

The current findings indicating a lack of understanding of the location of the nutrient content “per serving” may therefore also partly explain why this information may not be effective in guiding consumers’ dietary intakes (Anastasiou et al., 2019; Bucher et al., 2018; Faulkner et al., 2012; Zhang et al., 2016; Zhang D et al., 2017). In the UK, it is possible that a current lack of use (or understanding) of these label elements by consumers may partly explain recent research findings which contrast actual amounts consumed with the corresponding products’ labelled serving sizes. Specifically, consumption amounts of certain high fat or sugar foods, as reported in the UK National Diet and Nutrition Survey, were found to be substantially greater than the corresponding products’ labelled serving sizes (Rippin et al., 2018). In combination with these other studies, findings suggest there is a need for education to explain both the “per serving” and “per 100g” aspects of the UK back-of-pack nutrition label. The pilot nutrition education intervention therefore included basic explanations of the meaning of and “how to use” both “per 100g” and well as “per serving” label elements declared on the current UK nutrition labels.

The wider implications of these findings concerning older adults’ use and understanding of the current UK nutrition labels and public health legislation will now be described, before discussing the role of education in improving consumer understanding of this information in the following sections.

8.4.4 Implications: The potential impact of current UK nutrition labelling legislation on consumer understanding and public health

The current EU Regulations governing UK food and nutrition labelling state that this should be “*accurate, clear and easy for consumers to understand*” (EC, 2011, para. 7.2). Found here, issues with older adult consumer understanding of specific elements of the current UK nutrition labels imply that these may reduce the impact of this information on population dietary health. Due to the display of poorly understood label terminology which concerns dietary recommendations (“Reference Intakes”), or disparities in understanding of nutrition labels information among older adult consumers, mandating nutrition label information may therefore be less effective than expected in supporting (older) UK consumers' food choices in-line with recommended daily dietary intakes.

Such consequences could be due to the potential downstream effects of consumers' misunderstanding of "Reference Intakes" information, which may impact on their product health evaluations. As described in the conceptual framework, such evaluations are thought to be based on consumers' nutrition label understanding in combination with other influences, which together contribute to their overall product health "inferences" (Grunert and Wills, 2007) (Figure 6). Indeed, previous research has shown that GDA information on nutrition labels may play a role in supporting consumers' product health evaluations during experimental computer-based choices (Hieke and Newman, 2015; Raats et al., 2015). Furthermore, the presence of GDA values on computer-based nutrition labels may have a direct impact on food choice of UK females via effects on their levels of self-conflict and self-control (Hassan et al., 2010). In combination with these other research findings in the area of consumer understanding and use of (previously displayed) GDA nutrition label information, the current findings relating to a lack of understanding of RI label terminology among older adults imply that there may be a potential impact on consumers' perceptions and evaluations of foods. Research exploring this within experimental and real-life settings is now warranted.

For older adults, the implications of a lack of understanding of specific label elements may also be greater given that these consumers and those with health concerns have recently been shown as more likely to use this information compared to younger consumers' (Y. Zhang et al., 2017). These researchers have also suggested that as adults age they tend to "*pay more attention to food brands and incorporate label information to determine, for example, nutrition information and how much to eat*" (Y. Zhang et al., 2017). Objective understanding may therefore become more important with older age, given the need for these consumers to utilise product messages in evaluations relating to health and nutrition.

This issue of appropriate and adequate understanding of label information among consumers, ensuring their product evaluations are not comprised by misunderstanding, has been highlighted in other evidence concerning nutrition and health claims declared on food labels (van Trijp, 2009). For example, consumers' (mis) understanding of specific nutrition or health claims has been raised as a concern in the literature relating to the EU Nutrition and Health Claims Regulations (van Trijp, 2009). For example, commercial wording of these claims may lead to inadequate consumer understanding about their meaning. Inadequate levels of individual consumer understanding of this information is recognised as a potential "risk" which may result in "misinterpretation" via a "halo" effect and preclude proper examination of nutrition information, or truncates this process, to alter accurate product evaluations (Bialkova et al., 2016; Roe et al., 1999). Furthermore, these claims and other influences on consumers' product health "inferences", including product pictures, brand name or endorsements on packaging have been shown to directly influence consumers' product perception and purchase choices (Baltas, 2001; Benson et al., 2018; Brand et al., 2016; Grunert and Wills, 2007). Of concern, these product-level messages were recently shown to be particularly influential on the purchase intentions of older adults or those with high health motivations, compared to their counterparts (Loebnitz and Grunert, 2018; Steinhauser and Hamm, 2018).

Other evidence in this thesis also indicates that older adult online shoppers may use product attributes (i.e. "fresh" or "vegetarian") as "proxies" for product healthfulness (and use of nutrition information), within supermarket websites (Chapter 5). Previous research has also shown that product evaluations undertaken using "health" messages may be made with or without consultation of the provided nutrition label information (Roe et al., 1999). Together, these findings, including a lack of objective understanding of specific elements of the current UK nutrition labels among older adults, may therefore have implications for the ability of these consumers to correctly evaluate products in "real-life".

Where provided on nutrition labels, the terminology "Reference Intakes" and corresponding supplementary information must be used in-line with the EU Regulation 1169/2011 (EC, 2011). The findings presented here are thought to be the first to quantify consumer understanding of Reference Intakes terminology. Specific concerns relating to the impact of the (then forthcoming) EU Regulation 1169/2011 changes to label formats on consumers were first raised in 2010 by the National Institute for Health Care Excellence (NICE). Anticipating unfavourable changes to the UK front-of-pack nutrition labels, this organisation then issued a recommendation to "*ensure labelling regulations in England are not adversely influenced by EU regulation" as part of their advice on the prevention of cardiovascular disease* (National Institute for Health Care Excellence (NICE), 2010, Recommendation 6). The current PhD findings now provide some support for this concern. They suggest that there is potential for the current UK nutrition labels to sub-optimally impact on consumer health, via a lack of consumer understanding which may result in non, or altered, use of specific elements of label information during product evaluations and purchases.

As such, the findings of this PhD concerning objective understanding of nutrition labels, as well as the possible disparities across older adults, speak to the documented need for policy makers to better understand the effects of standardised information and terminology disclosure on consumer welfare, via the impact on consumer understanding (Hieke and Newman, 2015; Kasapila and Shaarani, 2016). Specifically, the current work implies that any future legislative changes to UK mandatory or voluntarily declared nutrition labels should first consider the role of consumer understanding of the new information, including among older adults. Indeed, the regulatory motivations and rationale for replacing "GDA" with the current "RI" terminology are not known to be documented (European Food Safety Authority, 2009). In contrast, recent changes to the format of US Nutrition Facts Panels have been evaluated in relation to the impact on consumer use and understanding (Graham and Roberto, 2016; Grebitus and Davis, 2017; Khandpur et al., 2017; Xie et al., 2015). This includes evidence that these format changes may lead to the variable effects on attention paid to "daily values" or calorie and sugar content information (Magnuson and Chan, 2019).

Any food and nutrition labelling changes which may follow the UK's expected exit from the EU (BREXIT) in 2019 could provide the opportunity to consider how to improve consumer understanding of nutrition labelling terminology. Indeed, any changes to the EU "national schemes" of front-of-pack nutrition label formats are currently required to be evidence-based (Buttriss, 2018; EC, 2011). Based on the need to increase consumer understanding of "Reference Intakes" identified here, potential label improvements could now include additional label text explaining the meaning of these label elements. Similarly, text now appears below the new US Nutrition Facts Panels to explain the term "Daily Values", which states: "*The % Daily Value (%DV) tells you how much a nutrient in a serving of food* *contributes to a daily diet. 2,000 calories a day is used for general nutrition advice*" (Food and Drug Administration, 2016).

Likewise, the results of the current PhD also emphasise the importance of general nutrition knowledge in supporting both use and understanding of UK nutrition labels in older adults. This implies this characteristic may be important to support increasing levels of nutrition label understanding and use in older adults (i.e. via education). As such, this work supports the need for complimentary research which evaluates consumers' objective understanding of various front-of-pack nutrition label schemes to identify the scheme most likely to be understood by those "with minimal nutrition knowledge", as undertaken with the NUTRI-SCORE system (Ducrot et al., 2015; Méjean et al., 2013a; Soederberg Miller et al., 2015; Roberto and Khandpur, 2014). Of note here, the NUTRI-SCORE scheme displays only letters (A to E) and colours without use of terminology or interpretive (i.e. %RI) values). In this respect, this PhD work also supports recommendations concerning the adoption of a simplified front-of-pack scheme as a nutrition labelling standard most likely to be understood by consumers in Europe (Julia and Hercberg, 2017; Kleef and Dagevos, 2015; Thow et al., 2019).

The current findings concerning disparities in and specific difficulties with older adults' objective understanding of current UK nutrition labels implies there is an important role for nutrition label education in supporting this antecedent to information use during product evaluations, which will be discussed next.

8.5 The role of nutrition label education

8.5.1 Potential effects on objective understanding of current UK nutrition labels

The current findings show a potentially overall positive effect of nutrition label education on levels of intervention participants' objective understanding of this information (Chapters 6 and 7). These can be considered to support theoretical estimates of the impact of mandatory nutrition labels on population health and obesity where it is assumed that consumers receive explanations of "how to use" this information (Bonsmann and Wills, 2012; Sassi et al., 2009). Findings from Chapter 7 also support the overall positive effects of in-person nutrition label education on label understanding which were indicated by the earlier review (Chapter 6). In terms of the existing UK research on the effects of nutrition label education on consumers' use and understanding of UK labels, this PhD work now adds to the limited evidence base. To the authors knowledge following a systematic literature search of the area (Chapter 6), only one study has previously evaluated participants' reported use of UK nutrition labels following a multi-component healthy-eating intervention which included nutrition label education (Garcia et al., 2017).

In addition, the findings indicate that the pilot nutrition label education intervention may have potentially reduced pre-existing inequalities in objective understanding of labels according to participants' educational attainment levels or whether they had previously been "advised" to use food labels. These results also support the need for nutrition label education as recommended by recent research which presents evidence of sub-optimal consumer understanding of (front-of-pack) labels in specific groups, including those with lower nutrition knowledge, educational attainment and older age (Ducrot et al., 2015; Gregori et al., 2014).

The pilot nutrition label education intervention developed during this PhD specifically targeted the "Reference Intakes" (i.e. the meaning of RI and the %RI elements of the label) and "per serving" elements of the current back and front-of-pack nutrition labels. These elements were not widely understood among the survey respondents and community service-user intervention participants (Chapters 4 and 7). The education session encompassed recent consumer messaging designed by the UK Department of Health and the Institute of Grocery Distributors (IGD) on how to use "RI" and "%RI" elements of front-of-pack nutrition labels which were issued during this PhD project. These described "RIs" as "daily allowances" (IGD, 2018) and provided guidance on how to use the %RI information to see "*how much an average adult's daily intake of each nutrient is in a portion […] in the context of a balanced diet*" (Department of Health, 2016b). The potential effect of the pilot nutrition label education intervention evaluated here was found to be positive in increasing participants' objective understanding of nutrition labels, as assessed using questions on the meaning and location of RI and corresponding label elements.

Consumer education on specific elements of nutrition labels has also been recently called for by researchers who found there exists potential to increase the effect of "serving size" information on nutrition labels on dietary intakes (Anastasiou et al., 2019; D. Zhang et al., 2017) and the impact of label types (i.e.

front-of-pack) on the healthiness of consumers' purchase choices and dietary intakes (Anastasiou et al., 2019; Campos et al., 2011; Ni Mhurchu et al., 2017; van 't Riet, 2013). Such nutrition label education may now be particularly needed, timely and potentially effective in the UK given the recent implementation of mandatory nutrition labels which optimises the availability of this information for consumers (Gregori et al., 2014). Indeed, a recent review of evidence collected since the 1990s has suggested that US mandatory nutrition labelling implemented under the Nutrition Labelling and Education Act has positively impacted on American consumers' food choices and industry practices (Shangguan et al., 2019).

8.5.2 Potential effects on subjective understanding of nutrition labels

This PhD work sheds some new light on the possible role of nutrition label education in influencing subjective (self-rated) understanding of nutrition labels among older adults. Although sub-group numbers were small, findings from the pilot intervention showed that self-rated (subjective) understanding may not always increase amongst some types of participants, including those who were of lower educational attainment or who had been "advised" to read food labels. In contrast, objective understanding did appear to potentially increase across these groups. It is therefore possible that both subjective and objective (actual) understanding of nutrition labels were differentially impacted by the educational intervention. These findings relating to the effects of nutrition label education on participants' self-rated (subjective) understanding of nutrition labels appear new and have not been noted within the research on nutrition label education interventions reviewed earlier (Chapter 6).

A possible explanation for such findings might be that at post-intervention, individual participant's self-rated understanding was influenced by their completion of the pre-intervention quiz assessment of actual (objective) understanding. In contrast, such self-rated understanding was simply assumed by participants and untested prior to their subsequent undertaking of the pre-intervention quiz. Participants' levels of self-awareness of their actual understanding of this information may also help explain the results of the earlier survey of older adults (Chapter 4) and other previous research. These note differences between (subjective) assumed and actual (objectively-tested) understanding of US Nutrition Facts Panels or front-of-pack labels (Feunekes et al., 2008; Gregori et al., 2014; Sharf et al., 2012) and the role of subjective, but not objective, understanding of the current UK nutrition labels in determining frequent use of this information in older adults' purchase choices (Chapter 4). It may therefore be of future interest to explore the role of consumers' conscious, and unconscious, competencies in their use of specific nutrition label information following education and during real-life purchase evaluations and dietary decisions (Cannon et al., 2014). In addition, these findings are related to some earlier research suggestions in this field which speculated, rather than reported, that "non-readers" may have different label-reading education needs compared to those consumers who do read labels (Byrd-Bredbenner et al., 2001). Overall, the role of consumers' subjective understanding of nutrition labels (i.e. "how well they think they understand") maybe of further importance in nutrition label education (Grunert and Wills, 2007).

8.5.3 The potential for education to improve consumer motivations to use nutrition labels

Some researchers have questioned if mandatory nutrition labelling is, in fact, an effective means to improve population nutrient intakes or reduce obesity (Gregori et al., 2014; Hieke and Taylor, 2012). These argue that labels are not always used by all consumers during shopping and are only likely to be used by consumers with an interest or knowledge in healthy eating or with the ability to use this information (Brambila-Macias et al., 2011; Thavorncharoensap, 2017). The need to improve consumer motivations use of nutrition labels also continues. This is evident in recent review and survey research which suggests that (mostly self-reported) use of nutrition labels is associated with better reported dietary intakes (Anastasiou et al., 2019; Christoph et al., 2018; Christoph and An, 2018; Shangguan et al., 2019; D. Zhang et al., 2017). Likewise, this PhD also provides initial insight that UK older adult self-reported "frequent" users of nutrition labels are also more likely to report better "dietary healthiness" than those who use labels "infrequently" (Chapter 4). Furthermore, new evidence on the effect of implementing novel (front-of-pack) labelling in New Zealand on consumer purchase choices also continues to show an overall lack of effect on consumer purchases, but that healthier choices are more likely among consumers who view the nutrition label (Ni Mhurchu et al., 2018, 2017).

As such, motivation to use and attend to nutrition labels is still considered to represent a major “bottle neck” in determining consumers’ use of this information (Grunert et al., 2012). Whether the nutrition label education developed here can impact on participants’ actual motivations to use UK nutrition labels remains to be seen. Although, as discussed in Chapter 7, it is promising that participants’ confidence to use this information to make healthy food choices and their intended use of nutrition labels both potentially increased following the pilot intervention. Furthermore, intervention participants’ overall personal involvement (i.e. their enduring personal motivation to engage with this information) also appeared to potentially increase following the intervention. As discussed in Chapter 7, it is thought that these findings are the first within the literature describing consumers’ personal involvement with nutrition labels and suggest that this characteristic, reflecting participants’ personal motivations, could be increased by nutrition label education. However, since the measures used in the pilot intervention study here are self-reported, without any follow-up period, future work will be necessary to assess the effect of the nutrition label education intervention on improvements in participants’ actual label use behaviours in real-life.

