Adolescents' food choices and dietary behaviour in the school food environment

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Intellectual Property and Publication Statements

The candidate can confirm that the work submitted is his own, except where work has formed part of jointly authored publications. 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 supervisors on the project: Dr Hannah Ensaff and Dr Mel Holmes. The paper is as follows:

Ryan, D., Holmes, M., & Ensaff, H. (2022). Adolescents' dietary behaviour: The interplay between home and school food environments. Appetite, 106056. https://doi.org/https://doi.org/10.1016/j.appet.2022.106056

A conference paper was also published for this study. The citation for this is as follows:

Ryan D, Holmes M, Ensaff H. 2020. "I Control What I Eat and I'm Sensible with What I Eat, Apart from School" – A Qualitative Study of Adolescents' Food Choices and the School Environment. Nutrition 2020 Live Online Current Developments in Nutrition Oxford University Press (OUP) 4(2), pp. 1345-1345

This study is outlined in Chapter 7 of this thesis. DR, HE and MH designed the study. DR moderated the focus group discussions, transcribed and coded the raw data. DR, HE and MH analysed the data. DR drafted the manuscript. All authors contributed to the critical review of the manuscript and approved the final version.

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Abstract

Introduction: Adolescent obesity is a pressing concern in the UK, with 39% of adolescents aged 11-15 years classified as overweight or obese[1]. Unfavourable dietary behaviours can be considered one of the key reasons for this phenomenon, as UK adolescents diets are typically high in energy and free sugars and low in several micronutrients[2,3]. Schools are seen as a sound setting to explore and address adolescent dietary behaviours, along with adolescent overweight/obesity. In the UK, food (FBS) and nutrient-based standards (NBS)[4] have tried to improve the nutritional quality of UK school food provision, in an effort to improve adolescent diets. However, few studies have examined the nutritional composition of UK school food provision since the shift from dual standards to solely FBS[5], or the role of catering practices thereon. Meanwhile, adolescents' school food choices continue to bias toward energy dense and micronutrient poor options. This thesis aimed to assess the nutritional composition of UK secondary school food (1) as provided by schools and (2) as chosen by students. The thesis also looked to explore how and why adolescents make their food choices within the school environment.

Methods: Three-week observations were conducted in two secondary schools in Northern England, coinciding with the three-week menu cycle. Detailed information (e.g. brands, weights, photos, recipes, preparatory methods) was collected for all foods/drinks provided. Nutritional composition data was assigned via McCance and Widdowson's Composition of Foods Integrated Dataset[6], United States Department of Agriculture (USDA) FoodData Central searchable website[7], WinDiets Standard 2016[8] suite and manufacturer correspondence. The nutritional composition of all foods/drinks (n =373) was examined across categories (Main Meals, Savoury Snacks, Sweet Snacks, Fruit, Drinks, Dessert Main Meal) and sub-categories. An average lunch, based on a FBS compliant menu cycle, was calculated, along with a number of typical lunches and evaluated against reference values (based on previous NBS and dietary reference values (DRVs)[9] apportioned for a school lunch). Thereafter, cashless catering data was downloaded and linked to nutritional composition data. The linked dataset was examined to (1) explore adolescents' school food choices via descriptive statistics and (2) evaluate the nutritional composition of adolescents' school food choices. Adolescents' school food choices were considered at each service in the school day, whilst their choices throughout the day were considered in relation to dietary reference values (DRVs)[9]. Finally, two sets of focus groups were conducted with year 8 and

9 students, to discuss their school food choices. The first focus group study focused on adolescents' lunchtime experience at school, along with exploration of how they make their food choices within the school environment. A flexible deductive approach was taken for the analysis. The second focus group study also explored adolescents' school food choices, but then explored the potential influence of parents and peers on said choices. Analysis was conducted using an inductive thematic approach.

Results:

During the three weeks of observation, a total of 334 foods (S1: 146; S2: 188) and 39 drinks (S1: 22; S2: 17) were provided across the two schools. Food and drink items were classified into 6 categories (Main Meals, Break Items, Sweet Snacks, Fruit, Drinks, Dessert Main Meal) and 19 constituent sub-categories. The observation visits highlighted that discretionary food preparation practices were present in both schools, but indications were that both schools largely complied with FBS. However, nutritional composition findings indicated that an average lunch in both schools exceeded reference values for free sugars and fell significantly below standards for fibre, calcium, iron, zinc, iodine and vitamins A and D in both schools (all $P < 0.01$). Moreover, the findings identified a number of sub-categories (e.g. juice-based drinks, pizzas, paninis, sweet snacks) of note; these items were typically high in free sugars and/or saturated fat and sodium. These items were also popular amongst students, which was discussed during the observation visits and confirmed after analysing the cashless catering data. The nutritional composition findings also highlighted a number of nutrients of concern, namely free sugars, calcium, fibre, iron, zinc; school food provision fell short of reference values for these nutrients (and others) across mean values for typical lunches, an average lunch (based on a FBS compliant menu cycle) and all main meal combinations across the three-week menu cycle.

Analysis of the cashless catering data suggested that adolescents' school food choices were dominated by grab and go, convenient options, such as sweet snacks, savoury snacks and juice-based drinks. Many of these (sub)categories were found to be high in free sugars and low in fibre and several micronutrients (e.g. calcium, iron, zinc). ANOVA results found significant differences in the energy and nutrient content of school food choices between younger and older students, and male and female students respectively. Meanwhile, analysis of cashless catering data found that break accounted for a large proportion of school food transactions. Finally, adolescents' choices throughout the school day, when accumulated, fell down with respect to DRVs; findings indicated that adolescents' school food choices throughout the school day provided them with over 75% of their recommended daily amount for free sugars, whilst providing less than a third of their recommended daily amounts for energy, fibre, calcium, iron, zinc and several other vitamins and micronutrients.

Qualitative findings highlighted queues, cost and a desire to socialise with friends as key factors influencing adolescents' school food choices. Findings from the first focus group study suggested that adolescents may use some of these factors (particularly cost and convenience) to compare and contrast school food and alternative options (e.g. purchasing food from a nearby outlet, bringing lunch from home). Students also made a number of suggestions for changing school food provision, highlighting their capacity to be co-producers in this domain. Findings from the second focus group study also found evidence for the relevance of queues, social aspects, and cost in determining adolescents' school food choices. However, discussions of the potential influence of parents highlighted how adolescents juxtaposed the home and school environment, in terms of food provision, food choices, rules and customs surrounding food choice. Findings suggested that both environments (in)directly influence adolescents' school food choices, which involve management of multiple influences. Adolescents reported adopting a number of unhelpful dietary rationalisations in their efforts to manage and reconcile these influences.

Conclusion: Compliance with current school food standards does not ensure that students receive a nutritious lunch (as per previous NBS). Considerations for school food provision include reducing levels of free sugars and increasing levels of important (micro)nutrients and vitamins (e.g. fibre, calcium, iron, zinc, iodine, vitamin D). These trends are also present in adolescents' school food choices, which are dominated by grab and go, convenient options. In order to change school food choices, there is a need for researchers, policymakers and school food providers to understand and appreciate the various influences underpinning adolescents' school food choices. Consistent consultation with students, and coproduction of school food research/initiatives is crucial in this regard.