Given the pilot intervention was undertaken with incentivised and self-selected community-centre service users, it is possible that the results are a “best case” scenario” of intended use and personal motivations. It is also possible that education may be ineffective at increasing label use in some consumer types. This view is in line with recent evidence from consumer “segmentation” analyses which suggested that frequent label use is part of an overall consumer profile in which greater health orientation and favourable dietary intakes are usually combined (Cavaliere et al., 2017; Visschers et al., 2013). Conversely, consumer segments with opposite profiles are unlikely to use food information and could be resistant to efforts to encourage use of nutrition labels to effect food consumption, including education (Visschers et al., 2013; Cavaliere et al., 2017).

Further detailed exploration of consumer “goals” and “nutrition label reading heuristics” has recently shown the importance of these motivational aspects when explaining “how” consumers use nutrition information (Chalamon and Nabec, 2016). Specific goals, concerning the positive and negative effects of food on the body, were likely to produce more health driven goals towards reading on-pack nutrition information and ingredient listings and performing nutrient content comparisons. In contrast, those with food gratification or “food as necessity” goals described discounting, or did not look at, nutrition information (Chalamon and Nabec, 2016). Together with the findings relating to the effects of the current nutrition label education intervention on specific types of participants’ personal involvement levels, these authors’ work has implications for the extent to which such education maybe expected to impact on motivations to use labels, across consumer types. Likewise, it is not yet known if the effects of nutrition label education could be comparable with efforts to motivate consumers to attend to this information via instigation of new innovative front-of-pack nutrition labels. Further work, including possible focus group or interviews, to elucidate the potential for education on nutrition labels to impact on a variety of consumer types would be useful in future.

8.5.4 Factors influencing the potential success of the pilot nutrition label education intervention

The potentially positive effects of this intervention might be explained by the focus within the development stages on formulating learning objectives based on specific “needs” relating to older adults’ understanding of UK nutrition labels. Elements of nutrition labels which were revealed as most problematic for older adults to understand were targeted, including “Reference Intakes” terminology and values (Chapter 4 and Chapter 7 section 7.3.2). Similarly, consumers’ prior needs in the areas of nutrition label use and understanding have been highlighted by other studies evaluating consumers’ label understanding and the need for education (Byrd-Bredbenner et al., 2001; Byrd-Bredbenner and Kiefer, 2001; Cottee et al., 2000; Cowburn and Stockley, 2005; Dooley et al., 1998). This includes studies reviewed in Chapter 6 (see section 6.5.2). Specifically, the pilot intervention developed in this PhD recognised the need to explain specific elements of the nutrition label (i.e. RI) as well as the combined role of nutrition knowledge (i.e. of healthy eating) in determining use and understanding of these elements of nutrition labels (Chapter 4).

These aspects of the intervention development are supported by previous research into the area of consumer understanding of other nutrition labels (i.e. the US Nutrition Facts panels) which indicated that some informational aspects (i.e. %DV) “require at least some instruction to use” (Byrd-Bredbenner et al., 2001; Fuan Li et al., 2000). The potential effect of the intervention on participants' objective understanding of UK nutrition labels is therefore comparable with other single-session group programmes conducted in the US with adolescents (Hawthorne et al., 2006) and low-income patients (Jay et al., 2009). These studies also reported a specific positive effect on participants' responses to questions about "what the percent daily value tells you about the food" (Hawthorne et al., 2006) and when identifying the "% daily value of fat in one serving" (Jay et al., 2009). In addition, the nutrition label education piloted here may have increased older adults' understanding of specific "Reference Intakes" elements of this information via increases in nutrition knowledge, including of daily nutrient "allowances" involved in healthy eating. Likewise, a recent study from the US also suggested that enhancing participants' "prior knowledge" of nutrition may increase the effectiveness of nutrition label "training" on improving accurate use and understanding of nutrition labels in younger adults (Miller et al., 2017b).

In addition, the delivery format of the nutrition label education programme may also be a factor in the success of the pilot intervention undertaken here. Group in-class sessions were the most common delivery format of nutrition label education as found in a review of this literature (Chapter 6) and were specifically selected here for use in a community setting. It is therefore possible that in-class teaching, including hands-on activities, group discussion and a short video, was required to effect increases in participants' nutrition label understanding. Furthermore, such delivery may have helped to potentially improve nutrition label understanding among participants of different educational attainment levels. In contrast, the intervention by Jay et al (2009) comprised on no instruction (only a video and pocket card) and did not affect any improvements in label comprehension among the small group of participants with low health literacy.

Whilst the present pilot intervention was considered feasible and well received in the community setting reported here, it is of note that such in-class delivery formats may not be scalable to larger audiences or disseminated nationally. However, two recent evaluations of nutrition label education, including via national media or in-store channels have provided mixed findings. For example, the evaluation of a large-scale national media and social media campaign on the Canadian Nutrition Facts Panel reported no significant increases in awareness and understanding of “percent daily values” (%DV) among younger adults (Cormier et al., 2019). This campaign did, however, aim to emphasise and explain label elements known to present consumers with difficulties, including the “percent daily values” (%DV) (Cormier et al., 2019). In contrast, provision of in-store signage “explaining” (newly implemented front-of-pack) labels within a US experimental laboratory supermarket may have influenced the relative healthiness of parents’ purchases. Compared to the absence of such signage, such explanations were found to improve healthy choices of parents with children (Graham et al., 2017). Whilst participants’ understanding of labels was not assessed in this study, the authors highlight that newly implemented labelling should be accompanied by information campaigns to impact on consumers’ use of this information. They also suggest research into “different forms of education provision” including televised public service announcements and other forms of in-aisle signage which may affect consumer understanding and use of nutrition labels (Graham et al., 2017).

Scaling up nutrition label education via online channels is also worth considering in future. However, the work in this PhD was influenced by the anticipated effectiveness of in-class teaching approaches. Indeed, this was initially highlighted by a lack of evidence on the effect of a web-based intervention on intended use of labels, compared to in-class methods (Neuenschwander et al., 2013) (Chapter 6). However, work with undergraduates, including that undertaken during the initial development and piloting of online data collection tools described in this thesis (Chapter 3), has shown some promise in terms of learning and improving understanding of nutrition labels with web-based education (Miller et al., 2017b). The weight of the current evidence, including the findings of this thesis, suggest that in-class education is a potentially effective approach to improving consumers understanding of nutrition labels, with future potential to explore other education channels.

Finally, the inclusion of healthcare professionals (e.g. dietitians) in the delivery of in-class nutrition label education, may have also been a factor in the success of the current pilot intervention and several similar interventions reviewed here (Chapter 6). The pilot educational intervention here was developed and delivered by a registered dietitian and advertised as such during the recruitment of participants. However, without a suitable control group (i.e. with non-healthcare professional instructor), it is not yet possible to provide evidence of the effect of a dietitian on participant outcomes relating to nutrition label use or understanding. However, there may be an under-researched yet important role for health care professionals in the delivery of nutrition label education, particularly following the increased provision of (mandatory) nutrition label information on food products (Koen et al., 2016). In addition, other types of interventions (weight loss education) have been found to be more impactful if delivered by dietitians, compared to non-dietitians (Sun et al., 2017). The current PhD findings support recommendations for the future development of nutrition interventions for older adults which provide opportunities for contact with health care professionals (Sahyoun et al., 2004).

It is also possible that older adults may be particularly responsive to education from these professionals given that a “top-rated” provider of nutrition information to “maintain health” was found to be doctors and dietitians (Chrisman et al., 2012). Indeed, healthcare professionals are known to be “trusted” sources of nutrition information among older adults of lower social groups and educational levels (McKay et al., 2006). The findings of the present pilot intervention suggest that potential changes in understanding of nutrition labels among adults who had been previously been “advised” to use food labels may have been particularly responsive to the education session. Further work, including with large subgroup sample sizes, is now needed to confirm this and if these participants are more likely to attend or be motivated by instructors who are health care professionals. To the researcher’s knowledge, the extended influence of a dietitian “instructor” on participants’ recruitment, learning or behavioural outcomes has not been formally explored here or in label education elsewhere, to the researcher’s knowledge. It is possible that such future work may find in favour of those theoretical projections in which “individual counselling by doctors or dietitian” anticipate an increase in the impact of nutrition labels on health (Bonsmann and Wills, 2012; Sassi et al., 2009).

8.5.5 Health literacy, nutrition knowledge and nutrition label understanding

As indicated elsewhere (Jay et al., 2009), participants’ existing levels of health literacy may have been a factor in the success of the education intervention here. Unfortunately, this cannot be confirmed by the current work since levels of this characteristic were not evaluated. The current PhD work was focussed specifically on older adults' objective understanding of nutrition labels and the effect of education on this outcome. However, insight into the role of health literacy in influencing levels of such understanding and use of nutrition labels has emerged during the course of this PhD. A recent review of the concepts of and relationships between health literacy and nutrition label understanding has also highlighted the links between these characteristics and complexities involved in research evaluation of these (Malloy-Weir and Cooper, 2016). Indeed, health literacy and objective understanding of nutrition labels were found to be both similarly assessed using "nutrition label quizzes" and instruments in the review of research undertaken in Chapter 2. Briefly, health (and nutrition) literacy were earlier defined as "the degree to which people have the capacity to obtain, process, and understand basic information about health (and nutrition)" (Velardo, 2015; Zoellner et al., 2009).

Levels of adequate health literacy were recently surveyed and reported as an important determinant in consumers' understanding and use of Nutrition Facts Panels in the US (Persoskie, 2017). Conversely, inadequate health literacy has also been cited as one of the reasons that nutrition labels may not be well understood by consumers or used correctly to shape dietary intakes (Sharif et al., 2014). Health and nutrition literacy levels have been found to impact on both use and understanding of nutrition labels and other health related information and behaviours, including among older adults (Chesser et al., 2016; Gibbs and Chapman-Novakofski, 2012; Nogueira et al., 2016; Park et al., 2016; Vandelanotte et al., 2016). For example, levels of "nutrition label numeracy" (assessed using quiz items requiring manipulation of nutrition label data) also appear to be linked to disparities in health behaviours including fruit consumption and health information seeking (Nogueira et al., 2016). Health (and nutrition) literacy can therefore be considered important in "promoting compliance with dietary guidance for Americans" (Zoellner et al., 2011).

Practically, there now appears to be several ways in which limited health or nutrition literacy may affect understanding or use of nutrition labels. For example, the role of information acquisition appears important and patients with low levels of health literacy were found to spend more time viewing non-relevant (nutrition label) information when answering questions concerning this information, than those with higher levels (Mackert et al., 2013). In addition, optimal nutrition literacy may be important when using increasing quantities of back-of-pack nutrition label information to make healthy food choices, as shown in experimental research (van Buul et al., 2017). Furthermore, levels of nutrition literacy, as assessed using a nutrition label quiz, have also been related to the quality of participants' "self-monitoring" in a behavioural weight loss intervention which involved tracking calories and food intake (Rosenbaum et al., 2018).

In general, 60% of UK adults aged 16-65yrs are now thought to have proficient health literacy (Rowlands et al., 2015). However, inadequate health literacy is thought to be more pronounced in older adults (Alberti and Morris, 2017; Sørensen et al., 2015) and is associated with their non-participation in preventative health behaviours, such as cancer screening or exercise (Fernandez et al., 2016; White et al., 2008). Furthermore, nutrition knowledge has been described as an "integral" part of consumers' health literacy (Spronk et al., 2014). Increased levels of nutrition knowledge is associated with healthier dietary intakes among participants in community-based studies (Barbosa et al., 2016; Spronk et al., 2014; Worsley, 2002). Whilst the current PhD work did not aim to evaluate health literacy levels of older adults, both nutrition knowledge (i.e. of healthy eating) and understanding of nutrition labels were objectively assessed and may therefore approximately reflect health literacy levels among the older adults surveyed here. Disparities in these older adults' nutrition label understanding according to age, educational attainment, previously "advised" label use and levels of nutrition knowledge may also reflect the likely needs of these adults in terms of health literacy.

Increasing population health literacy is a key recommendation of the World Health Organisation (World Health Organization, 2003) and initiatives to support this are currently underway with older adults in the UK (NHS, 2016; Public Health England, 2015b). It is possible that improvements in an individuals' health literacy may enhance their understanding of nutrition label information (Malloy-Weir and Cooper, 2016; Sharif et al., 2014). In parallel, there is a need to increase nutrition knowledge, via education, in older adults to support their healthy eating practices (Barbosa et al., 2016; Meck Higgins and Clarke Barkley, 2004; Sahyoun et al., 2004). Increases in specific types of nutrition knowledge, such as that concerning diet-disease relationships, are thought to help reduce socioeconomic differences in adherence to dietary guidelines (McKinnon et al., 2014). The overall function of the nutrition label education developed in this PhD may have been to combine the complimentary aspects of nutrition knowledge, label understanding and health (and nutrition) literacy in order to better facilitate label use as a tool for participants' future healthy eating. Future research into the relationships and synergies between these constructs and older adults' healthy eating behaviours could be used to enhance the effect of nutrition label education interventions in future.

8.5.6 Implications: The need for nutrition label education and evaluation of consumers' nutrition label understanding

Overall, this PhD implies there is potential for nutrition label education to impact on label understanding and use. In particular, improvements in understanding as measured using quiz questions relating to "Reference Intakes" and "per serving" label elements suggest that such education may be of particular value where aspects of nutrition labels have the potential to fall short of their expected effects on consumer use of this information (Anastasiou et al., 2019; Chavasit et al., 2017). Policy makers should therefore be made aware of the need and legislative requirement for consumer education on nutrition labels (EC, 2011; US Food and Drug Administration, 1995). The findings also imply that nutrition label education should also now be provided to older adults following advice from (i.e. from health care professionals) to "read food labels" for dietary or health reasons.

Since findings of the current study show that levels of such understanding may be improved by nutrition label education, these imply that the absence of nutrition label "understanding" outcome measures from substantive food choice and healthy eating interventions should now be highlighted. Few studies have explored the role of label use, or understanding, in improving intervention participants' health outcomes. For example, neither nutrition label use nor understanding were assessed in participants who undertook a UK dietary intervention specifically promoting label use to manage sodium intakes and hypertension, which was not effective (Petersen et al., 2013). In contrast, among US Latinos with diabetes who received an individualised, long term intervention from health support workers which included nutrition label education, food label use was linked with better dietary quality and glycaemic control (Kollannoor-Samuel et al., 2016). Evaluation of participants' nutrition label understanding would have also helped explain, but can be seen to be missing from, the variable impact of interventions on intakes in which dietary modifications and nutrition label use were promoted, including with nutrition label education (Francis and Taylor, 2009; Garcia et al., 2017; Hermann et al., 2000; Ireland et al., 2010; Petersen et al., 2013; Rustad and Smith, 2013; Steenhuis et al., 2004). Furthermore, in a healthy eating intervention undertaken in the UK, the inclusion of an evaluation of participants' understanding of nutrition labels may have helped explain the disappointing impact of the intervention on participants' judgements of the nutrient "levels" of scones and crisp products at three month follow-up (Garcia et al., 2017).

The potential to improve older adults' understanding of specific elements of the current UK nutrition labels may also have overarching implications for the design, and potential success, of two recent UK public health campaigns. These both encourage consumers to use nutrition labels to enact dietary improvements. For example, the Change4Life campaign is aimed at promoting the adoption of healthier lifestyles by incorporating a reduction in intakes of sugar, saturated fat and salt. Campaign materials illustrate this with a video explaining the use of traffic light colour coding within voluntary UK front-of-pack nutrition labels (NHS Change4life, 2018b). In addition, the "400-600-600" Public Health England campaign encourages consumers to keep track of their calories by following a daily meal pattern comprising of these amounts of calories (Public Health England, 2018b). Using nutrition labels is suggested as one means to do this:

"Most shop-bought foods will display calorie (kcal) content on the nutrition label, under the 'Energy' heading. This is normally per 100 grams of the product, but often it also tells you how many calories are in the whole pack or product. But be aware that the manufacturer's idea of a portion may be slightly different from your own." (Public Health England, 2018b)

The present work suggests these campaigns may not yet provide sufficient explanations or education on the meaning of, or how to use, specific elements of nutrition information displayed (mandatory) within back and (voluntarily) on front-of-pack nutrition labels. Specifically, the Change4Life resources do not provide explanation of the meaning of "Reference Intakes (RI)" or associated values declared on front-of-pack traffic light labels. In addition, both campaigns do not indicate or explain the location of "per 100g" or "per serving" values declared on back-of-pack labels. As such, there may be limitations to how well consumers can locate (replay) the product's calorie content in-line with recommendations provided as part of the "400-600-600" campaign. The description of the development of the pilot nutrition label education intervention learning materials devised here may now be used to support the development of similar UK education initiatives.

The potential to improve older adults' understanding of "Reference Intakes" terminology, as suggested by this PhD thesis, also presents implications for the success of the currently proposed UK policy proposal to mandate the provision of calorie labelling on foods sold in the UK "out of home" sector. Such calorie labelling will also require the display of accompanying information concerning "Reference Intakes" (Department of Health and Social Care, 2018b). Findings from this PhD suggest that the real-life impact of this policy may also be reliant on how well consumers can understand their ("Reference Intake") calorie requirements given that these values and %RI information will indicate the significance of the number of calories provided by foods sold in out of home settings. Specifically, older adult consumers' may now require nutrition label education to possess adequate nutrition knowledge and understanding of the meaning of "Reference Intake" terminology and contextual values (i.e. %RI) which are important in interpreting the meaning of the absolute values of calories displayed on out-of-home food products (i.e. "550kcals"). Although consumer research is lacking in this specific area (Kasapila and Shaarani, 2016), further motivation for consumer education on the significance of calorie contents in relation to recommended intakes originates from the results of a recent survey conducted by Public Health England. These show low awareness among consumers of how many calories are required each day with many citing their intakes are much less than recommended (Public Health England, 2018a).

Finally, the insights into the development and effects of nutrition label education provided here may therefore inform current policy efforts to implement new nutrition labels, including European and global front-of-pack labelling schemes and their associated "education initiatives" (Kelly and Jewell, 2018; Thow et al., 2019). Policy makers should also be aware that, although ubiquitous in the UK, nutrition labelling is considered a high "agency" population public health policy which requires individuals to use their health literacy, motivation and knowledge to make decisions about what they eat given the information provided (Adams et al., 2016). In comparison to other public health strategies (i.e. folic acid fortification) labelling is considered to be of decreased effectiveness and furthermore, expected to widen health inequalities (Adams et al., 2016). The findings here make a case for nutrition label education and its potential role in reducing inequalities in health relating to age and other demographic attributes, via increasing consumers' nutrition label understanding. Similarly, reducing inequalities is thought possible by other educational policy, including education on fruit and vegetable consumption (Collins et al., 2018; Hyseni et al., 2017).

Conversely, these findings also imply that without nutrition label education, the imposition of mandatory nutrition labelling may not help to reduce health inequalities relating to population dietary intakes. For those consumers who do not use, or understand, nutrition labels, product reformulation to reduce calories, sugar and saturated fat may be key to improving the dietary health of the population (Mhurchu et al., 2017; Muth et al., 2019). Efforts to industrially reformulate foods, requiring the use of nutrition label information by manufacturers, therefore remain important key strands of the current UK public health policy (Public Health England, 2018a).

8.6 Nutrition information in supermarket websites

8.6.1 Use of online nutrition information by older adults

Findings from this PhD study reflect a potential generalised lack of older adult consumer engagement with product nutrition information available within online supermarkets (Chapter 5). New findings presented here also suggest that greater levels of personal involvement with and use of nutrition labels are also associated with frequent (self-reported) use of nutrition information in supermarket websites amongst these consumers. However, those other consumer characteristics usually associated with label use (i.e. nutrition knowledge, being female or previously advised to use food labels) do not appear to be related to frequency of use of this online information in older adults surveyed here. These findings of the current PhD now support the limited evidence examining actual (lack-of) consumer engagement with online nutrition information displayed in real-life supermarket websites (Benn et al., 2015).

Findings presented here (Chapter 5) also now help explain why this online information is not frequently viewed by (older adult) consumers. Specifically, use of this information may be considered unnecessary by consumers given the need to use automatic product search functions within supermarket websites, or else, hindered by the location and inconsistent presentation of the nutrition information provided online. Further to the discussion of the results presented in Chapter 5, these findings and their implications will now be discussed here in relation to the current literature, including recent evidence on consumer behaviours and food choices in online settings.

The lack of engagement with online product nutrition information found here among older adult online shoppers may now be considered in light of the "promise" of other evidence on the effects of online shopping on the healthiness of consumers' product purchases (Jilcott Pitts et al., 2018). A recent study involving a large European cohort of online shoppers has used real-life consumer purchase data to report a tendency for online shoppers to purchase less "vice" (unhealthy) products, compared to in-store (Huyghe et al., 2016). In addition, another recent survey of European consumers gave their most frequent reasons for online grocery shopping as "easier", "quicker" and "more information" (GSK, 2018). However, the current PhD work suggests these authors' findings may more likely be explained by shoppers' use of product list refinement strategies as well as efficient online search strategies, rather than their use of online product nutrition information.

The current findings showing a lack of engagement with online nutrition information may also help explain the results of a study conducted in a real-life online supermarket. This found that implementation of nutrition labels in certain product categories did not result in improvements to the healthiness of products purchased (Sacks et al., 2011). There may have also been a similar lack of engagement with online nutrition information as displayed within a real-life digital intervention with supermarket shoppers in a recent digital intervention. This intervention encouraged consumer use of traffic light labels and provided tailored nutrition feedback on the nutritional composition of product purchases but did not find any effect on food purchase behaviours (Harrington et al., 2019). Overall, there appears to be some real-world evidence supporting the view that there is potential for shopping online to encourage greater access to healthy food and increase consumers' healthy choices (Jilcott Pitts et al., 2018), yet the role that nutrition information plays in this process remains unclear and may, in fact, be limited.

Findings of the PhD specifically concerning the limited use, and sub-optimal presentation, of online nutrition information displayed in real-life supermarket websites may also now be compared to the findings of several studies which have evaluating the effects of providing such information on participants' food choices in experimental settings (i.e. experimental online "supermarkets"). These studies have shown participants paid attention to, and their food choices were influenced by, "nutrition information" (Billich et al., 2018; Epstein et al., 2016; Forwood et al., 2015). However, this information appeared to be provided relatively more prominently and consistently than that seen in UK real-life supermarket websites (Chapter 5; Stones, 2016). Specifically, these studies described their experimental websites as displaying product nutrition information, including warnings or symbols, in locations on or nearby the product images within the initial search page.

These studies, together with the current PhD work (see Chapter 5, section 5.6.3) and other research conducted with labels shown on computer screens (Bialkova and van Trijp, 2010; Graham and Jeffery, 2012), also imply the position and prominence of online nutrition information can influence consumer use of this information. Specifically, Bialkova and van Trijp (2010) reported that familiarity with, and consistency of, the location of front-of-pack nutrition labels were key determinants of consumer viewing of this information (i.e. when presented during computer-based experiments). The position of these nutrition labels within such mock supermarket shopping webpages was found to be important in terms of fixation time (Bialkova and van Trijp, 2010). Researchers have projected a "high impact on purchase choices", should consumers be exposed in real life to front-of-pack information presented and located as optimally as experimental evidence suggests (Bialkova and van Trijp, 2010; Graham and Jeffery, 2012). In combination with these studies and research highlighting presentational inconsistencies (Stones, 2016), this thesis therefore argues for improvements in the presentation and consistency of online nutrition information. Such presentational improvements may therefore enable better consumer use of this nutrition information during online grocery shopping and purchase evaluations.

In future, advances in online access and technology may reduce the need for consumers to engage with and process nutrition labels or online information. The use of Apps and smartphone tracking of products using bar code scanning as suggested by the UK Change4life and "400-600-600" campaigns may be helpful to consumers (NHS Change4Life, 2018b; Public Health England 2018b). As an alternative to requiring consumers to view labels, product nutrition information can now be automatically used to attain food preference goals with technology. An example of this is the "Spoon Guru" app (https://www.spoon.guru/). This technology uses product nutrition and food label information in combination with consumer "preferences" to list suitable products against a pre-defined criterion. An automatically generated list of suitable products is provided and could be considered similar to those strategies used by participants to find "healthy" products in the Think aloud online supermarket study undertaken here (Chapter 5). The effect of "using" nutrition labels in this manner on both product purchase and dietary outcomes is a future direction for research. However, there may also be issues surrounding consumers' digital literacy and online access which would therefore disadvantage specific consumer groups.

8.6.2 eHealth literacy and older adults: Considerations for online grocery shopping

The insight gained here from older adult online shoppers can also be considered alongside the research into the emerging field of eHealth literacy. In line with the concept of consumers' health literacy described earlier, the construct of eHealth literacy emphasises the role of information and communication technologies in health information. Specifically, eHealth literacy focusses on an individual's access to, understanding and use of, health information according to their level of health literacy (Soellner et al., 2014). Whilst eHealth literacy levels of Think aloud study participants were not specifically assessed in the current study, participants were intentionally sampled from experienced online shoppers. Even so, these participants reported challenges using supermarket websites and nutrition information to evaluate products. This insight may therefore support other research which highlights that, compared with younger adults, older adults aged 62 years or older may possess lower confidence (Paige et al., 2018) and capabilities, including trust (Miller and Bell, 2012; Wagner et al., 2014) when seeking information online.

The present work therefore provides insight into consumer groups which are under-represented in research, specifically among older adult online shoppers, or those with lower eHealth literacy (Stone and Faughnan, 2018). Furthermore, the current study implies that more can be done to improve the online shopping experience for older adults and to support their nutritional evaluations of products sold in supermarket websites. Indeed, recent research has been aimed at helping older adults to stay "in control" of their food shopping by recommending modifications to in-store supermarket environments which aim to improve dietary quality (Wills and Dickinson, 2018). With a similar ambition, emerging research also aims to further explore the use of supermarket websites by older adults (Osman and Hwang, 2016). In addition, development of a pilot online shopping platform specifically for older adults has recently been promisingly evaluated (Gorkovenko et al., 2017). Findings concerning older adults' use of supermarket websites and online nutrition information highlighted in this thesis may also now be used to help inform efforts to develop technology to support functional independence into older age (Mynatt and Rogers, 2001).

8.6.3 Implications for supermarket websites

The current findings imply that in its current form, the mandatory provision of online nutrition information (i.e. with supermarket websites) may not be effective at supporting consumers' use of this information in online purchases. Indeed, there may be a potential disadvantage for (older adult) online shoppers in terms of their use of online nutrition information to evaluate product healthiness within supermarket websites, compared to those shoppers using this information on labels in-store. This is of importance given the need for consumers to be "exposed" to nutrition information before they can use it effectively (Grunert and Wills, 2007). Equitable consumer access to information is also a recognised factor in empowering people to actively engage in their own health (Levin-Zamir and Bertschi, 2018). As such, the findings therefore provide specific implications for UK supermarkets to improve the display of both mandatory and voluntarily provided nutrition information for food products sold online. Increasing the prominence and consistency of online product nutrition information is now recommended by this research and others (Stones, 2016). Consistent, prominent provision of both mandatory and voluntarily provided nutrition information in supermarket websites could be achieved under current EU regulations governing the provision and format of this information via distance selling (Department of Health, 2016a; Motarjemi et al., 2001).

8.7 Overall limitations of the PhD project

8.7.1 Self-reported label use

The studies in this PhD were limited by available resource which meant that the collection of data replied on self-reported methods (i.e. survey) without access to directly observed use of labels by participants. Survey approaches and questionnaire self-report measures, as used in the PhD, are mainstay of the literature in this area (Campos et al., 2011). Findings throughout the thesis are therefore comparable with other research and review evidence, which are also based on mainly self-reported measures of label use (Campos et al., 2011). However, these are known to be likely to over report actual (observed) use of nutrition labels by approximately 50% (Grunert et al., 2010b). This may be because self-reported use of nutrition labels is considered to reflect participants' own motivations or "intentions" to eat healthier foods, rather than their actual previous use (Soederberg Miller et al., 2015). In addition, these measures of use of nutrition labels are likely to be influenced by the social desirability of consumers' responses indicating their frequency use nutrition labels (Drichoutis et al., 2005; Hieke and Taylor, 2012; Soederberg Miller et al., 2015). However, the present research did attempt to mitigate overreporting in the survey and intervention studies by differentiating different types of possible label "use". These include nutrition label (or online nutrition information) "reading" and "influence on purchase choices" (Chapter 4 and Chapter 5), including for online nutrition information (Chapter 5). Such usage aspects are featured in other validated research measures used in this area (Mackison et al., 2010).

The use of survey and questionnaire methods employed here also enabled collection of additional data on participant characteristics (Grunert and Wills, 2007). However, in future, objective assessment of participants' real-life use of nutrition labels (i.e. via in-store observation) would be the best possible outcome measure here (Grunert et al., 2010b). Although, participants consent to be observed shopping would be needed in advance which may also affect their label-related behaviours. Alternatively, participants' (self-reported) use of nutrition labels in purchase choices could be assessed by more immediate self-reported measures. For example, in-store intercept might ask consumers' "*did you look at nutrition labels today*?" directly following their product purchases. Furthermore, novel data collection methods enabling viewing of labels via mobile phone apps has also been recently reported in large scale research studies (Ni Mhurchu et al., 2018, 2017). However, this may be also subject to the additional constraints of being unrepresentative of on-pack label "use".

The present work also recognises the limitations of measuring self-reported frequency of use of online nutrition information, which may have reflected these respondents' frequency of use of this shopping channel (i.e. monthly, a few times a year). Although eye tracking data measures of viewing webpage information are an option for more experimental type studies, real-life online shoppers might be prompted to click "yes" or "no" in response to the post-shop pop-up question *"did you view any product's nutrition information whilst shopping today?".* In the current PhD, an addition qualitative approach was also employed here to explore the relatively new area of consumer use nutrition information in online supermarkets (Chapter 6).

8.7.2 Sample populations

This PhD project is also limited by the initial use of an undergraduate sample to support and inform the development of the online survey data collection tools. This provided an accessible study population with which to obtain practical insight into question types and online survey display which were then further refined by feedback from older participants. It also provided the calculated effect sizes for differences in levels of understanding of nutrition labels (quiz scores) which were also used here to inform the required sample size for the older adult survey (Chapter 3). It is acknowledged that such data collected from younger undergraduates, rather than older adults, may reflect a heightened estimate of "understanding" of nutrition labels and therefore lead to potential differences in sample size calculations. In addition, differences in quiz scores were obtained from an experimental study design, as reported in Chapter 3, based on between group differences and did not include a control group or any assessment of baseline understanding of labels. The latter would have been helpful in informing a survey sample size needed to evaluate levels of such understanding in older adults.