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Abbreviations

AOAC: Association of Analytical Chemists

CoFiD: Composition of Foods Integrated Dataset

DEFRA: Department for Environment, Food and Rural Affairs

DfE: Department for Education

DfES: Department for Education and Skills

DH: Department of Health

DRV: Dietary Reference Values

EHWB: Emotional Health and Wellbeing

FBS: Food-based standards

FCPM: Food choice process model

FFQ: Food Frequency Questionnaire

FoP: Front of Pack

FSA: Food Standards Agency

HFSS: High in Fat, Sugar Salt

HPS: Health-Promoting Schools

LA: Local authority

LEA: Local Education Authority

NBS: Nutrient-based standards

NCD: Non-Communicable Disease

NDNS: National Diet & Nutrition Survey

NHSP: National Healthy Schools Programme

NMES: Non-milk extrinsic sugars

NSP: Non-starch Polysaccharides

Ofsted: Office for Standards in Education, Children's Services and Skills

PA: Physical activity

PSHE: Personal, Social, Health and Wellbeing Education

S1: School 1

S2: School 2

SACN: Scientific Advisory Committee on Nutrition

SEM: Socio-ecological model

SES: Socio-economic status

SFT: School Food Trust

SMRP: School Meals Review Panel

SSB: Sugar-sweetened beverage

USDA: United States Department of Agriculture

Chapter 1. Introduction

1.1 Thesis Outline

1.1.1 Brief Overview

Obesity is a substantial public health issue in the UK. Recent figures suggest 68% of men and 60% of women over the age of 16 in the UK are overweight or obese[10], whilst 39% of adolescents aged 11-15 years are classified as overweight or obese[1]. Obesity related illnesses cost the UK government roughly £6 billion per year[11]. Obesity may be influenced by several inter-related factors, including genetics, metabolic rates, physical activity (PA), dietary intake and consumption behaviour[12]. One of the most important predictors of obesity is dietary behaviour[12]. Adolescence is a pivotal time in terms of dietary behaviours across the life-course[13]. This is a behaviourally malleable stage in one's development, whereby health behaviours such as dietary behaviours can change[13], and interventions focused on adolescents have potential to establish healthy dietary behaviours prior to adulthood.

The secondary school environment provides a sound setting to explore adolescent food choice and dietary behaviours. Research on school food choices has gleaned substantial insights already, including students' preference for energy dense, grab and go items[14–17], the importance of the school dining environment[14,18–22], the relevance of various school food choice factors including school food prices, length of queues, availability of healthy options[23,24] and the presence of competitive nearby food outlets[17,25,26]. Schools also hold great potential as a site for dietary intervention, assembling students of various ages, genders, ethnicities, socio-economic status and religious backgrounds. School-based dietary interventions have attempted to improve students' dietary behaviours, exploring educational[27,28], environmental[29] and norms-based approaches[30]. However, research has yet to fully elucidate how to have a sustained positive influence on adolescents' school food choices. Furthermore, the shift in England from food (FBS) and nutrient-based standards (NBS) to solely food-based standards (FBS) has been accompanied by little in terms of formal monitoring or evaluation efforts, from policy or research perspectives. As such, relatively little is known regarding the nutritional composition of UK school food provision. Consequently, the same can be said of adolescents' school food choices.

This PhD thesis explores the nutritional composition of English secondary school food (1) as provided by schools and (2) as chosen by students. The thesis also looks to gain a deeper understanding of adolescents' dietary behaviours within the school environment by exploring how and why students make their school food choices. In doing so, the thesis will hopefully support the development of future school-based dietary interventions, by providing a greater understanding of the current secondary school food landscape, assessing the nutritional composition of school food provision, differentiating between what is provided and what is chosen, and conveying students' perspective on why those items are chosen.

1.1.2 Structure of Thesis

Figure 1.1 outlines the structure of the thesis.

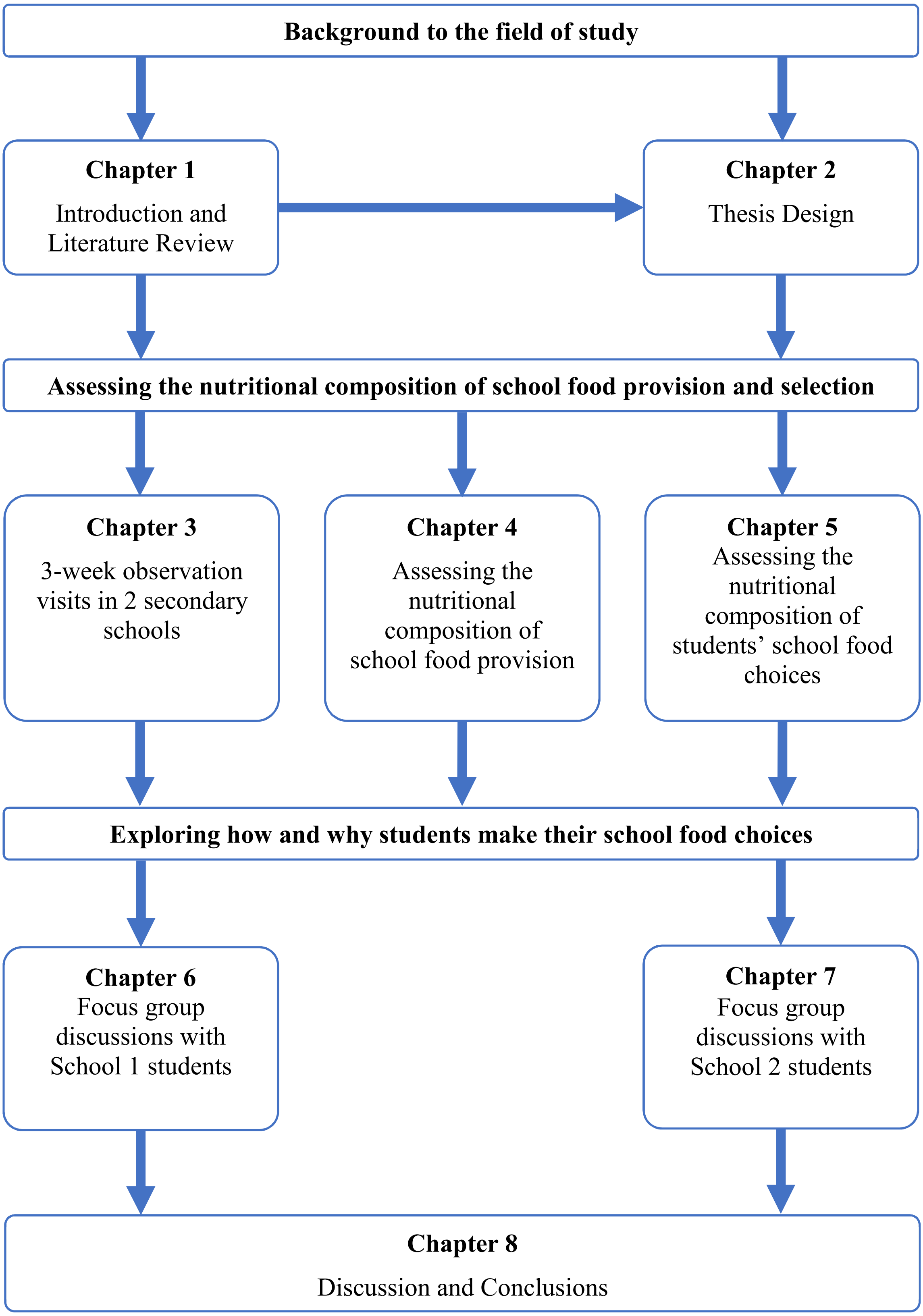

Figure 1.1 Structure of the Thesis

Chapter 1 discusses the relevant literature pertaining to adolescent food choice and the UK school environment. The chapter outlines the current state of adolescent obesity in the UK, after which it moves on to discuss adolescents' dietary behaviours and the key influences thereof. The review defines the school environment and considers the school environment as a setting for dietary research. The proceeding sections of the chapter provide a discussion of English school food policy; the effectiveness of English school food policy is considered, and possible mediators of this effectiveness are explored. The chapter then explores the existing body of research on adolescents' food choices in and around the school environment. Relevant theoretical considerations for the thesis are outlined, including the socio-ecological model (SEM)[31], food choice process model (FCPM)[32] and social norms approach[33]. The final sections of the chapter outline the emergent research questions and conclude with the aims and objectives of the thesis.

Chapter 2 describes the thesis design. The chapter begins with a general discussion of mixed methods approaches and the benefits of integrating findings from mixed methods. After this, there is a brief discussion of the design of the data collection for each component of the thesis, the different types of data collected and the strengths and limitations of these collection methods. The chapter also outlines what each thesis component looks to achieve in terms of knowledge contribution.

Chapters 3-7 constitute the study chapters. Chapter 3 gives a detailed account of the observation visits and the observant participant approach[34,35] to data collection. The chapter first defines what an observant participant approach is and provides examples of its use in previous research. The chapter describes the methods adopted to collect data within a school environment using an observant participant approach, discussing the researcher's daily routine, practices and experiences throughout the observation period. The key findings pertaining to school food preparation practices are described, before considering the findings in relation to current research and the thesis. Finally, the strengths and limitations of this approach are discussed and reflections made on how it impacted the thesis.

Chapter 4 focuses on the nutritional composition of English school food provision. The chapter describes how information and insights gathered during the observation visits were used in tandem with nutritional composition databases to inform the development of nutritional composition tables, encompassing all food/drink items provided in two schools. School food provision is assessed in relation to current food-based standards (FBS)[5], along with dietary guidelines and standard reference values for a lunch for this age group (equivalent to the previous NBS[4]); while the findings are considered in relation to school food policy. Before exploring adolescents' school food choices or dietary behaviours, it is important to establish the current landscape of school food, i.e. the nutritional composition of school food provision. In this way, chapters 3 and 4 set the stage for the remaining study chapters and the thesis overall.

Chapter 5 builds on chapters 3 and 4, by linking nutritional composition data with cashless catering data to examine the nutritional composition of adolescents' school food choices. By shifting the focus from school food provision to school food choices, chapter 5 outlines the nutritional implications of students' real-life school food choices. Once again, findings are discussed in relation to school food policy and previous research. In this way, chapters 3, 4 and 5 describe the current state of English school food from both sides of the counter, i.e. gaining catering staff's views on school food, along with their food preparation and provision practices, evaluating the nutritional composition of school food provision and then evaluating the nutritional composition of students' school food choices.

Chapters 6 and 7 describe the two focus group studies that were conducted, one in each of the two schools involved in the project. These chapters look to give context and insight to the preceding chapters by exploring how and why students make their food choices within the school environment. Moreover, the inclusion of an in-depth student perspective builds on pre-existing models of food choice to identify key opportunities and barriers to promoting healthy school food choices. Chapter 6 describes the focus group study in school 1, which explores students' school food choices within the school environment, students' lived experiences of having school food and the key mediators of their school food choices. The findings are described in relation to previous research and the socio-ecological model (SEM)[31] of food choice. Findings are also discussed in relation to the previous thesis chapters and implications for policy and practice are considered.

Chapter 7 describes the focus group study in school 2. This chapter examines food choices across the home and school environments to see how different environments may promote different choices and to better understand the potential role of family and friends in influencing school food choices. Once again, findings are discussed in relation to the SEM[31], and also the food choice process model (FCPM)[32], whilst implications for policy and practice are considered.

Chapter 8 summarises the overall findings of the thesis. Findings from chapters 3-7 are synthesised and discussed in relation to the relevant literature. The chapter brings together evidence from the quantitative and qualitative aspects of the thesis, after which there is a discussion of how the thesis contributes to the current knowledge base in the area of school food and adolescent dietary behaviours. The aims and objectives from chapter 1 are revisited and the key findings from the thesis are considered in relation to these. The chapter reflects on the complexities and challenges of conducting school food research, along with the PhD candidate's experience conducting the research. Finally, the strengths and limitations of the thesis are described and implications are discussed for future research, and policy and practice.

1.2 Adolescent Obesity in England

1.2.1 Current State of Adolescent Obesity in England

Adolescent obesity is a pressing concern in England, with 39% of adolescents aged 11-15 years classified as overweight or obese[1]. This is illustrated in figure 1.2, which shows the percentage of adolescents aged 11-15 classified as overweight and/or obese for the years 1995-2018 inclusive. The trend lines indicate that adolescent obesity levels have steadily risen in England over this same period, suggesting that the issue is worsening rather than improving.