Study limitations also include the recruitment methods and sample characteristics for the older adult survey and pilot intervention studies (Chapter 4 and 7). For example, recruitment of older adults for the survey was undertaken online, rather than in-person (i.e. in-store). This was intended to simultaneously capture older adults who shopped online, to address the related research question. However, the survey sample is likely unrepresentative of the UK older adult population since it comprised of mostly "younger" older adults (aged 50-60yrs), those who had access to internet facilities (i.e. at work) and were mainly of University-level educational attainment and management/professional occupations. Whilst efforts were made by the researcher to recruit older adults from diverse backgrounds (by promoting the survey at Third sector organisations across Leeds), it is recognised that the results obtained for this sample may reflect a "best case" scenario of levels of understanding of UK nutrition labels.

Furthermore, limitations of the pilot educational intervention included recruitment which was unscreened and inclusive, from all attendees at the community centre. This meant that participants who were younger than 50 yrs were included. The differences in sociodemographic and age characteristics between the online survey sample and community-service-users who participated in the pilot intervention have been discussed in Chapter 7 (see section 7.5.4). For example, given that learning materials used in the session were based on the results of the earlier survey of older adults (i.e. all aged 50 yrs +), it is possible that the intervention was less effective for some participants (i.e. those not represented in the survey), compared to others.

Finally, the systematic review of interventions featuring nutrition label education (n=17) was not limited to studies which solely encompassed older adults. Indeed, these included (n=7) studies which were targeted at undergraduates, younger adults and children. Reflecting the paucity of literature in this area, insight from these particular interventions was encompassed alongside those targeted solely at older adults (n=3) since they included online delivery methods, specifically developed learning materials and validated assessment instruments. The review also aimed to be inclusive and collate features of effective interventions, particularly since the effects of interventions on label use and understanding were found to be positive across the different population types.

8.7.3 Assessment of understanding

The quantification of both subjective (self-rated) and objective understanding of the current UK nutrition labels is a strength of the work conducted in Chapters 3, 4 and 7 which now contributes to the evidence-base, particularly concerning older adults and these UK label formats. The work undertaken in Chapters 2 and 3 to develop quiz questions to specifically assess objective understanding also highlighted the need to develop data collection tools in this area. Tool development was based on a review of the existing research evaluating consumer understanding of other label formats. Whilst content and face validity were ascertained, the specific (quizzes) used to assess objective understanding in Chapter 4 and 7 were now require reliability assessments, including among older adult populations, as discussed earlier (Chapter 4). This work would contribute new tools to assess understanding of the current UK nutrition labels, building on one previously published by Mackinson et al (2010).

In addition, further exploring what consumers “think they understand” about nutrition labels would have also helped gain further insight into the differences found here between participant’s self-rated and objective understanding of this information. For example, results from survey respondents’ multiple-choice quiz answers provided insight into the most common incorrect answers, yet participants assumptions and “working out” on which these answers were based might have been explained further by using in-depth interviews. This type of qualitative research has also been called for by other researchers to provide insight into consumers’ actual and perceived understanding of this information (Grunert and Wills, 2007; Chalamon and Nabec, 2016).

8.7.4 Evaluating “advised” use of food labels

Since the measures used in the survey and intervention were reliant on self-reported information, no information on BMI or health conditions was collected. This limited the analysis of these characteristics and their associations with respondents’ use, or understanding, of nutrition labels. In addition, although participants were asked if themselves or a member of their family had been advised to read food labels, they were not further questioned on who “advised” them, or why. As such, throughout this thesis those participants categorised as being “advised” to use labels reflect a potentially heterogeneous group, who might comprise of people with diabetes, or those living with allergic family member. Collecting insight into the reasons for being “advised” to use labels would therefore have been a useful measure here. In addition, such detail would have helped disentangle the need and potential for nutrition label education in specific individuals. However, the findings of this PhD relating to variations in understanding and use of nutrition labels according to “advised” use of food labels are a novel addition to the literature which until now appears to have classified older adults on health conditions only (Post et al., 2010 An, 2016; Macon et al., 2004).

8.7.5 A need for insight into the effect of label understanding on actual behaviours

It is acknowledged that the potential for the pilot intervention reported here to impact on participants’ actual use of nutrition labels is limited, given the focus on improving understanding of this information. For example, the pilot intervention lasted one hour and therefore presented limited opportunities for the incorporation of additional behavioural change principles or techniques. These are considered necessary for behavioural change and isolated improvements in knowledge are widely accepted to be insufficient to promote sustained changes and an unreliable indicator of behaviour change (Contento et al., 2002; Rustad and Smith, 2013; Worsley, 2002). Simply demonstrating group improvements in understanding and self-reported use of nutrition labels is therefore unlikely to translate into sustained actual daily use of this information in participants' real lives.

However, other related research supports the idea that a "deep understanding of material", which includes recommended daily intake levels, can be used to shrink the "gap between knowledge and action" (Wohldmann, 2013). For example, individual participant education on how much of their recommended intake levels were met by their (recorded) dietary intakes, including which foods contributed the most to these amounts, which appeared to positively affect their behaviours in one study (Wohldmann, 2013). Similarly, it is possible that improving participants' awareness of "daily allowances" and understanding of nutrition label information will also improve label use and food choices. Positive evaluations of the effect of nutrition label education on health outcomes, including dietary intakes, have also been found in the previously reviewed larger study with participants with diabetes (Kollannoor-Samuel et al., 2016) (Chapter 6). Overall, the findings here suggest there is future potential to evaluate the developed nutrition label education intervention as a component as part of a wider multi-component intervention assessing appropriate behavioural change indicators at follow up time points.

Throughout this thesis the evaluated self-reported frequency of label reading and use of this information in purchases is not considered to reflect the potential impact of this information on consumers' dietary or food choices. This work does however, form a basis on which to further evaluate the impact of mandatory UK nutrition labels and evidence-based nutrition label education on participants' dietary intakes. Future investigation into consumer's actual use of nutrition labels, their levels of understanding, and the effect on both their purchase choices and their dietary intakes would help definitively explore the impact of nutrition label education and information use on these outcomes. Such work would add to the vast literature in this area which mostly reports on the effect of implementation of labels (i.e. without education) on consumer behaviours.

8.7.6 Timing

Another possible limitation is the timing of this research which was undertaken at a variety of time points between 2015 and 2018. It is acknowledged that some of the studies undertaken here were conducted with the 2014 - 2016 transition period for the implementation of the new nutrition labels on products (EC, 2011). It is therefore technically possible that not all products displayed the current UK nutrition labels during this time and as such consumer (un)familiarity with the information may partly explain the findings of the 2015 survey. However, the transition rules required that all existing products which were already declaring nutrition labels were required to update their food labels to comply with the EU Regulation 1169/2011 by December 13th 2014. Based on the researcher’s own knowledge, it was also known that many UK retailers complied with this requirement for their own products from 2013. Other research has also confirmed that all major UK supermarket websites also displayed mandatory product nutrition information at the time this study was conducted (Stones, 2016). It is therefore likely that the vast majority of pre-packed food and drink products which were viewed and purchased by consumers during the course of this PhD project will have declared the new nutrition labels compliant with the EU Regulation 1169/2011. Indeed, difficulties in understanding nutrition label data and terminology were still identified among pre-intervention participants of the 2018 pilot intervention study (Chapter 7).

8.8 Further research

This work can now be used as a basis on which to further evaluate the effect of nutrition label education on consumer use and understanding of nutrition labels. The materials developed here may be adapted to allow further, larger scale, research into the effect on nutrition label understanding and use among consumers. Qualitative, in-depth and individualised insight from intervention participants would also benefit the future development of these pilot educational materials and wider consumer communication recommendations in this area (Eyles et al., 2009).

Exploring exactly how participants improved or changed their use of nutrition labels and the reasons for these, is another area which may now be explored. This would help to shed light on the effect of the educational intervention at follow-up in participants’ real-lives. For example, did participants utilise their improved label understanding during their purchase evaluations in-store, or at home when selecting which foods and amounts to consume? Data collection using interviews could take place across a follow-up period whereby these consumers could first implement their knowledge and improved understanding of nutrition labels as gained from the intervention. This insight would further help to refine the intervention to increase its efficacy to support participants' practical use of this information in real-life. Furthermore, it may be of future interest to explore how well consumers use nutrition labels to satisfactorily attain their personal nutrition and food consumption goals (Chalamon and Nabec, 2016), with and without nutrition label education.

Health and nutrition literacy have emerged as key characteristics which may impact on nutrition label use and understanding. Evaluation of intervention participants' levels of health literacy would now enable investigation into the equity of the intervention across consumers with adequate/inadequate levels of this characteristic. This would also build on prior research which suggests that participants' levels of literacy or health literacy may be a factor in explaining disparities in the effect of education on learning or health outcomes (Gibbs and Chapman-Novakofski, 2012; Jay et al., 2009; Schillinger et al., 2006). Tailored nutrition label education which is designed for particular health and nutrition literacy levels, or includes "prior screening" in order to identify adults who "would benefit most", could then also be developed and evaluated (Begley et al., 2019; Gibbs and Chapman-Novakofski, 2012). Indeed, review evidence suggests that more general educational interventions specifically designed for those with low health literacy show promising effects to "mitigate the effects of low health literacy" on health outcomes (Sheridan et al., 2011).

There is now a need to evaluate the effects of nutrition label education on a larger scale. This could include additional written materials provided to participants besides the video developed here, which permits wider dissemination of this educational intervention. However, this thesis first noted little apparent development of UK education materials or resources designed to promote consumer understanding of the current UK nutrition labels (Chapter 3). In contrast, US consumer education and resources on Nutrition Facts Panels aimed at consumers and health care professionals can be easily accessed via US Government websites. These have recently included specific resources for older adults (US Food and Drug Administration (FDA), 2018), as well as multiple resources which focus on the newly modified Nutrition Facts Panels (available at https://www.fda.gov/food/food-labeling-nutrition/changes-nutrition-facts-label).

Promisingly, some recently issued resources for UK consumers and health care professionals can now be seen to include an explanatory fact sheet developed by the British Nutrition Foundation (British Nutrition Foundation, 2019). In addition, the researcher has also been responsible for the development of a new "Food Labelling: Nutrition Information" fact sheet explaining the current UK nutrition labels in collaboration with the British Dietetic Association (British Dietetic Association, 2018) (available at: https://www.bda.uk.com/foodfacts/food_labelling). Future, larger scale evaluation of the effects of these written materials is now recommended. Such research recommendations are supported by a noted lack of evidence on the extent to which written materials, including pocket information cards, may help support consumer understanding of nutrition labels (Brunt and Schafer, 1997; Jay et al., 2009).

In future, the video developed here, as well as the subsequently developed fact sheet, could now be used remotely or in online settings to test the effect of this amongst consumers, including those shopping online. This work might also provide further insight into the optimal delivery format of nutrition label education. There are also known advantages to costs of delivery and dissemination of online nutrition education, compared to traditional methods in the area of behaviour change (Vandelanotte et al., 2016; Wantland et al., 2004). Within the online setting, consumer use, or viewing of web-based nutrition information could also be examined pre and post-intervention. Furthermore, the effect on online purchases may also be evaluated. A link with online dietary assessment software may also further enable evaluation of the impact of this education on food consumption. This future work would build on existing digital or smartphone intervention evaluations of consumer use of nutrition information which have not yet assessed the effects of education on use, or improvements in understanding, of nutrition labels (Benn et al., 2015; Forwood et al., 2015; Harrington et al., 2019; Mhurchu et al., 2017; Ni Mhurchu et al., 2018; Sacks et al., 2011).

Further development and evaluation of nutrition label education can now be undertaken to specifically compliment advice provided by healthcare professionals in primary health care settings (Koen et al., 2016). For example, such education may be delivered as part of the advice provided to patients to help them manage specific health conditions with lifestyle changes and when patients may be advised to use nutrition label information to help improve their diets (An, 2016). If employed in health care settings, the nutrition label education described here can be used as a “component” of existing, broader “healthy eating” interventions. These may also include evaluation on the corresponding outcomes relating to label understanding, nutrition knowledge and dietary intakes. Indeed, much of the work undertaken on digital technologies to improve healthy eating practices has not yet reported the incorporation of nutrition label education or outcome measures of use and understanding of this information (Chen et al., 2017a, 2017b; Fakih El Khoury et al., 2019). From a practice perspective, such work may also respond to the need to provide client-centred and evidence-based resources and materials for practitioners to use for this specific nutrition education purpose (MacLellan et al., 2011). The provision of these educational resources may also consider the alternative costs and need to train healthcare professionals and medical practitioners in this area. Readily available (e.g. online) nutrition education materials could therefore provide an accessible means of supporting those older adults who might benefit most from improved understanding and use of nutrition labels (Rollo et al., 2018).

Finally, evaluation of label use and understanding of dietary intakes can now be examined in older adults. The existing evidence on the impact of nutrition labels on consumers’ dietary intakes does not yet account for levels of objective understanding as a potential “mediator” between label use and dietary intakes. However, there is further reason to believe that older adults’ dietary intakes may be favourably impacted by increased label use (and understanding) given that the available evidence suggests a positive association between nutrition label use (and nutrition knowledge) and dietary quality in younger adults (Christoph et al., 2018; Christoph and An, 2018; Cooke and Papadaki, 2014; Graham and Laska, 2012). Furthermore, frequent use of US Nutrition Facts Panels has been recently associated with reduced risk of diabetes and improved dietary quality among Latinos with Type 2 diabetes (Kollannoor-Samuel et al., 2017a, 2017b).

The synergies between health literacy, nutrition knowledge and nutrition label understanding now warrant further exploration in relation to older adults’ dietary intakes. From a theoretical perspective, such evaluations would also provide insight into the proposed relationships between these characteristics (Malloy-Weir and Cooper, 2016), as well as the effects of nutrition label education. The overall need to optimise the impact of nutrition labelling on health warrants innovative future research encompassing label education and consumers' understanding of this information.

8.9 Conclusion

This PhD provides the first insight into UK older adults' use and understanding of the current UK nutrition labels, which have been displayed on food products since 2014. New evidence contributed by this PhD has identified that levels of nutrition knowledge and personal involvement with nutrition labels, as well as self-rated label understanding, are promoters of frequent use of nutrition labels among these adults. Furthermore, some difficulties are highlighted with these adults' understanding of the meaning of specific nutrition label elements, including "Reference Intakes" terminology and values designed to help consumers use nutrition label information within the context of their daily diet. A lack of association between levels of objective understanding of current UK nutrition labels and their reported use in purchases has also been highlighted here, including among older adults who report being previously advised to look at nutrition labels for diet or health reasons. Other work undertaken here has also found a lack of engagement among older adults with nutrition information now displayed mandatorily in online supermarkets. Complimenting existing limited literature on this area, specific explanations for this finding include the need for consumers use to supermarket website product search functions and the potentially sub-optimal presentation of online nutrition information.

Despite the calls for nutrition label education to increase the impact of nutrition labels on consumers' health, this work is the first known evaluation of the effect of UK nutrition label education on participants' objective understanding of this information. The newly developed educational intervention concerning the current UK nutrition labels appeared to potentially increase participants' understanding of these labels and their elements. The effects of the intervention on reducing disparities according to levels educational attainment or whether participants had previously been "advised" to use nutrition labels also require further research to confirm. Implications include the need for nutrition label education to accompany and promote optimal use of the newly mandatory UK nutrition labels in purchases and dietary decisions by older adult consumers, via improvements in their understanding of this information. This insight may also now be used to inform future public health policy and food labelling legislation, which aims to optimise consumer use of nutrition labels. Future research evaluating the impact of UK nutrition label education, at scale, on older adults' use of labels and dietary intakes is now warranted.