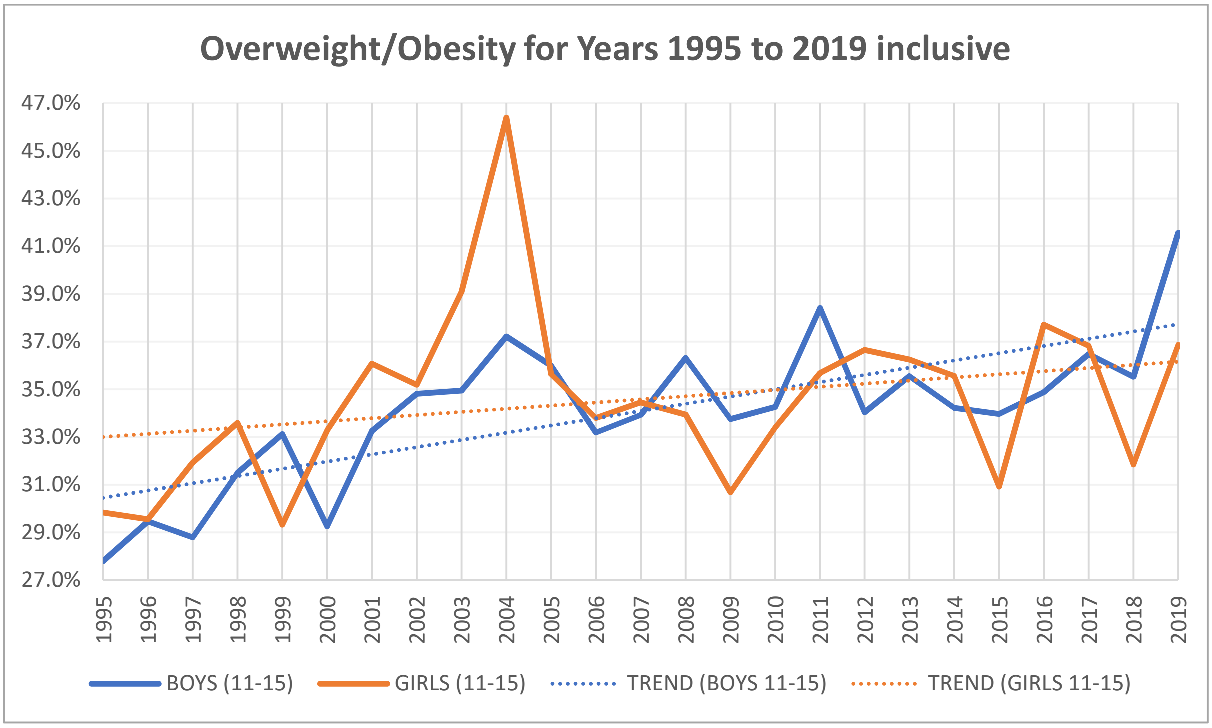

Figure 1.2. Trend of Overweight & Obesity Prevalence for Boys and Girls aged 11-15 years for the years 1995 to 2018 inclusive (Source: Health Survey for England 2019[1])

Globally, child and adolescent obesity rates have increased in recent decades[36,37], but prevalence remains highest in developed areas, such as the UK. Comparison to developed countries indicates that the UK has much room for improvement. For example, the Association for Young People's Health used data from the Global Burden for Disease 2016 study to compare adolescent (aged 15-19) obesity prevalence among 19 high-income countries, and found that the UK had the fifth highest proportion of adolescents (aged 15-19) classified as obese (8.1%)[38]. Moreover, the UK had the highest proportion of obese adolescents among any European country included in the analysis[38]. Increased consumption of energy dense foods and decreases in physical activity, together with sedentary lifestyles associated with modern urbanisation[39] have seen UK obesity rates grow in recent decades. Unhealthy dietary behaviour is a core component contributing to these heightened obesity rates[12].

The urgency of addressing obesity, both for adults and for children/adolescents, was evident in the Government's latest obesity strategy[40]. This policy paper outlined several ambitions for addressing adult and childhood obesity, including product reformulation, reduction of sugar, salt and calories in food/drink items, informative marketing and labelling of children's foods and weight loss support programmes. However, the introduction of some of the initiatives, such as restrictions on advertising of HFSS items and multibuy deals, were later delayed for a year[41]. The report served as a precursor for the national food strategy[42,43], part two of which was published last year[43]. Several recommendations were included in the strategy plan[43], including the introduction of a sugar and salt reformulation tax over a three-year period, trialling of a community eatwell programme to support individuals from lower socio-economic status (SES) areas to improve their diets and lower healthcare costs, and guaranteeing agricultural payments until 2029 to support sustainable farming.

Schools were prominent in the national food strategy report and a number of recommendations centred around the school environment. For example, a new “eat and learn” initiative was proposed, whereby food and nutrition would be formally embedded in the school curriculum, cookery and nutrition lessons would be formally monitored by the Office for Standards in Education, Children's Services and Skills (Ofsted), and foods needed for cooking and sensory food lessons would be Government subsidised. The report recommended running the initiative for three years in the first instance, after which there would be a formal evaluation of progress, with a view to continuing investment for ten additional years. Other recommendations included extending free school meal (FSM) eligibility to include all children from households earning under £20,000 per year, along with children from households with no recourse to public funds (NRPF), and funding the Holiday Activities and Food programme for the next three years (this programme offers free activities and at least one hot meal, which complies with school food standards, to FSM students during school holidays. Non-FSM students can often access the programme for a small fee).

The Government’s Levelling Up white paper[44] followed on from the National Food strategy and reported a commitment to adopting some of its recommendations for school food. For example, in the white paper, the Government announced a new project “to design and test an approach for local authorities in assuring and supporting compliance with school food standards”, along with a commitment to encourage schools to complete a statement on their school websites outlining their whole school approach to food. The paper also states the Government’s intention to make this statement mandatory, once schools can do this effectively. Furthermore, the paper states that the Government will invest £5 million in developing school cooking content for the school curriculum, upskilling teachers on cooking through training and leadership, and promoting a whole school approach to food. A listed ambition for this work is that every student leaving secondary school will know at least six recipes that they can use throughout their lives.

Whilst the latest obesity strategy and the national food strategy look to tackle adolescent obesity as part of a larger national obesity initiative, the Government had previously published reports focusing specifically on young people; chapters 1 and 2 of the Childhood Obesity action plan were published in 2016[45] and 2018[46] respectively. The plan aimed to halve childhood obesity by the year 2030, and substantially reduce health inequalities between adolescents from the most and least deprived areas. The plan outlined a number of initiatives intended to tackle childhood/adolescent obesity, including introducing a tax on high-sugar soft drinks, encouraging food and drinks reformulation (especially caloric and sugar reductions, e.g. challenging industry to a 20% sugar reduction from the foods most commonly eaten by children, challenging food and drinks companies to reduce the energy content of a range of foods consumed by children by 20% by the year 2024). The plan also proposed a 9pm watershed for TV advertising of food/drink items that are high in fat, sugar and salt (HFSS items) and encouraged children to do at least 60 minutes of physical activity each day. The school environment was highlighted as vital to achieving the ambitions of the Childhood Obesity plan and facilitating healthy dietary behaviours in young people. For instance, chapter 1[45] listed recommendations such as (1) using the revenue generated from the soft drinks levy (estimated at £10 million a year) to fund the expansion of healthy breakfast clubs, (2) offering high quality sports and physical activity programmes to schools and (3) increasing the number of students walking/cycling to school as part of a larger £300 million investment to support cycling/walking among the general population.

Chapter 2[46] provided an update on progress since the publication of chapter 1, reporting a 2% sugar reduction across the foods most commonly consumed by children, reformulation efforts by many major food producers and reporting an observed channelling of funds from the soft drinks levy into school breakfast clubs for the most disadvantaged children, physical education classes and school sport. Chapter 2 also gave some additional details, including a commitment to invest £1.6 million to support walking/cycling to school, updating school food standards to reduce sugar consumption and revising the nutrition standards in the Government Buying standards for Food and Catering Services, to better align with recent scientific dietary advice. Chapter 2 also indicated that Ofsted, the national school inspection body, would revise its inspection framework for September 2019, to consider schools' performance in supporting students' broader personal development, including healthy behaviours (e.g. diet, physical activity). Within the revised inspection handbook, relevant dimensions of students' personal development included the following: "developing pupils' understanding of how to keep physically healthy, eat healthily and maintain an active lifestyle, including giving ample opportunities for pupils to be active during the school day and through extra-curricular activities".

Whilst these measures have shown some positive effects, there remains much to do. For example, the first year after the sugar reduction programme was introduced saw a 2% decrease in the sugar content of food/drink items commonly consumed by children[47]; however, this falls short of the intended decrease of 5% in the first year and the larger aim of 20% by the year 2020. A 2020 progress report[48] indicated an overall reduction of 3% in the sugar content for food/drink items commonly consumed by children, for the period 2015 to 2019, suggesting a limited effect for the sugar reduction programme. Stronger evidence of effect was found for the soft drinks levy; during this same period (2015-2019), there was a 43.7% reduction in total sugar per 100ml for drinks subject to the soft drinks levy. That said, chocolate confectionary sales increased by 10.7% over the same period, leaving question marks in terms of how much the soft drinks levy resulted in decreased overall consumption of sugar and, moreover, how much it impacted childhood obesity.

Whilst these steps are encouraging, it is too early to say what effect publications like the Levelling Up white paper, the national food strategy, or the Childhood Obesity plan will have long-term, or how many of the recommendations will come to fruition. However, these repeated policy efforts reflect the importance of the adolescent obesity challenge. Gaining a deeper understanding of adolescents' dietary behaviours and learning how to encourage positive changes will be pivotal to meeting this challenge, while the school environment will hold great relevance as a health promotion setting.

1.3 Adolescent Dietary Behaviour

1.3.1 Adolescents as a Unique Cohort

In terms of health and health behaviours across the life course, adolescents are a particularly unique cohort. In the UK, many adolescents do not meet government guidelines for daily dietary intakes[2,3] or levels of physical activity[49]. Moreover, research indicates that poor diet, reduced physical activity and sedentary lifestyles often coexist[50]. This concurrence may exacerbate the negative effects of these unhealthy behaviours, thus hastening the development of risk factors for non-communicable diseases (NCDs).

Adolescents' status as a unique cohort is evident in their dietary behaviours. Table 1.1 outlines dietary intakes from recent National Diet & Nutrition Survey (NDNS) data[3] for three groups along the life course: children (aged 4-10 years), adolescents (11-18 years) and adults (19-64 years). The NDNS findings suggest that all three cohorts exceed dietary reference values for saturated fat (no more than 11% of food energy) and free sugars (no more than 5% of total dietary energy)[3]. However, differences between the three age cohorts become more apparent when considering intakes of fibre and select micronutrients. For example, substantial percentages of adolescents (aged 11-18 years) have nutrient intakes below lower reference nutrient intakes for iron (32%), calcium (16%), zinc (22%), magnesium (38%), potassium (28%), iodine (20%) and vitamin A (21%)[3]. This is in stark contrast to both younger children (aged 4–11 years) and adults (aged 19-64 years), of whom much smaller percentages have nutrient intakes below lower reference nutrient intakes for these same nutrients and vitamins.

Table 1.1. Comparison of dietary intakes (energy, select nutrients, and fruit & vegetables) across children, adolescents and adults. Source is NDNS Years 7 and 8 combined[3].

Nutrient/Food Intake	**Measure**	**Children (4-10 years)**	**Adolescents (11-18 years)**	**Adults (19-64 years)**
Energy	kcal/day	1432	1716	1860
Saturated Fat	% food energy	13.0	12.4	12.5
Free Sugars	% total dietary energy	13.5	14.2	11.7
Protein	% food energy	15.0	15.6	17.6
AOAC Fibre	% meeting recommendation	9.9	4.0	13.1
Iron	% below LRNI	1.6	32.2	1.9
Calcium	% below LRNI	1.4	16.4	8.7
Zinc	% below LRNI	11.3	22.4	7.5
Iodine	% below LRNI	5.2	20.3	11.9
Potassium	% below LRNI	0.1	27.7	16.9
Magnesium	% below LRNI	1.3	37.8	12.6
Vitamin A	% below LRNI	11.8	21.2	12.9
Folate	% below LRNI	0.8	9.2	4.5
5 portions fruit & vegetables a-day	% meeting recommended 5 portions of fruit & vegetables a day	N/A	7.9	30.6

Table 1.2 illustrates the mean daily intakes for adolescents in general, along with adolescent boys and girls. As illustrated in the table, most adolescent diets do not meet recommendations for levels of sugar, sodium and saturated fat, or number of portions of fruit and vegetables[2,3]. Adolescents consume just 2.7 of the (minimum) 5 recommended portions of fruit and vegetables per day[3]; meanwhile descriptive analysis of 666 adolescent (11-18 years) food diaries found that 39.5% of their energy intake comes from non-core foods (e.g. soft drinks, crisps, savoury snacks, chips, chocolate, biscuits[51]. Adolescents snack and graze, skip meals, consume energy dense and nutrient poor fast foods[52], and diet (especially females) more frequently than younger children[53,54]. Adolescents also consume increasing amounts of

sugar sweetened beverages (SSBs) and confectionary items up to the age of 18, after which it starts to decrease[13].

Table 1.2. Comparison of select daily nutrient/food intakes across all adolescents, adolescent boys and adolescent girls. Source is NDNS Years 7 and 8 combined.

Energy/Nutrient	Adolescents (11-18)	Boys (11-18)	Girls (11-18)	Measure	Adolescents (11-18)	Boys (11-18)	Girls (11-18)
Energy (kcal)	1716	1868	1555				
Saturated Fat (g)	24.2	26.7	21.4				
Free Sugars (g)	67.1	71.6	62.4	% below or at 5% of energy	5.5	5.3	5.6
Protein (g)	65.4	72.5	57.9				
Carbohydrate (g)	230	248	210				
AOAC Fibre (g)	15.3	16.5	14.1	% meeting recommendation	4.0	5.9	2.0
Iron (mg)	9.2	10.1	8.3	% below LRNI	32.2	12.0	53.7
Calcium (mg)	762	854	664	% below LRNI	16.4	11.0	22.0
Zinc (mg)	7.2	8.0	6.3	% below LRNI	22.4	17.9	27.1
Iodine (mg)	119	137	101	% below LRNI	20.3	13.9	27.0
Potassium (mg)	2249	2456	2029	% below LRNI	27.7	18.4	37.5
Magnesium (mg)	207	226	187	% below LRNI	37.8	26.8	49.6
Vitamin A (ug)	549	598	497	% below LRNI	21.2	18.8	23.8
Folate (ug)	193	210	174	% below LRNI	9.2	3.3	15.4
Vitamin D (ug)	2.1	2.3	1.9	mean as % of RNI	21.0	23.1	18.8

As mentioned earlier, adolescence is a critical period in terms of dietary behaviours across the life course. This time is associated with dietary changes[13], namely decreases in diet quality, increases in energy intake and subsequently increases in obesity levels[55,56]. Unhealthy dietary behaviours and obesity levels can hold physical and psychological consequences during adolescence[57–60]. Moreover, unhealthy dietary patterns can continue into adulthood[61–64] and are associated with various physiological (e.g. cardiovascular diseases, diabetes)[65–67] and psychological (e.g. depression, anxiety)[68,69] health conditions in adulthood. Therefore, establishing healthy behaviours during the adolescent stage may hold benefits for people's physical and psychological health throughout the remainder of the life-cycle.

Adolescent obesity is also associated with substantial economic implications. Recent estimates indicate that obesity and obesity-related issues cost the NHS £6.1 billion per year, whilst obesity costs wider society an estimated £27 billion[11]. Another important benefit of positively influencing adolescent dietary behaviour lies in the potential educational outcomes. For example, a systematic review (n=40 studies) explored the impact of dietary intake and behaviour on academic performance and found moderate positive associations between regular breakfast consumption, increased diet quality and academic achievement among school-aged children and adolescents (aged 5-18 years)[70]. These points underscore adolescence as a critical period for dietary intervention. A pressing challenge for researchers therefore is to better understand adolescent dietary behaviours and food choices, as this is central to designing effective interventions and tackling rising obesity rates.