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Appendix A Pre-course questionnaire (VLE)

Q1 What is your age (in years)?	
Q2. What gender are you?	□ Female □ Male
Q3. What type of residence do you live in?	□ Own accommodation □ Parent's home □ University/rented accommodation (catered for on campus) □ University/rented accommodation (self catering)
Q4. Do you have or share responsibility for buying food for yourself?	□Yes □No
Q5. Do you or a member of your household have a medical condition that is to be taken into consideration when shopping for food?	□Yes □No
Q6. Have you ever visited a dietitian or another nutrition professional?	□Yes □No
Q7. Have you ever studied nutrition?	□Yes □No
Q8. How interested are you in nutrition?	□ Very interested □ Interested □ Neither interested nor uninterested □ Uninterested □ Very uninterested
Q9 How would you rate your nutrition knowledge?	□ Very knowledgeable □ Knowledgeable □ Neither knowledgeable nor unknowledgeable □ Unknowledgeable □ Very unknowledgeable
Q10. Thinking about the last 6 months, how frequently do you READ nutrition information on food labels?	□ Always □ Often □ Sometimes □ Rarely □ Never
Q11. Where do you look at nutrition information on food labels?	□ Both at home and in the shop □ At home □ In the supermarket □ Elsewhere □ I don't look at this information

Q12. Do you think nutrition information on food labels is	□ Very important □ Important □ Neither important nor unimportant □ Not important □ Don't know
Q13. How frequently do you USE nutrition information on food labels when buying food?	□ Always □ Often □ Sometimes □ Rarely □ Never

Q14. How often do you use nutrition information for the following reasons?

		Never	Rarely	Sometimes	Often	Always
a	To figure out how much food you should eat	□	□	□	□	□
b	To see if the advertising on packaging is true	□	□	□	□	□
c	To compare similar type of food with each other (e.g. choosing between ready meals)	□	□	□	□	□
d	To compare different types of food with each other (e.g. cookies vs. ice cream)	□	□	□	□	□
e	To see if a food has a low or high amount of the nutrient you may want more of, like calcium	□	□	□	□	□
f	To see if a food has a low or high amount of the nutrient you may want less of, like fat or salt.	□	□	□	□	□

Q15. Please state your reasons for rarely or never consulting nutrition label information. Select all that apply. (If this question does not apply to you, please select "Not applicable")

I usually buy the same product so I am familiar with the nutrition information	□
It takes too long to read	□
It is hard to see to read	□
The information is not always presented in the same way from one product to another	□
I really don't know what to do with the information	□
It is hard to understand	□
I prefer getting nutrition information from other sources besides labels	□
I am just not interested	□

It is not always on the products I need	▫
Other	▫
Not applicable	▫

Q16. When looking at nutrition labels, who often to you look at the following components?					
	Never	Rarely	Sometimes	Often	Always
Per 100g	▫	▫	▫	▫	▫
Per serving	▫	▫	▫	▫	▫
Serving size	▫	▫	▫	▫	▫
Energy	▫	▫	▫	▫	▫
Kcals	▫	▫	▫	▫	▫
KJ	▫	▫	▫	▫	▫
Fat	▫	▫	▫	▫	▫
Of which saturates	▫	▫	▫	▫	▫
Carbohydrate	▫	▫	▫	▫	▫
Of which sugars	▫	▫	▫	▫	▫
Fibre	▫	▫	▫	▫	▫
Protein	▫	▫	▫	▫	▫
Salt	▫	▫	▫	▫	▫
Reference Intake of an average adult (RI)	▫	▫	▫	▫	▫
%RI	▫	▫	▫	▫	▫

Q17. Think about the amount of nutrition information on food labels do you think there is:	▫ Not nearly enough information ▫ Not enough information ▫ Enough information ▫ Too much information ▫ Far too much information
Q18. Do you think nutrition information on food labels is	▫ Very easy to understand ▫ Quite easy to understand ▫ Neither easy nor difficult to understand ▫ Quite difficult to understand ▫ Very difficult to understand

Q19. How would you rate your overall levels of confidence in understanding nutrition labels?	Very unconfident	Unconfident	Neither confident nor unconfident	Confident	Very confident
	▫	▫	▫	▫	▫

Q20. Please rate your understanding of the following terms found on the nutrition label							
	Do not understand						Understand completely
Energy	▫	▫	▫	▫	▫	▫	▫
KJ	▫	▫	▫	▫	▫	▫	▫
Fat	▫	▫	▫	▫	▫	▫	▫
Of which saturates	▫	▫	▫	▫	▫	▫	▫
Carbohydrate	▫	▫	▫	▫	▫	▫	▫
Of which sugars	▫	▫	▫	▫	▫	▫	▫
Fibre	▫	▫	▫	▫	▫	▫	▫
Protein	▫	▫	▫	▫	▫	▫	▫
Salt	▫	▫	▫	▫	▫	▫	▫
Reference Intake of an average adult (RI)	▫	▫	▫	▫	▫	▫	▫

Q21. How often do nutrition labels affect your purchase choices?	Never	Rarely	Sometimes	Often	Always
	▫	▫	▫	▫	▫

THE END

Appendix B Post-course questionnaire (VLE)

Post-course questionnaire

Q1. Following the course, please rate your understanding of the following terms found on the nutrition label

	Do not understand						Understand completely
Energy	□	□	□	□	□	□	□
KJ	□	□	□	□	□	□	□
Fat	□	□	□	□	□	□	□
Of which saturates	□	□	□	□	□	□	□
Carbohydrate	□	□	□	□	□	□	□
Of which sugars	□	□	□	□	□	□	□
Fibre	□	□	□	□	□	□	□
Protein	□	□	□	□	□	□	□
Salt	□	□	□	□	□	□	□
Reference Intake of an average adult (RI)	□	□	□	□	□	□	□

	Very unconfident	Unconfident	Neither confident nor unconfident	Confident	Very confident
Q2. Following the course, how would you rate your overall confidence in your understanding of nutrition labels?	□	□	□	□	□

Q3. Following the course, do you now think nutrition information on food labels is	□ Very easy to understand □ Quite easy to understand □ Neither easy nor difficult to understand □ Quite difficult to understand □ Very difficult to understand

Q4. When looking at nutrition labels, who often will you now look at the following components?

	Never	Rarely	Sometimes	Often	Always
Per 100g	□	□	□	□	□
Per serving	□	□	□	□	□
Serving size	□	□	□	□	□
Energy	□	□	□	□	□
Kcals	□	□	□	□	□
KJ	□	□	□	□	□
Fat	□	□	□	□	□
Of which saturates	□	□	□	□	□
Carbohydrate	□	□	□	□	□
Of which sugars	□	□	□	□	□
Fibre	□	□	□	□	□
Protein	□	□	□	□	□
Salt	□	□	□	□	□
Reference Intake of an average adult (RI)	□	□	□	□	□
%RI	□	□	□	□	□

Q5. Following the course, how frequently do you think you will now READ nutrition information on food labels?	□ Always □ Often □ Sometimes □ Rarely □Never
Q6. In future, where do you think you will look at nutrition information on food labels?	□ Both at home and in the shop □ At home □ in the supermarket □ Elsewhere □I don't look at this information
Q7. Following the course, do you think nutrition information on food labels is:	□ Very important □Important □ neither important nor unimportant □ Not important □ Don't know

Q8. Following the course, how frequently do you will USE nutrition information on food labels when buying food?	□ Always □Often □ Sometimes □ Rarely □Never

Q9. Following the course, how often will you use nutrition information for the following reasons?

		Never	Rarely	Sometimes	Often	Always
a	To figure out how much food you should eat	□	□	□	□	□
b	To see if the advertising on packaging is true	□	□	□	□	□
c	To compare similar type of food with each other (e.g. choosing between ready meals)	□	□	□	□	□
d	To compare different types of food with each other (e.g. cookies vs. ice cream)	□	□	□	□	□
e	To see if a food has a low or high amount of the nutrient you may want more of, like calcium	□	□	□	□	□
f	To see if a food has a low or high amount of the nutrient you may want less of, like fat or salt.	□	□	□	□	□

Q10. Thinking about the amount of nutrition information on food labels following the course, do you think there is:	□ Not nearly enough information □ Not enough information □ Enough information □ Too much information □ Far too much information

	Never	Rarely	Sometimes	Often	Always
Q11. Following the course, how often do you think that nutrition labels will affect your purchase choices?	□	□	□	□	□

Q13. If you have any comments on your undertaking of the Moodle course, or your experiences at part of this study, please write these here:

THE END

Appendix C Post-course quiz (VLE)

Q1. Using the information this food label, how much salt is there is a serving of this product?

Nutrition

Typical values	per 100g	per quiche (170g)
Energy	1184kJ/284kcal	2013kJ/483kcal
Fat	18.8g	32g
of which saturates	5.9g	10g
Carbohydrate	19.2g	32.6g
of which sugars	1.6g	2.7g
Fibre	0.9g	1.5g
Protein	9.1g	15.5g
Salt	0.3g	0.5g

	per quiche (170g) %RI	your RI*
Energy	24%	8400kJ/2000kcal
Fat	46%	70g
Saturates	50%	20g
Sugars	3%	90g
Salt	8%	6g

*Reference intake of an average adult (8400kJ/2000kcal) (RI).

□ 1.25g
□ 0.5g
□ 0.3g
□ 6g
□ 8%

Q2. Looking at the information on the label below, what serving size is nutrition information given for?

Nutrition

Typical values	per 100g	per pack	%RI	your RI*
Energy	982kJ 234kcal	1886kJ 449kcal	23%	8400kJ/ 2000kcal
Fat	8.5g	16.3g	23%	70g
of which –saturates	5.1g	9.8g	49%	20g
Carbohydrate	24.7g	47.4g		
of which –sugars	3.9g	7.5g	8%	90g
Fibre	2.3g	4.4g		
Protein	13.5g	25.9g		
Salt	1.2g	2.3g	38%	6g

*Reference intake of an average adult (8400kJ/2000kcal) (RI).

□ The amount you would realistically eat
□ Per 100g
□ Per pack
□ Half a pack (per pack divisible by two)
□ Per half sandwich

Q3. Reference Intakes (RI) are stated on nutrition labels. What does this term mean?

Please select one.

□ Amount for the food you should eat

□Percentages of nutrients in reference products

□ Nutrients for reference (i.e. fat, saturates, salt, sugars) contained within a serving of the product

□ Daily "guideline" amounts of nutrients (i.e. energy, fat. Saturates, sugars, salt) which are recommended for a healthy diet

□ Specific "reference intakes" which are relevant for that particular type of food

Q4. Using the nutrition labels below for two products, which product contain the greatest percentage fat (i.e. per 100g)?

Mini savoury eggs (pack size 216g)

Each mini savoury egg contains

ENERGY	MED	MED	LOW	MED
211kJ	Fat	Saturates	Sugars	Salt
50kcal	2.8g	0.7g	0.4g	0.2g
3%	4%	4%	1%	3%

of your reference intake

Typical energy values per 100g: 1179kJ/282kcal

Nutritional Values

Typical values	Per 100g	Per mini savoury egg
Energy	1179kJ	211kJ
	282kcal	50kcal
Fat	15.8g	2.8g
of which saturates	4.1g	0.7g
Carbohydrate	24.5g	4.4g
of which sugars	2.3g	0.4g
Fibre	2.1g	0.4g
Protein	9.5g	1.7g
Salt	0.9g	0.2g

Mini Sausage Rolls (pack size 300g)

Each mini sausage roll contains

ENERGY	HIGH	HIGH	LOW	MED
146kJ	Fat	Saturates	Sugars	Salt
35kcal	2.1g	0.9g	0.2g	0.1g
2%	3%	5%	1%	2%

of your reference intake

Typical energy values per 100g: 1460kJ/350kcal

Nutritional Values

Typical values	(as sold) Per 100g	(as sold) Per mini sausage roll
Energy	1460kJ	146kJ
	350kcal	35kcal
Fat	21.1g	2.1g
of which saturates	8.8g	0.9g
Carbohydrate	30.2g	3.0g
of which sugars	1.7g	0.2g
Fibre	2.5g	0.3g
Protein	8.8g	0.9g
Salt	1.0g	0.1g

Box Contents
30 Rolls.

□ Mini sausage rolls

□ Savoury eggs

□ Difficult to say

□ Fat is the same in each

Q5. How much sugar is found in a serving of this product?

Nutrition

Typical values	per 100g	per pack		your RI*
Energy	982kJ	1886kJ	%RI	8400kJ/
	234kcal	449kcal	23%	2000kcal
Fat	8.5g	16.3g	23%	70g
of which				
–saturates	5.1g	9.8g	49%	20g
Carbohydrate	24.7g	47.4g		
of which				
–sugars	3.9g	7.5g	8%	90g
Fibre	2.3g	4.4g		
Protein	13.5g	25.9g		
Salt	1.2g	2.3g	38%	6g

*Reference intake of an average adult (8400kJ/2000kcal) (RI).

□ 7.5g

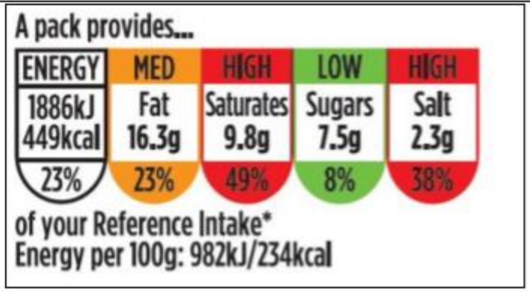
□ 90g

□ 3.9g

□ 39.9g

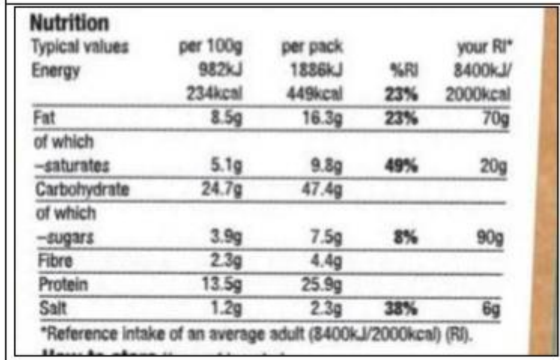
□ 8%

Q6. Using the information on this front of pack nutrition label, which nutrients are present at "low" levels?



- ▫ Energy (calories and KJ) only
- ▫ Energy and sugars
- ▫ Energy and fat
- ▫ Fat and Sugars
- ▫ Sugars only

Q7. Using the information on the label below, what is the percentage (%) contribution to your reference intake for saturates?



Nutrition

Typical values	per 100g	per pack	%RI	your RI*
Energy	982kJ 234kcal	1886kJ 449kcal	23%	8400kJ/ 2000kcal
Fat	8.5g	16.3g	23%	70g
of which -saturates	5.1g	9.8g	49%	20g
Carbohydrate	24.7g	47.4g		
of which -sugars	3.9g	7.5g	8%	90g
Fibre	2.3g	4.4g		
Protein	13.5g	25.9g		
Salt	1.2g	2.3g	38%	6g

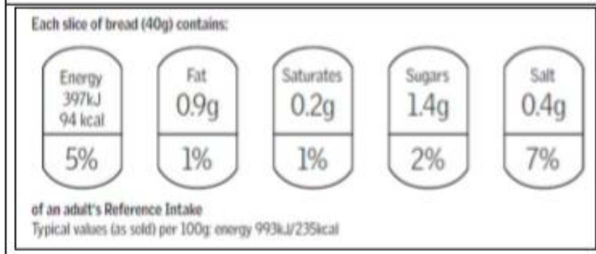
*Reference intake of an average adult (8400kJ/2000kcal) (RI).

- ▫ 5.1g
- ▫ 9.8%
- ▫ 9.8g
- ▫ 49%
- ▫ 20g

Q8. True or False? You should aim to get 100% of the reference intake (RI) for fat, saturates, sugars and salt?