1.3.2 Influences on Adolescent Dietary Behaviours

Similar to other age groups, adolescent dietary behaviours can be influenced by a multitude of individual, social, physical, environmental and macro system factors[71,72]. However, adolescents are unique in the number and intensity of influences acting upon their health behaviours. For instance, adolescent dietary behaviours can be influenced by a number of maturational factors including changes in body shape[73], cognitive processes[74,75] and a desire for personal autonomy and independence. The following sections will explore some key influences of adolescent dietary behaviours, namely physiological, social/peer, familial, socio-economic and media, and outline relevant research evidence for each influence.

1.3.2.1 Physiological Influence on Dietary Behaviours

Adolescence is a period of rapid growth and development, second only to that seen in infancy[76]. However, the adolescent period of growth and maturation lasts longer than in infancy and as such, the total nutritional demands may be greater for adolescents[76]. Adolescents attain approximately 15% of adult height and 45% of adult skeletal mass during the pubertal process[77], while the nutritional demands associated with adolescence are relatively high for most nutrients compared to other age groups. For example, increased levels of calcium and vitamin D are required to facilitate bone growth and ossification[76,78]. Iron requirements also increase during adolescence and are important for supporting muscle development[79] and cognitive functioning[80,81].

In terms of physiology and physiological changes, adolescence can be characterised into different sub-cohorts; for instance, a recent Lancet commission on adolescent health and wellbeing divided adolescence into early adolescence (10-14 years) and late adolescence (15-19 years)[82]. Early adolescence is typified by the onset of puberty and sexual development, late adolescence is also characterised by puberty and maturation but these developments are less obvious compared to young adolescents[82]. Adolescent development may also be considered with respect to gender. Whilst the maturational process of adolescence can be described generally for both males and females (changes in body shape, increases in height and weight), the physiological mechanisms of this process differ by gender (increased testosterone for males, increased oestrogen for females) and may present different challenges for each. For example, caloric requirements are typically higher for males than females, due to greater increases in height, weight and lean body mass experienced by male adolescents compared to female adolescents[77]. Moreover, gender differences in peak growth rates means that protein requirements are highest for girls aged 11-14 years and males aged 15-18 years old[83]. Iron requirements may be higher for males during growth spurts, due to higher rates of growth and muscular development compared to females. However, generally iron requirements are higher for female adolescents than males once menarche has begun[79].

Despite the above examples, relatively little is known regarding the nutritional requirements associated with physiological changes during adolescence or how this may manifest itself in terms of dietary behaviours. Finally, research and policy dissemination efforts often describe adolescents as a single cohort; whilst this is useful for making population-level inferences, it is still important to explore how nutritional demands may fluctuate across gender and/or stages of adolescence and how dietary behaviours may differ as a function of age and gender.

1.3.2.2 Family/Parental Influence on Dietary Behaviours

Another key characteristic of adolescence is that it signals a time of transition from childhood into adulthood; this transition can influence adolescent-parent dynamics and associated adolescent dietary behaviours. During childhood, parents are typically the primary influences on children's health behaviours[84] but as individuals develop from late childhood into adolescence, they begin to take on a greater sense of autonomy and independence from their parents[85]. However, parents still play an important role in determining and shaping adolescent health behaviours. For example, research indicates that parents can influence adolescent health behaviours through their own diet and physical activity behaviours[86,87], monitoring efforts[88,89], and by providing support to their child(ren)[90]. As such, discussions of school food choice and adolescent dietary behaviours benefit from an understanding of adolescents' home food environments, and the influence their parents have had on their dietary behaviours throughout their childhood.

Consistent with family systems theory[91], which posits that families function as an interactive group rather than independent individuals, research suggests that adolescents' dietary autonomy is co-constructed by both parents and adolescents in a reciprocal dynamic[92]. Within the home environment, adolescents may take on greater autonomy by ignoring parental advice, preparing their own separate meals or eating food from outside the home. Parents, in turn, serve as nutritional gatekeepers within the home environment[93], often deciding what foods/drinks are available in the home and taking responsibility for purchasing and preparing foods. Parents can grant autonomy to their adolescent children by trying to coach their children to make certain food choices and enabling adolescents to make independent food choices within the home environment. In this way, adolescent home food choices are arrived at through a process of negotiation and interaction with parents[92,94].

A number of studies have found evidence for the role of parental food modelling in influencing adolescent dietary behaviours[86,95–98]. For example, an Australian study found parental (especially maternal) intake of various foods and drinks was significantly associated with adolescent boys' intakes of high energy drinks ($P < 0.01$), sweet snacks ($P = 0.01$), savoury snacks (P < 0.01) and take-out food (P < 0.01)[97]. Fleary and Etienne[96] examined concordance amongst 1859 parent-adolescent dyads for the consumption of fruits and vegetables, junk foods and SSBs and found that parental modelling of healthy dietary behaviours (consumption of fruits & vegetables) was positively associated with adolescent consumption. This echoes a Polish study by Zarychta, Mullan and Luszczynska[98], which found that adolescents (n =100) who perceived that their parents had healthy diets and engaged in regular physical activity reported a healthier diet and higher levels of physical activity themselves. A related study by Loth et al.[95] explored potential associations between different aspects of the home food environment (food availability, parental modelling, food restriction) and adolescent dietary intake; the findings indicated that parental modelling of healthy eating behaviour was associated with adolescent consumption of SSBs. These findings point to the importance and effectiveness of healthy parental behaviours in influencing adolescent dietary behaviours.

Linked to parental food modelling is home food availability (what foods parents/guardians provide/make available within the home), which provides a valuable opportunity for parents to influence adolescents' home food choices. Research by Loth et al.[95] indicated that of three commonly investigated aspects of the home food environment (food availability, food restriction, parental modelling), food availability was the aspect that most consistently influenced healthy adolescent dietary intakes. Availability of healthy foods at home was positively associated with adolescent fruit and vegetable intake and negatively associated with adolescent consumption of SSBs or palatable snacks. This builds on previous research which indicates that mothers' provision of unhealthy foods at home is significantly associated with adolescent girls' consumption of sweet snacks, savoury snacks and high energy drinks[97]. A longitudinal study by Arcan et al.[86] explored associations between parental reports of in-home food availability, parental intakes and subsequent adolescent intakes for 509 parent-adolescent pairs from 1999 to 2004. The findings indicated that parents' provision of vegetables at dinner significantly predicted intakes of these foods among male and female adolescents, while provision of milk at dinner time significantly predicted intake of dairy amongst young adults at 5 year follow up[86].