- ▫ True
- ▫ False

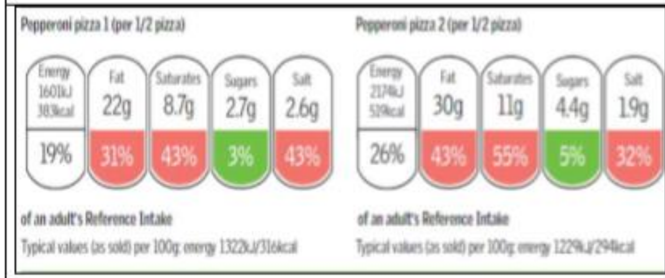
Q9. How much energy does a serving of this product provide?



- ▫ 235 kcal
- ▫ 993 KJ
- ▫ 47 kcal
- ▫ 94 kcal
- ▫ 100 KJ

Q10. Nutrition labels from two pizzas are shown below.

Which product is healthier?



- ▫ There's no difference between these products
- ▫ The one on the right
- ▫ The one on the left
- ▫ Difficult to say

Q11. If you ate two servings of this product what percentage of your reference intake for SALT would you consume?

Nutritional Values

Typical values	Per 100g	Per 1/2 tub
Energy	296kJ	222kJ
	70kcal	53kcal
Fat	1.6g	1.2g
of which saturates	1.0g	0.8g
Carbohydrate	5.1g	3.8g
of which sugars	2.8g	2.1g
Fibre	0.2g	0.2g
Protein	8.8g	6.6g
Salt	0.6g	0.4g

Country of Origin
United Kingdom

Features
No artificial colours, flavours or hydrogenated fat. Suitable for vegetarians.

Other information
Each 1/2 tub serving contains Energy 222kJ 53kcal 3%, Low Fat 1.2g 2%, Low Saturates 0.8g 4%, Low Sugars 2.1g 2%, Med Salt 0.4g 7% of your reference intake Typical energy values per 100g: 296kJ/70kcal As a guide, we recommend this product provides: 2 servings

□ 7%

□ 14%

□ 0.8g

□ 0.4g

□ 6%

THE END

Appendix D Online survey

Information for participants

Study information: Use of food information and food choices.

This survey is about food choices and use of information. It is for adults aged 50 years old or over.

It will take appropriately 20 minutes to complete. It involves answering several questions about yourself and your use of food information. Your participation is entirely voluntary you are not required to respond and can chose not to take part. There is considered to be no risk of discomfort in participating.

The questions are intended to gather insights on your perceptions of food labels, your food choices and your use of this information.

Part A asks about your background

Part B is a short quiz designed to see how you use this information

You will not be asked for your email address or any identification information. Following closure of the survey, your anonymous responses will be retained for period of 5 years. Responses will be analysed and used in research looking at how adults use information on foods. These results may be shared with others, including in published reports.

If you have any further questions regarding your participation, please contact the study researcher at s.moore@leedstrinity.ac.uk. Or Sally Moore, Department of Sport Health and Nutrition, Leeds Trinity University, Brownberrie Lane, Horsforth, Leeds, UK, LS18 5HD.

Thank you for your interest and time taking part in this survey.

Your consent: Have you read the study information and agree to take part?	Yes ☐	No☐

This study is interested in the views of people ages 50 years old and over. Are you aged 50 year old or older?	Yes ☐	No☐
	Directed to Part A	Thank you for your interest in this survey, which is for those aged 50 years old or older. END

Part A:

Q1	Do you have or share responsibility for buying food for yourself or others?	Yes ☐	No☐
Q2	Do you or a member of your household have a personal diet or a medical condition where looking at food label information is advised?	Yes ☐	No ☐

Nutrition Information on Food Labels

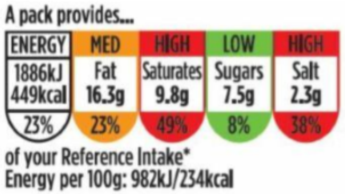
The following questions are about the nutrition information displayed on food labels.

Nutrition information on food labels often looks similar to the information below.

Nutrition		
Typical values	per 100g	per quiche (170g)
Energy	1184kJ/284kcal	2013kJ/483kcal
Fat	18.8g	32g
of which saturates	5.9g	10g
Carbohydrate	19.2g	32.6g
of which sugars	1.6g	2.7g
Fibre	0.9g	1.5g
Protein	9.1g	15.5g
Salt	0.3g	0.5g
	per quiche (170g) %RI	your RI*
Energy	24%	8400kJ/2000kcal
Fat	46%	70g
Saturates	50%	20g
Sugars	3%	90g
Salt	8%	6g

*Reference intake of an average adult (8400kJ/2000kcal) (RI).

Nutrition information may also appear on the front of products, and look like this:



Q3. Nutrition labels on product packaging (i.e. in store)

For each question below please tick one answer.

		Never	Rarely	Sometimes	Often	Always
i	How often do you READ nutrition information on food labels when buying a food product for the first time?	☐	☐	☐	☐	☐
ii	In general, how often do you READ nutrition information on food labels?	☐	☐	☐	☐	☐
iii	How often does the nutrition information affect your PURCHASE choices?	☐	☐	☐	☐	☐

Q4. Please indicate how often you use nutrition labels for each of the following reasons

		Never	Rarely	Sometimes	Often	Always
a	To figure out how much food you should eat	☐	☐	☐	☐	☐
b	To see if the advertising on packaging is true	☐	☐	☐	☐	☐
c	To compare similar type of food with each other (e.g. choosing between ready meals)	☐	☐	☐	☐	☐
d	To compare different types of food with each other (e.g. cookies vs. ice cream)	☐	☐	☐	☐	☐
e	To see if a food has a low or high amount of the nutrient you may want more of, like calcium	☐	☐	☐	☐	☐
f	To see if a food has a low or high amount of the nutrient you may want less of, like fat or salt.	☐	☐	☐	☐	☐

Q5. When you do not use nutrition labels why is this? Please select the reason(s) for this from the list below. Select all that apply to you.

I usually buy the same product so I am familiar with the nutrition information	☐
It takes too long to read	☐
It is hard to see to read	☐
The information is not always presented in the same way from one product to another	☐
I really don't know what to do with the information	☐
It is hard to understand	☐
I prefer getting nutrition information from other sources besides labels	☐
I am just not interested	☐
It is not always on the products I need	☐

Q6. How confident are you in your understanding of nutrition label information?	Not at all confident	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	I'm very confident

Q7. Please rate yourself from 1 to 7 for each of characteristics below with the following statement in mind: ***To me, nutrition information on food labels is:***

	1	2	3	4	5	6	7	
Unimportant	☐	☐	☐	☐	☐	☐	☐	Important
Boring	☐	☐	☐	☐	☐	☐	☐	Interesting
Irrelevant	☐	☐	☐	☐	☐	☐	☐	Relevant
Unexciting	☐	☐	☐	☐	☐	☐	☐	Exciting
Means nothing to me	☐	☐	☐	☐	☐	☐	☐	Means a lot to me
Unappealing	☐	☐	☐	☐	☐	☐	☐	Appealing
Mundane	☐	☐	☐	☐	☐	☐	☐	Fascinating
Worthless	☐	☐	☐	☐	☐	☐	☐	Valuable
Uninvolving	☐	☐	☐	☐	☐	☐	☐	Involving
Not needed	☐	☐	☐	☐	☐	☐	☐	Needed

Technology and You

Q8. Do you have internet at home?	☐ Yes ☐ No
Q9. How often do you access the internet?	☐ Daily ☐ 2-6 times a week ☐ Less than once a week ☐ Less than once a month

Q10. Using the scale, please indicate how confident you feel in general about using technology

Not confident at all	1	2	3	4	5	6	7	Extremely confident
	☐	☐	☐	☐	☐		☐	

Q11. How would you rate your ability to use the internet?	☐ Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Poor
Q12. How often do you shop for food online using a supermarket website?	☐ At least once a week ☐ Monthly ☐ A few times a year ☐ Never ☐ Never, but I plan to in the next 12 months

Q13. Using nutrition information when shopping for food online

For each question below please tick one answer.

i	In general, how frequently do you READ nutrition information when shopping for food online?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Always ☐
ii	How often does the nutrition information affect your PURCHASE choices when you are shopping for food ONLINE?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Always ☐

About You

Q14. How old are you?	Please state your age in years ____________
Q15. What is your gender?	Female □ Male □
Q16. What is your ethnicity?	□ White/White British □ White other □ Black/Black British (e.g. African, Caribbean) □ Asian/Asian British (e.g. Pakistani, Chinese) □ Mixed ethnic groups (e.g. White and Black Caribbean) □ Other
Q17. Which of the following describes your current or pre-retirement occupation? (Please select one)	□ Unable to work/Long term unemployed □ Managerial and professional Occupations –e.g. teacher, nurse, physiotherapist, finance manager, accountant, solicitor, civil/mechanical engineer, chief executive □ Intermediate Occupations –e.g. secretary, personal assistant, clerical worker, call centre agent, nursery nurse, nursing auxiliary □ Small Employers and own account workers □ Lower supervisory and technical occupation e.g. motor mechanic, fitter, inspector, plumber, printer, electrician, train driver □ Semi-routine and routine occupations–e.g. receptionist, sales assistant, farmworker, HGV/van driver, caretaker
Q18. What is the highest level of education you have completed?	□ None □ NVQ/GNVQ/CSEs □ Levels/GCSEs □ AS/A Levels □ City and Guilds Technical or Trade Certificate □ HNC/HND/Diploma □ University: Higher Degree /Post-Graduate /Teaching Qualification
Q19. How would you rate your current health?	□ Excellent □ Good □ Neither healthy nor unhealthy □ Fair □ Poor
Q20. How would you rate the healthiness of your diet?	□ Excellent □ Good □ Neither healthy nor unhealthy □ Fair □ Poor

Part B: Short quiz on nutrition labels

The following questions are about nutrition information found on food labels. Please take time to read each question, view and information and then select the answer you think is correct. Thank you.

Q1. Looking at this label how much salt is there in a serving (portion) of this product? (Select one answer option)

Nutrition

Typical values (as consumed)	per 100g	per 1/4 quiche (90g)
Energy	1014kJ/243kcal	912kJ/219kcal
Fat	14.3g	12.9g
of which saturates	4g	3.6g
Carbohydrate	21.4g	19.3g
of which sugars	2.1g	1.9g
Fibre	1.5g	1.4g
Protein	6.4g	5.8g
Salt	0.43g	0.39g

	per 1/4 quiche (90g) %RI	your RI*
Energy	11%	8400kJ/2000kcal
Fat	18%	70g
Saturates	18%	20g
Sugars	2%	90g
Salt	6%	6g

*Reference intake of an average adult (8400kJ/2000kcal) (RI).
Contains 4 portions.

□ 0.39g

□ 0.43g

□ 6g

□ 0.86g

□ 6%

Q2. Reference Intakes (RI) is a term stated on nutrition labels. What does this term mean?

□ Percentages of nutrients comparing reference products

□ Reference amount of the food you should eat

□ Reference nutrients which are relevant for that particular food type

□ Daily guideline amounts of nutrients (e.g. energy, fat, saturates, sugars and salt) which are recommended for a healthy diet

□ Percentage amounts of reference nutrients (e.g. energy, fat, saturates, sugars and salt) contained within 100g of all products

Q3. What is the Reference Intake of an average adult for FAT, as given on the label below?

Nutrition

Typical values (as consumed)	per 100g	per 1/4 quiche (90g)
Energy	1014kJ/243kcal	912kJ/219kcal
Fat	14.3g	12.9g
of which saturates	4g	3.6g
Carbohydrate	21.4g	19.3g
of which sugars	2.1g	1.9g
Fibre	1.5g	1.4g
Protein	6.4g	5.8g
Salt	0.43g	0.39g

	per 1/4 quiche (90g) %RI	your RI*
Energy	11%	8400kJ/2000kcal
Fat	18%	70g
Saturates	18%	20g
Sugars	2%	90g
Salt	6%	6g

*Reference intake of an average adult (8400kJ/2000kcal) (RI). Contains 4 portions.

- □ 20g
- □ 70g
- □ 8400KJ/2000kcal
- □ 18.8g
- □ 32g

Q4. How much of the Reference Intake for FAT should you aim to eat each day?

- □ 100%
- □ 150%
- □ As much as you like
- □ 50%
- □ Less than 100%

Q5. How much sugar is found in a serving (portion) of this product?

Classic Houmous 300g

A dip made with chickpeas, sesame seed paste, lemon juice and garlic.

Ingredients Cooked chickpeas (47%) (chickpeas, water), Rapeseed oil, **Sesame seed** paste (13%), Water, Concentrated lemon juice (3%), Garlic purée, Salt, Preservative (potassium sorbate).

ALLERGY ADVICE For allergens, see ingredients in bold.

Nutrition

Typical values	per 100g	per 1/6 pot (50g)	%RI	your RI*
Energy	1520kJ/368kcal	760kJ/184kcal	9%	8400kJ/2000kcal
Fat	32.8g	16.4g	23%	70g
of which saturates	3g	1.5g	8%	20g
Carbohydrate	8.5g	4.2g		
of which sugars	0.5g	0.3g	<1%	90g
Fibre	4.6g	2.3g		
Protein	7.4g	3.7g		
Salt	0.6g	0.3g	5%	6g

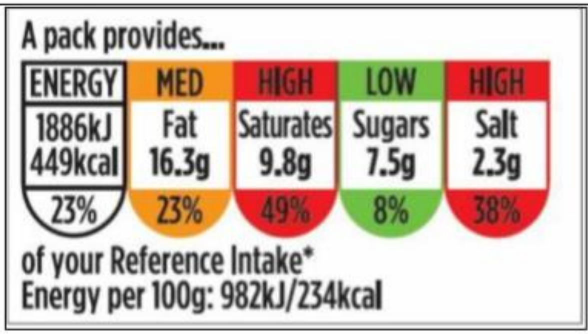
*Reference intake of an average adult (8400kJ/2000kcal) (RI). Contains 6 portions.

- □ 0.5g
- □ 0.3g
- □ <1%
- □ 90g
- □ 8.5g

Q6. Look again at the label. If you ate one serving (portion), what percentage (%) of your Reference Intakes for saturates would this be?

- □ 4g
- □ 1.5g
- □ 8%
- □ 20g
- □ 23%

Q7. Using the information on this nutrition label, which nutrients are present at low levels?

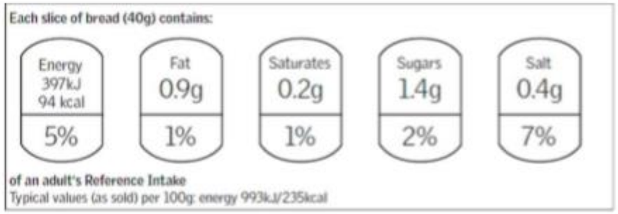


- ◻ Energy and sugars
- ◻ Energy only
- ◻ Sugars only
- ◻ Sugars and fat
- ◻ No nutrients are present at low levels

Q8. Looking again at the label above, what percentage (%) of your Reference Intake for sugars does this pack provide?

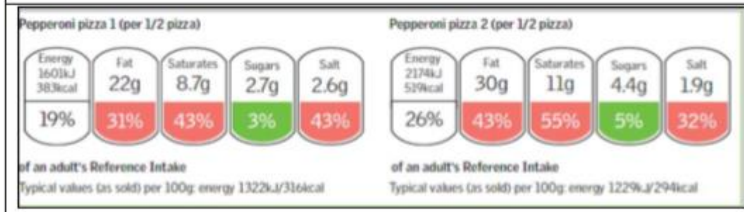
- ◻ 7.5g
- ◻ 100g
- ◻ 23%
- ◻ 234 kcal
- ◻ 8%

Q9. How many calories does a serving of this product provide (label shown below)?