The aforementioned studies on home food availability illustrate how parents influence adolescents' food choices indirectly/implicitly via the foods they make available. Interestingly however, evidence suggests that when parents try to exert influence in more direct/explicit ways, for example, by restricting the availability and/or consumption of less healthy foods in the home environment, this can be counterproductive to facilitating healthy adolescent food intake[95,99,100]. For example, a review of parenting styles and child/adolescent's (1-21 years) eating and weight status found a generally positive association between restrictive parenting practices and increased child intake and weight status[99]. Fleary and Etienne[96] examined concordance of dietary behaviours amongst 1859 parent-adolescent dyads and found that parental imposition of rules or limits pertaining to junk foods/SSBs was associated with adolescents' consumption of these same foods. Similarly, Zarychta, Mullan and Luszczynska[98] perceived parental verbal pressures to engage in health behaviours was shown to have no effect on adolescents' dietary behaviours or physical activity engagement. Interestingly, Loth et al.[95] found that parents' food restriction efforts were positively associated with adolescent consumption of both healthy fruit and vegetables and less healthy snack foods.

This last point regarding parenting practices (rules, food restrictions) and unintended consequences (increased food intake/weight status) brings attention to the importance of parenting styles with regard to adolescent dietary behaviours. Whilst parenting practices can encompass the actions, interventions, rules and supports parents enact to influence their child's behaviour, parenting style refers to the overall culture and climate in which the parenting occurs. Researchers have argued that the effectiveness of specific parenting practices may be moderated by the encompassing parenting style[101]. The four key styles of food parenting include: authoritative, authoritarian, permissive/indulgent and uninvolved/ neglectful[102–104], which are posited across two different dimensions: responsiveness, which encompasses parents' warmth, involvement, nurturance and support towards their child and demandingness, which refers to parents' exertion of control on their child's behaviours (via rules and restrictions)[104]. The four parenting styles are conceptualised as follows: (1) authoritative parents are both responsive and demanding, (2) authoritarian parents are less responsive but highly demanding, (3) indulgent or permissive parents provide a high level of responsiveness but are less demanding, and (4) neglectful or uninvolved parents show relatively low levels of both dimensions[104].

A cross-sectional study by Pearson et al.[102], conducted with 328 adolescents (12-16 years) in secondary schools in the East Midlands of the UK, tested for associations between the four parenting styles and adolescents' dietary behaviours. Findings revealed that regardless of family structure, adolescents who described their parents as having an authoritative parenting style reported having healthier dietary behaviours than adolescents who described their parents as authoritarian, indulgent or neglectful. Similarly, a systematic review exploring associations across 36 studies between parenting styles and weight-related outcomes found that children and adolescents (0–16 years) with authoritative parents ate healthier foods, engaged in higher levels of physical activity and had lower BMI levels compared to children who had authoritarian, permissive/indulgent or uninvolved/ neglectful parents[103]. These studies suggest that an authoritative parenting style may be the most conducive style in terms of positively influencing adolescents' dietary behaviours.

An authoritative parenting style scores high on the responsive and demanding dimensions of parenting. This raises an interesting point as demanding parents may well enact practices such as restricting food, setting rules and exercising control over their child's intake, which some of the research mentioned earlier[95,96,99,100] suggests can backfire and lead to worse adolescent health behaviours. However, the coupling of demandingness with a high level of responsiveness (i.e. nurturing, giving attention, warmth) may enable authoritative parents to exercise a level of control but in a manner that is more amenable to their children. This points to the importance of context in determining how adolescents react to different influences.

As mentioned at the beginning of this section, in understanding adolescents' school food choices and dietary behaviours, it is important to consider the home environment. Indeed, consideration of the home, and inclusion of parental perspectives is recommended within whole-school approaches to school food[105]. Meanwhile, research indicates that school-based dietary interventions may be more effective when parental involvement is sought[106]. Moreover, the principles regarding parenting style may well be applicable to the school context and could help inform how school messaging efforts are communicated (i.e. schools being authoritative). For example, research by Hermans et al.[107] explored Dutch adolescents' response to the "Healthy School Canteen Program" and found that while the students supported the program, they reported that schools were relatively inattentive, as there was no scope for them to be involved as consultants. Adolescents were therefore skeptical as to whether their views would be incorporated, which diminished their buy-in to the program. Therefore, it is important that any efforts to improve school food choices include parental involvement and perhaps, also learn from parents in terms of how new rules and initiatives are co-constructed with students themselves.

1.3.2.3 Peer Influence on Dietary Behaviours

As children transition from childhood to adolescence, they become increasingly independent from their parents and spend more and more time with their friends[85]. Peers become more influential in late childhood and preadolescence (6-12 years) with peers' influence peaking during adolescence[85,108]. Peer influence is a distinctive aspect of adolescent dietary behaviour and research has highlighted the importance of peers and peer influence on adolescent dietary behaviours. For example, evidence suggests that attachment to peers and close friends can influence adolescents' decision-making[109], consumer behaviour[110] and food consumption[111–113]. Research has also found that adolescents' healthy eating patterns mirror those of their best friends, while peers' (dis)approval and attitudes towards adolescents' food choices have been shown to significantly predict adolescent's food choices[114].

Whilst there is evidence supporting the influence of peers on adolescent dietary behaviour, the mechanisms of this influence are equivocal. There is also uncertainty regarding the directionality of this influence, i.e. peers can be a positive or negative influence on adolescent behaviours. For example, a cross-sectional study with 2500 European adolescents from 24 schools (10-17 years) explored associations between subjective eating norms and adolescents' healthy eating intentions and intake of healthy/unhealthy foods; the study found that peer encouragement towards and endorsement of healthy foods was associated with increased adolescent consumption of healthy foods, along with decreased consumption of less healthy foods[115].

However, evidence also indicates that peer modelling is related to adolescent consumption of sugar-sweetened beverages[116], peer liking of unhealthy foods (e.g. cookies, sweet items) significantly predicts adolescents' unhealthy food consumption[117] and that peer support for unhealthy eating is significantly associated with increased selection and consumption of unhealthy foods[118]. Furthermore, some studies have found no significant impact of peer influence over adolescent dietary behaviours[119–121]. For example, a cross-sectional survey study by Gerrits et al.[119] found that despite adolescents holding positive perceptions of peers who ate healthily, this did not hold significant influence over their self-reported dietary behaviours. Similar results were reported in a study by Pedersen, Grønhøj and Thøgersen[120], which surveyed 757 adolescent-parent dyads, and found that the attitudes and behaviours of peers did not influence adolescents' fruit and vegetable consumption. Finally, an American cross-sectional study found no association between peers' support for healthy eating and healthy food consumption[121].

Some systematic review studies have tried to synthesise the research evidence pertaining to peer influence and dietary behaviours. For example, a review of 32 studies by Chung, Ersig and McCarthy[122] found that adolescents' PA and dietary habits were significantly associated with those of their peers. However, associations differed depending on gender, the nature of the dietary/PA behaviour and the relationship to the peer[122]. In the context of diet specifically, (1) the type of food consumed and (2) the closeness of the peer relationship were noted as important mediators. The review also found significant associations between the diets of adolescents and peers in 6 of the 7 quantitative studies solely looking at diet; adolescents' intakes resembled those of their friends for soft drinks[123,124], snacks[124] and fast food[111].

One of the larger studies in the review[123] explored associations between adolescents' and friends' (n = 2043) reported healthy eating behaviours, namely breakfast, fruit, vegetables, whole grain and dairy food intake. Findings indicated significant associations between adolescents' and peers' intakes for whole grains and dairy foods, suggesting that peer influence can hold effect for healthier foods also. Interestingly, the study found no association between adolescents' and friends' reported fruit intakes[123], suggesting that peer influence over adolescent dietary behaviour may not be consistent across food types. Positive associations were also found between adolescents' and their closest friends' vegetable consumption but there were no such associations between adolescents and casual friends[123].