- ◻ 235 kcals
- ◻ 993 KJ
- ◻ 397 KJ
- ◻ 94 kcal
- ◻ 188 kcal

Q10. Nutrition labels from two pizzas are shown below. Which pizza contains less salt?



- ◻ The one on the left
- ◻ the one on the right
- ◻ Both contain the same
- ◻ Don't know

THE END

Appendix E Ethical approval for VLE study

Leeds Trinity University

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PRIVATE & CONFIDENTIAL

Dr John Perry
Chair of Departmental Ethics Committee for Sport, Health and Nutrition
Tel: 0113 283 7175
E-mail: j.perry@leedstrinity.ac.uk

Date: 2nd October 2014

Dear Sally Moore

Re: ethics application 'Virtual Learning Environment and student learning and engagement: Optimising Moodle".

Thank you for your recent resubmission of your application for ethical approval for the above named project. The committee received the application along with the following documents attached:

i. Information for participants
ii. Participant consent form
iii. Comprehension and perception of nutrition labelling pre and post questionnaires and quiz

After reviewing the application I am pleased to confirm that your application for ethical approval has been successful. Good luck with your research.

Yours sincerely

Dr John Perry
Chair of Departmental Ethics Committee for Sport, Health and Nutrition

Cc: Ethics committee file

INVESTORS IN PEOPLE | Gold

Appendix F Participant information, consent form and debrief (VLE study)

Leeds Trinity University

Optimising the Usability of Moodle

Information Sheet

What is the Study About?

You are invited to take part in a study investigating how students search for information on Moodle. The main research question focuses on how the layout and presentation of information on Moodle can be optimised to enhance student learning and the student learning experience.

Another aspect of the study focuses on how people can be helped to understand nutritional information on food labels.

Please read the following information carefully before deciding whether you wish to participate in this study.

Who is Carrying Out the Study?

The study is being conducted by a team at Leeds Trinity University, led by Dr. Steve Jones, Associate Principal Lecturer in Psychology.

The research team is:
Dr. Julie Allen, Associate Principal Lecturer in Psychology
Sally Moore, Associate Senior Lecture in Food & Nutrition
Marcus Sugden, e-Learning Manager

What Does the Study Involve?

This will involve working through a short Moodle page on the topic of nutrition labelling on food packaging. While doing this, your eye movements will be tracked and recorded. You may also like to provide your thoughts on your experiences afterwards by talking through the materials with the researcher.

You will also be asked to complete some short questionnaires, which are designed to measure your experience of searching for information online, your existing knowledge of food-labelling, and how much you prefer to think about things (known as 'need for cognition').

How Long Will It Take?

This will take approximately 45-60 minutes.

Can I Withdraw from the Study?

Participation in this study is entirely voluntary and you are not obliged to take part.

You are free to stop performing the task at any time and leave the study without having to give a reason. If you do not wish to answer any of the questions or complete any of the tasks, you do not have to do so, and may leave the study.

If, having participated, you decide that you do not wish for your data to be included in the study, you may withdraw your data, but must do so within one week of your participation. After this time, it will not be possible to identify which data are yours, as they will be anonymous. In order to withdraw, please email the researcher at the email address given below.

There will be no negative consequences for you if you choose to withdraw.

How will the data be dealt with and who will see the results?

After you have participated, it will not be possible for anyone to identify you from your data, and the data will be treated confidentially. After completion of the study, data and other materials will be stored securely at Leeds Trinity for a period of six years.

The data will be used only for the purposes of the study, and individual data will be seen only by the researchers running the study. Following analysis, summarised data may form the basis of published research papers or conference presentations. At no point will any individual's participation or data be disclosed or be identifiable.

Are there any benefits or risks associated with participation in this study?

You will be paid £5 in printer credits for your participation in the study. Other than this, there are no direct benefits to you of participating in this study, beyond any enjoyment derived from participating in the task. You will not be given any type of 'score' or feedback on your performance.

If you participate, you will find out more about the study at the end. This may have some value to you if you are studying psychology or are interested in psychology generally.

If you are a Level 4 Psychology student, participation will count towards the Research Participation Scheme.

If you have any medical condition (e.g. photo-sensitive epilepsy) that may be triggered or worsened by attending to a computer screen, or if you have ever experienced any negative side effects of any similar activity, you should not take part in this study. If you choose to take part in this study despite these warnings, you do so at your own risk.

Beyond this, there are no anticipated risks or dangers associated with this study and it should not cause you any discomfort or inconvenience, other than the time spent completing it.

What if I require further information about the study or my involvement in it?

When you have read this information sheet, the researcher will discuss it with you further and answer any questions that you may have. If you would like to know more at any stage, or if, having participated, you wish to withdraw from the study, please feel free to contact:

Dr. Steve Jones
Department of Psychology
Leeds Trinity University
Brownberrie Lane
Horsforth
Leeds
LS18 5HD
Email: st.jones@leedstrinity.ac.uk

If you are willing to participate in the study as outlined above, please sign the consent form. If you have any questions that you wish to ask before deciding whether to participate, please ask them now.

Leeds Trinity University

Optimising the Usability of Moodle

Consent Form

Lead Researcher: Dr. Steve Jones

Please read the following carefully and, if you agree to participate, please sign and date this form.

I have read, understood, and been provided with a copy of the participant information sheet for the study identified above.

I have been given the opportunity to ask any questions that I have about the study and these have been answered to my satisfaction.

I have received enough information about the study.

I understand that I am free to withdraw from the study without having to give a reason.

I understand that I can withdraw my data from the study up to seven days after I have taken part, but to do so I will need to provide my participant number.

I agree to participate in this study.

Name: ______________________________

Signature: ____________________________

Date: _______________________________

Participant Number: ______________________

Leeds Trinity University

Optimising the Usability of Moodle

Debrief

Thank you for participating in this study. Your help is very much appreciated.

The main aims of this study are to investigate how the layout and presentation of information on Moodle can be optimised to enhance student learning and the student learning experience.

In doing this, we are using two different versions of Moodle pages. One is a 'traditional' layout in which the content is presented in a list-like format, with PowerPoint slides used to present information. The other is set out in a grid format which should be easier to navigate, and the content is presented in a more interactive way, using narrated materials. In both versions of the Moodle page, the information that is presented is exactly the same. Then only differences are in the manner in which the information is presented.

The specific research questions of the study include:

- How can information be organised to provide a good match to students' natural eye-movements?
- How are eye movements related to the perceived importance and comprehensibility of information?
- What do measures of memory, comprehension, Web-User Self-Efficacy (WUSE), Need for Cognition (NFC) and the user experience reveal about the optimal organisation of material on Moodle?

The use of Moodle is becoming increasingly important for supporting student learning and enhancing the student learning experience and student engagement with their learning. In order to optimise the effectiveness of the Moodle, it is important to establish exactly how students interact with these resources. The way in which information is organised, sign-posted and cued impacts upon the usability of Moodle. Badly organised material can increase student frustration and decrease engagement.

The study in which you have participated will, hopefully, allow us to examine not just what Moodle users look at, but what they take in, how easy they find the VLE to use, and their retention and understanding of the information presented.

The overall aim is to develop a set of principles that can be applied across the University, and beyond, to make the VLE as engaging, useful and effective as possible for students.

Once again, thank you for your contribution to the study. If you have any questions, either please ask them now, or contact us afterwards. If you decide that you wish to withdraw your data from the study, please contact Dr. Steve Jones (see below) **within seven days**, and provide your participant number (at the top of this sheet). You do not need to give any reason for wishing to withdraw.

Finally, in order to maintain the integrity of the study, it would be very helpful if you could please not mention to any other person who may participate that there are two different versions of the Moodle page. Thank you for your co-operation with this.

Contact:

Dr. Steve Jones, Department of Psychology, Leeds Trinity University, Leeds, LS18 5HD.
Email: st.jones@leedstrinity.ac.uk

Appendix G Ethical approval for the online survey and 'Think aloud' study

Leeds Trinity University

Brownberrie Lane . Horsforth . Leeds . LS18 5HD . UK
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PRIVATE & CONFIDENTIAL

Dr John Perry
Chair of Departmental Ethics Committee for Sport, Health and Nutrition
Tel: 0113 283 7175
E-mail: j.perry@leedstrinity.ac.uk

Date: 2nd April 2015

Dear Sally Moore

Re: ethics application 'Nutrition Labelling Legislation and Education: Evaluation of use and understanding of nutrition labels and online nutrition information: survey and qualitative interviews.

Thank you for your recent resubmission of your application for ethical approval for the above named project. The committee received the application along with the following documents attached:

i. Information for survey participants
ii. Information sheet (for interviews)
iii. Participant consent form
iv. Comprehension and perception of nutrition labelling questionnaire
v. Online shoppers interview protocol

After reviewing the application I am pleased to confirm that your application for ethical approval has been successful. Good luck with your research.

Yours sincerely

Dr John Perry
Chair of Departmental Ethics Committee for Sport, Health and Nutrition

Cc: Ethics committee file

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Appendix H Participant Information sheet and consent form for the 'Think aloud' study with online shoppers

Leeds Trinity University

Information Sheet

Understanding consumers food choice- research into online supermarket shopping and product information

What is the Study About?

You are invited to take part in a study investigating consumer use of online supermarket shopping and product information. The main research question focuses on how well this information can be understood and used.

Another aspect of the study focuses on how people can be helped to understand this better.

Please read the following information carefully before deciding whether you wish to participate in this study.

Who is Carrying Out the Study?

The study is being conducted by a researcher at Leeds Trinity University, Sally Moore.

What Does the Study Involve?

This will involve a series of short tasks in which you search for and use on an online supermarket website and product information. While doing this, your computer screen will be recorded.

You will be asked to 'think aloud' about where and how you are looking for the information, how easy it is to find, how easy it is to understand, and so on.

You will also be asked to complete a short quiz and questionnaire, which are designed to measure your knowledge of information use and your perceptions of your existing knowledge of food-labelling. The questionnaire will also ask questions about your background and occupation etc.

How Long Will It Take?

This will take approximately 40-60 minutes.

Can I Withdraw from the Study?

Participation in this study is entirely voluntary and you are not obliged to take part.

You are free to stop performing the task at any time and leave the study without having to give a reason. If you do not wish to answer any of the questions or complete any of the tasks, you do not have to do so, and may leave the study.

If, having participated, you decide that you do not wish for your data to be included in the study, you may withdraw your data, but must do so within one week of your participation. After this time, it will not be possible to identify which data are yours, as they will be anonymous. In order to withdraw, please email the researcher at the email address given below.

There will be no negative consequences for you if you choose to withdraw.

How will the data be dealt with and who will see the results?

After you have participated, it will not be possible for anyone to identify you from your computer screen recording, verbal or questionnaire/quiz data. The data will be treated confidentially. After completion of the study, data and other materials will be stored securely at Leeds Trinity University for a period of six years.

The data will be used only for the purposes of the study, and individual data will be seen only by the researchers running the study. Following analysis, summarised data may form the basis of published research papers or conference presentations. At no point will any individual's participation or data be disclosed or be identifiable.

Are there any benefits or risks associated with participation in this study?

You will be paid £5 for your participation in the study.

Other than this, there are no direct benefits to you of participating in this study, beyond any enjoyment derived from participating in the task. You will not be given any type of 'score' or feedback on your performance unless you specifically request this following quiz completion.

If you have any medical condition (e.g. photo-sensitive epilepsy) that may be triggered or worsened by attending to a computer screen, or if you have ever experienced any negative side effects of any similar activity, you should not take part in this study. If you choose to take part in this study despite these warnings, you do so at your own risk.

Beyond this, there are no anticipated risks or dangers associated with this study and it should not cause you any discomfort or inconvenience, other than the time spent completing it.

What if I require further information about the study or my involvement in it?

When you have read this information sheet, the researcher will discuss it with you further and answer any questions that you may have. If you would like to know more at any stage, or if, having participated, you wish to withdraw from the study, please feel free to contact:

Sally Moore
Department of Sport Health and Nutrition
Leeds Trinity University
Brownberrie Lane
Horsforth
Leeds
LS18 5HD
Email: s.moore@leedstrinity.ac.uk
07762122108

If you are willing to participate in the study as outlined above, please sign the consent form. If you have any questions that you wish to ask before deciding whether to participate, please ask them now.

Leeds Trinity University

Participant Consent Form

Research into consumers and Food choice

Lead Researcher: Sally Moore

Please read the following carefully and, if you agree to participate, please sign and date this form.

- ☐ I have been provided with and read, a copy of the participant information sheet for the study identified above.
- ☐ I have been given the opportunity to ask any questions that I have about the study and these have been answered to my satisfaction.
- ☐ **I understand I meet the inclusion criteria since I**
  - **have used online supermarket shopping at least once in the last 3 month**
  - **am current 50yrs old or older**
- ☐ I have received enough information about the study.
- ☐ I understand that I am free to withdraw from the study without having to give a reason.
- ☐ I understand that I can withdraw my data from the study up to seven days after I have taken part.
- ☐ I agree to participate in this study.

Name: ______________________________

Signature: ____________________________

Date: ______________________________

Appendix I Protocol for the 'Think aloud' sessions

Think Aloud protocol

The details of how participants were trained in the 'think aloud' protocol are presented in box 1. The training lasted approximately 10 minutes and was undertaken exactly before the partipcant were asked to perform tasks during accompanied online mock shopping trip.

Box 1

As I have already mentioned, in this task I would like you to think aloud while you are doing your usual shopping. What I mean by thinking out loud is to say everything you are thinking while you are shopping, during the task. So maybe this will be what you are looking at, reasons why you are choosing to buy it, or reasons why you aren't buying it and so on...

When I say 'everything you are thinking' I literally mean just that, no matter how fleeting or apparently trivial the thoughts may be. That means including everything that you are looking at and registering mentally, as well as anything you are doing.

The idea is that you continue talking as much as possible about what you are thinking, rather than you and I having a conversation, so you will find that I will follow you and observe what you are doing, but not talk a lot to you. When you are talking out loud it is fine for you to aim that at me, so you feel you are not talking to yourself!

I'd like you to practice "thinking-aloud" first. I have a task I'd like you perform to help to get used to talking out loud. I will demonstrate the first example then if you are happy to have a go you can try the following example.

It is also really useful if you mention what in particular you are looking at, for the benefit of the tape recording.

So, I'll start now with an example of how I might think aloud if I was trying to count the rooms in my house.

"I'm walking through the front door and walk down the corridor. Straight ahead there is the kitchen. I turn left and I'm into the lounge. Following that I head up the stair and turn into the bathroom, and if I turn right the first bedroom)".

Could you now do the same as though you wanted to count the number of rooms in your home?

Instructions for tasks during accompanied mock online shopping

Instructions that were provided to participants for the accompanied shop task are presented in Box 2.

Box 2

I'd like you to first choose a soup product and think aloud to describe what you are think whilst you are doing so.

Just before we begin please do 'Think aloud' at all times.

- I will prompt you if you fall silent for more than 10 seconds and I will probably say: 'Keep thinking aloud'; or 'What are you thinking'; or 'What are you looking at?' I will not embark on any conversation with you.

- I may make some notes during the session, don't worry about this. Just to reassure you, I'm not here to judge what products you actually select.

****

Thank you.

Would you now find the healthiest soup. Again, keep 'Thinking aloud' aloud about what you are thinking and doing.

******

Thank you

Finally, could now select a health ready meal. Once again, please keep 'Thinking aloud' about what you thinking and doing.

Appendix J Data extraction form used in the systematic review (Chapter 6)

Review title or ID		
Study ID *(surname of first author and year first full report of study was published e.g. Smith 2001)*		
Date form completed *(dd/mm/yyyy)*		
Name/ID of person extracting data		
Reference citation		
Study author contact details		
Publication type *(e.g. full report, abstract, letter)*		
Type of study	Randomised Controlled Trial	
	Pre-post intervention	
	Other	
Participants		
Types of intervention		
Types of comparison		
Types of outcome measures		
INCLUDE ☐	EXCLUDE ☐	Reason for exclusion (criteria A,B,C,D)
Descriptions as stated in report/paper		**Location in text or source**
Aim of study *(e.g. efficacy, equivalence, pragmatic)*		*(pg & ¶/fig/table/other)*
Design *(e.g. parallel, crossover, non-RCT)*		
Unit of allocation *(by individuals, cluster/ groups or body parts)*		
Start date / end date		
Duration of participation *(from recruitment to last follow-up)*		
Ethical approval needed/ obtained for study. And informed consent obtained?	☐ Yes ☐ No ☐ Unclear	
Population description *(from which study participants are drawn)*		Location in text or source *(pg & ¶/fig/table/other)*
Setting *(including location and social context)*		
Inclusion criteria		
Exclusion criteria		
Method of recruitment of participants *(e.g. phone, mail, clinic patients)*		
Total no. randomised *(or total pop. at start of study for NRCTs)*		
Clusters *(if applicable, no., type, no. people per cluster)*		
Baseline imbalances		
Withdrawals and exclusions *(if not provided below by outcome)*		
Age		
Sex		
Race/Ethnicity		
Other relevant sociodemographics		
Subgroups measure		

Subgroups reported		
Intervention description as stated in report/paper		
Group name		Location in text or source (pg & /fig/table/other)
No. randomised to group.(specify whether no. people or clusters)		
Theoretical basis (include key references)		
Description (include sufficient detail for replication, e.g. content, dose, components)		
Duration of treatment period		
Timing (e.g. frequency, duration of each episode)		
Delivery (e.g. mechanism, medium, intensity, fidelity)		
Providers (facilitators)(e.g. no., profession, training, ethnicity etc. if relevant)		
Co-interventions		
Economic information (i.e. intervention cost, changes in other costs as result of intervention)		
Resource requirements (e.g. staff numbers, cold chain, equipment)		
Integrity of delivery		
Compliance		
OUTCOME 1 (replica for OUTCOME 2)	Description as stated in report/paper	
Outcome name		
Time points measured (specify whether from start or end of intervention)		
Time points reported		
Outcome definition (with diagnostic criteria if relevant)		
Person measuring/ reporting		
Unit of measurement (if relevant)	Scales: upper and lower limits (indicate whether high or low score is good)	
Is outcome/tool validated?	☐ Yes ☐ No ☐ Unclear	
Imputation of missing data *(e.g. assumptions made for ITT analysis)*		
Assumed risk estimate *(e.g. baseline or population risk noted in Background)*		
Power *(e.g. power & sample size calculation, level of power achieved)*		
Study funding sources (including role of funders)		
Possible conflicts of interest (for study authors)		

Appendix K Ethical approval for the pilot community education intervention

Leeds Trinity University

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PRIVATE & CONFIDENTIAL

Dr Mark Russell
Chair of SSHS Ethics Committee
Tel: 0113 283 7100 ext 649
E-mail: m.russell@leedstrinity.ac.uk

Date: 22nd March 2018

Dear Sally

Re: SSHS-2018-002 - Improving understanding and use of nutrition label information

Thank you for your recent application for ethical approval for the above named project.

After reviewing the application it has been resolved that the research project is granted ethical approval.

I wish you well in your study,

Yours sincerely

M. Russell

Dr Mark Russell
Chair of School of Social and Health Sciences Ethics Committee

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Appendix L Participants information sheet, consent form and debrief for the pilot community educational intervention

Participant information sheet

Using Nutrition Labels Better

You are invited to participate in a study about using nutrition labels on food and drink products. It aims to seek you views on understanding and using these labels and how we can improve this.

(1) What is the study about?

The study is about how you can use nutrition labels. It seeks your participation in an educational session about these labels on food and drink products and would like to collect data on how well you can to understand and use this information.

(2) Who is carrying out the study?

This study is being conducted by Sally Moore as a research project for a PhD degree programme at Leeds Trinity University, under the supervision of Professor Judy Donnelly, Professor of Nutrition Education.

(3) What does the study involve?

You will participate in a short (1 hour) educational session how to use nutrition labels and be asked to complete two pre and post session questionnaires on your use and understanding of labels.

Throughout the session you will be invited to discuss your views on how to use nutrition label information.

(4) How much time will the study take?

The session will take about 1 hour, including 30 minutes for the education session and discussion and around 10 minutes in total to fill in the pre and post session questionnaires.

(5) Can I withdraw from the study?

Yes. Your participation is entirely voluntary, so participants can choose not to take part. You may withdraw at any time without a reason. If you choose to withdraw from the study following the completion of the session you can do so by simply informing the researcher or emailing 1408371@Leedstrinity.ac.uk. Once you have submitted your questionnaires, your responses can be withdrawn up to one week afterwards, as after that time it will not be possible to identify which questionnaire is yours.

(6) How will the data be dealt with and who will see the results?

Your participation in the education session and results from your questionnaire responses will be anonymised. As you will be also participating as part of a group, it cannot be guaranteed that other participants will not reveal details of your participation with others. All participants are asked to respect the privacy of others but please bear in mind that this cannot be guaranteed.

All materials relating to this study, including data, recordings and signed consent forms, will be stored in a secure location at Leeds Trinity University for a period of five years before being securely destroyed.

Withdrawal: You are able to withdraw from the study at any time (to do so please contact Sally Moore 1408731@leedstrinity.ac.uk) and your questionnaire responses can be identify and removed if you inform us within 1 week following your participation in the educational session. After this time questionnaires will have been anonymised and it will be not be possible to identify a participant's responses.

Are there any benefits or risks associated with participating in this study?

There are some anticipated benefits to you of taking part in this study including the anticipated increase in your knowledge and skills surrounding use of food and nutrition labels. Benefits to the wider Leeds community are expected following their viewing of the subsequent video.

You will not receive feedback on your performance or any kind of score immediately after completing the task. Under the Freedom of Information Act (2000) you are entitled to ask for feedback in relation to your scores on a task. If you wish to have this information, you must email the researcher and their supervisor in an email within a month of completing the session at 1408371@leedstrinity.ac.uk. Please note that you are entitled to information on your score only and not feedback on your performance. You will not be told how well you performed on the task compared to other people.

(7) What if I require further information about the study or my involvement in it?

When you have read this information sheet, Sally Moore will be happy to discuss it with you further and answer any questions you may have. If you would like to know more at any stage or if, having participated, you wish to withdraw from the study, please feel free to contact: 1408371@leedstrinity.ac.uk

(8) What if I have a complaint or any concerns?

Any person with concerns or complaints about the conduct of a research study should contact Dr. Mark Russell, Chair of the School of Social and Health Sciences Ethics Committee, Leeds Trinity University, Brownberrie Lane, Leeds, LS18 5HD. Email m.russell@leedstrinity.ac.uk

Consent form

Using Nutrition Labels Better

I have read, understood, and been provided with a copy of the participant information sheet for this study. I have been given the opportunity to ask any questions that I have about the study and these have been answered to my satisfaction.

- ✓ I have received enough information about the study.
- ✓ I understand that I am free to withdraw from the group session without having to give a reason.
- ✓ I understand that I can withdraw my questionnaire data from the study up to one week afterwards.

I agree to participate in this study.

Signed…………………………………

Name ……………………………….. Date……………………………

Debrief (please do not share with others)

Using Nutrition Labels Better

Having taken the time and trouble to participate in this study, you are entitled to an explanation of what the study is about, what it was based on, what is going be done to analyse the data, what may be found , and what value this might have.

We hope to find that the educational session will improve people's use and understanding. That is, answers to the questionnaire questions on nutrition labels will be 'better' following their attendance at the educational session.

Although some participants may have become aware of this during the educational session (and whilst filling out the questionnaires) we were not able to share our aims with you beforehand in case this influenced your answers or efforts.

Aims of study: To evaluate the impact of an educational session on nutrition label use and understanding.

Taking part on the study and filling in the questionnaire is designed to be interesting but difficult in order to 'test understanding'. So that, if you found this tricky, this was to be expected. We are grateful for your help with this.

Confidentiality: Given the study has involved a discussion group, we ask that you respect the privacy of others and not to discuss what was said (or who said what) during the discussion.

Withdrawal: You are able to withdraw from the study at anytime (to do so please contact Sally Moore 1408731@leedstrinity.ac.uk) and your questionnaire responses can be identify and removed if you inform us within 1 week following your participation in the educational session.

Complaints: Please contact Sally or Judy on 1408731@leedstrinity.ac.uk or J.donnelly@leedstrinity.ac.uk to make any comments or complaints.

Appendix M Pre and post-intervention questionnaires (including quizzes)

PRE SESSION QUESTIONNAIRE **NAME(or initials)** ____________________

Nutrition information displayed on food labels looks similar to these pictures, appearing on back and front of the package.

Nutrition

Typical values	100g contains	Each slice (typically 44g) contains	% RI*	RI* for an average adult
Energy	985kJ	435kJ		8400kJ
	235kcal	105kcal	5%	2000kcal
Fat	1.5g	0.7g	1%	70g
of which saturates	0.3g	0.1g	1%	20g
Carbohydrate	45.5g	20.0g		
of which sugars	3.8g	1.7g	2%	90g
Fibre	2.8g	1.2g		
Protein	7.7g	3.4g		
Salt	1.0g	0.4g	7%	6g

This pack contains 16 servings
*Reference intake of an average adult (8400kJ / 2000kcal)

Q1. Thinking about the last **six months**, how often have you **read** nutrition information on food labels? (Please tick the appropriate box below).

Never	Rarely	Sometimes	Often	Always

Q2. Thinking about the last **six months**, how often has nutrition information **affected your purchase choices**?

Never	Rarely	Sometimes	Often	Always

Q3. Please rate yourself on the scale below for each item, with this statement in mind:

***To me, nutrition information is*:**

	1	2	3	4	5	6	7	
Unimportant								Very important
Boring								Interesting
Irrelevant								Relevant
Unexciting								Exciting
Means nothing to me								Means a lot to me
Unappealing								Appealing
Mundane								Fascinating
Worthless								Valuable
Uninvolving								Involving
Not needed								Needed

Q4. How well would you say that **you understand** nutrition label information?

	1	2	3	4	5	6	7	
I do not understand it at all								I understand it perfectly

Q5. How confident are you that **you can use** nutrition labels to make healthy food choices?

	1	2	3	4	5	6	7	
I'm not at all confident								I'm very confident

Please use the information on the nutrition label shown below to answer the following questions. Write you answers in the spaces provided. If you are not sure please write "NS".

Nutrition

Typical values	100g contains	Each slice (typically 44g) contains	% RI*	RI* for an average adult
Energy	985kJ	435kJ		8400kJ
	235kcal	105kcal	5%	2000kcal
Fat	1.5g	0.7g	1%	70g
of which saturates	0.3g	0.1g	1%	20g
Carbohydrate	45.5g	20.0g		
of which sugars	3.8g	1.7g	2%	90g
Fibre	2.8g	1.2g		
Protein	7.7g	3.4g		
Salt	1.0g	0.4g	7%	6g

This pack contains 16 servings
*Reference intake of an average adult (8400kJ / 2000kcal)

Q7. How much **salt** (in grams) is in one serving of this food?

Q8. What does the term "reference intake" mean to you?

Q9. What is the reference intake for **fat,** as given on the label above?

Q10. What percentage (%) of your reference intake for **fat** is provided by one serving of this food?

Q11 How much of the reference intake **for fat** should you aim to consume each day?

ABOUT YOU

Q12. Do you or a member of your household have a diet or medical condition where looking at food label information is advised?

Yes	
No	

Q13 Please indicate your gender

Female	
Male	

Q14 Please write your age in years: ________________Years

Q15 What is your ethnicity (please tick one below)?

White/White British	
White other	
Black/Black British (e.g. African, Caribbean)	
Asian/Asian British (e.g. Pakistani, Chinese)	
Mixed ethnic group (e.g. White and Black Caribbean)	
Other	

Q15. Your education. Please tick the highest award you have.

None	
NVQ/GNVQ	
CSEs	
0 Levels/GCSEs	
AS/A Levels	
City and Guild Technical or Trade Certificate	
HNC/HND/Diploma	
University: Higher Degree/Post Graduate or Teaching Qualification	

THANK YOU
THE END

***POST QUESTIONNAIRE** **NAME (or initials)**____________________

Q1. Following the session, how often do you think you will **read** nutrition information on food labels? (Please tick the appropriate frequency in the table below).

Never	Rarely	Sometimes	Often	Always

Q2. Following the session, how often do you think that nutrition information on food labels will **affect your purchase choices**?

Never	Rarely	Sometimes	Often	Always

Q3. Please rate yourself on the scale below for each item, with this statement in mind:

To me, nutrition information is:

	1	2	3	4	5	6	7	
Unimportant								Very important
Boring								Interesting
Irrelevant								Relevant
Unexciting								Exciting
Means nothing to me								Means a lot to me
Unappealing								Appealing
Mundane								Fascinating
Worthless								Valuable
Uninvolving								Involving
Not needed								Needed

Q4. Following the session, how well would you say that **you understand** nutrition label information?

	1	2	3	4	5	6	7	
I do not understand it at all								I understand it perfectly

Q5. Following the session, how confident are you that **you can use** nutrition labels to make healthy food choices?

	1	2	3	4	5	6	7	
I'm not at all confident								I'm very confident

Q6. How useful was the session in terms of helping you to use nutrition labels?

	1	2	3	4	5	6	7	
Not at all useful								Extremely useful

Please use the information on the nutrition label shown below to answer the following questions. Write you answers in the spaces provided. If you are not sure please write "NS".

Fat Free Authentic Greek Yogurt 500g ℮
Strained fat free natural Greek yogurt.
ALLERGY ADVICE Contains milk.
Nutrition

Typical values	per 100g	per 1/4 pot (125g)	%RI	your RI*
Energy	279kJ 66kcal	349kJ 82kcal	**4%**	8400kJ 2000kcal
Fat	0.3g	0.4g	**1%**	70g
of which saturates	0.2g	0.3g	**1%**	20g
Carbohydrate	6g	7.5g		
of which sugars	4.6g	5.8g	**6%**	90g
Fibre	nil	nil		
Protein	9.8g	12.3g		
Salt	0.21g	0.26g	**4%**	6g

*Reference intake of an average adult (8400kJ/2000kcal) (RI).
Contains 4 portions.

Q7. How much **sugar** (in grams) is in one serving of this food?

Q8. What does the term "reference intake" mean to you?

Q9. What is the reference intake for **sugar,** as given on the label above?

Q10. What percentage (%) of your reference intake for **sugar** is provided by one serving of this food?

Q11. How much of the reference intake for **sugar** should you aim to consume each day?

Please write any comments you have about the session here:

Thank you for taking part
The End

Appendix N Conference presentations of work undertaken in this PhD

Presentation title	Conference	Date
Nutrition label Information: A systematic review of interventions targeting consumer understanding and use (Poster)	Society of Social Medicine and Population Health, Annual Scientific Meeting, York, UK	September 16th , 2016
Awareness and use of nutrition information during online grocery shopping for "healthy" foods: a think aloud qualitative analysis with older adults (Oral)	British Dietetic Association Research Symposium, Birmingham, UK	December 6th , 2017
Use and understanding of current UK nutrition labels (Oral)	"Getting the energy balance right". The Nutrition Society Summer Conference, Leeds, UK	July 11th, 2018