A systematic review by Rageliene and Grønhøj[112] examined the influence of peers and siblings on adolescents' eating behaviours across 29 studies. The review revealed mixed results; a substantial number of the included studies (37.93%) indicated a negative influence of peers and siblings on preadolescents' (9-13 years) and adolescents' (13-18 years) healthy eating behaviours via increases in consumption of energy-dense and low-nutrition value foods. Just under a fifth (17.24%) reported a positive influence of peers and siblings on adolescents' healthy eating behaviour, under a fifth (17.24%) reported no significant effects while the remaining studies (27.59%) found both positive and negative influences of peers and siblings on adolescents' healthy eating behaviour. The findings resembled the previous review in illustrating the relevance of different factors, and different contexts, in impacting the direction (positive or negative) of peer influence over adolescent dietary behaviours. As it pertains to school specifically, student consumption norms predicted adolescents' consumption of energy-dense, nutrient-poor snack foods.

1.3.2.4 Socio-economic Influence on Dietary Behaviours

Another important influence on adolescent dietary behaviours is socio-economic status (SES). SES is generally characterised by a combination of three core aspects: educational level, employment status and level of parental/household income. Research suggests a SES gradient in dietary behaviours, physical activity and obesity levels, both within the UK[125] and internationally[126]. In terms of dietary behaviours, research generally suggests that lower SES is associated with decreased selection and consumption of fruits, vegetables and dairy products, along with increased consumption of SSBs and energy dense options among adolescents and young adults[127,128]. Significant associations have been found between SES and less favourable adolescent dietary behaviours in multiple studies; for example significant associations have been found between lower SES and lower daily fruit, vegetable, dairy products and breakfast consumption in Greece[129], lower fruit, vegetable and whole grain bread and cereal product consumption and greater SSB consumption in Belgium[130], low vegetable intake and higher SSB consumption in Australia[131], lower intakes of fruit and vegetables and yoghurts and higher intakes of starchy foods, meat, milk, sugar-sweetened beverages and pizzas/sandwiches in France[132], lower fruit and vegetable consumption in Norway[133] and greater intakes of sugar-sweetened beverages, confectionery, crisps and savoury snacks and lower intakes of fruit, fruit juice and vegetables in the UK[125]. This suggests that the association between lower SES and less favourable dietary behaviours is consistent cross-culturally.

A systematic review, published in 2019, investigated dietary differences among adolescents and young adults according to SES[127]. Findings indicated that greater consumption of fruits and vegetables, dairy products and lower consumption of SSBs and energy dense foods was associated with higher parental SES. The review also concluded that whilst all three aspects of SES may influence adolescent dietary behaviours, parental education was a more consistent determinant of adolescent diet than occupation or income. This was especially true in the case of maternal education levels. One proposed reason for this is that more educated parents may have higher levels of food knowledge and food literacy, which may help to contribute towards healthier food messaging and choices for the family. Other reasons include the observation that mothers often assume the role of nutritional gatekeeper in the household[134], while research suggests that maternal communication is more effective in influencing adolescents compared to paternal communication[135].

Whilst the review indicated that paternal education was the most prominent determinant of adolescent dietary behaviour, consideration of parental income and employment status also illustrates how SES can hold substantial effects on dietary behaviours. For example, evidence from a mixed-methods study exploring food purchasing practices of English secondary school students (n=535 for questionnaire; n= 651 for qualitative section, which included semi-structured interviews, focus groups, written exercises) suggests that the importance of food choice values such as cost, taste and nutritional content of food may differ between adolescents from higher SES schools (assessed by IMD of school postcode and FSM%) and adolescents from lower SES schools[136]. Moreover, parental occupation may also impact how much time and availability parents have to prepare foods for their children or to spend time with their children and serve as food models.

A large-scale study (n= 1768) by Béghin et al.[137] examined the relationship between parental SES and adolescent diet quality across northern and southern Europe and found that in general, parental education level and parental occupational level was positively associated with adolescent diet quality. However, the quality of adolescent diets was positively correlated with parental education level in northern Europe but not in southern Europe. In line with previous studies[138,139], the researchers suggested that the more favourable dietary habits (i.e. Mediterranean diet) and healthier nutritional environment found in southern Europe mediated against health risks and attenuated the influence of parental education levels on adolescent diet quality. Meanwhile, parental occupation (which is a predictor of household income) was found to be positively associated with adolescent diets across both northern and southern Europe, indicating that the financial cost of food holds relevance cross-culturally.

Research has highlighted ways in which SES differences can be highlighted within the school environment. For example, a systematic review of 43 studies by Mackenback et al.[140] examined associations between food environments and dietary behaviours of adolescents and adults from different SES groups in different countries. Overall, the findings indicated no clear evidence for SES differences in associations between environment and dietary behaviours; however, the limited number of school-based studies (n= 4) did find SES differences in associations between dietary behaviours and the school food environment. That said, the findings were inconsistent; two studies indicated that healthy school food provision benefitted lower SES students more so than higher SES students[141,142], one study reported that higher SES students benefitted more from healthy school food provision than lower SES students[143], while the fourth study found the presence of nearby fast food outlets was associated with less favourable eating habits in low SES students only[144].

Moving to a narrower focus, the role of SES has also been explored within the UK school setting. For example, findings from a mixed methods study of 7 UK secondary schools found that students attending lower SES schools were more likely to purchase foods from nearby food outlets compared to students from high SES schools[136]. SES differences were also apparent in the salience of certain food choice values; responses via purchasing recall questionnaires (n=535) and various qualitative methods (e.g. interviews, focus group discussions, semi-structured written activity) (n= 651) indicated that taste, ingredients and advertisements were important factors to students from lower SES schools, while health was only mentioned as a food choice factor by students at a high SES school[136]. A qualitative study also found SES differences in lunchtime dietary behaviours, as lower SES students reported purchasing lunch at nearby food outlets rather than at school[145]. Lower SES students reported that they felt more welcome in nearby outlets and could more easily socialise with their friends here as opposed to having lunch in school[145]. On the other hand, students from higher SES schools reported feeling more welcome to have lunch in school, but many reported bringing lunch in from home. Meanwhile, students at mixed SES schools reported feeling less welcome in nearby outlets but also highlighted how they were not eligible for FSM but also still struggled to afford certain school foods. This illustrates how students of different SES backgrounds face different challenges when making school food choices and highlights the importance for schools in trying to minimise these gaps and associated behaviours.

1.3.2.5 Media & Marketing Influences on Dietary Behaviours

The final major influence on adolescents' dietary behaviours to discuss is media and food marketing, both on traditional mediums and newer forms such as social media. Research indicates that exposure to food advertising holds influence over children's dietary health by prompting consumption in the immediacy following the advert and, over the longer-term, by influencing children's food preferences[146,147]. Moreover, systematic reviews on the effects of food promotion and on-screen advertising to children and adolescents (aged 2-15 years) have reported significant effects in terms of influencing food preferences and consumption[146,148,149]. A 2019 review[150] focusing solely on pre-adolescents and adolescents, found a significant effect for exposure to food marketing on unhealthy diet-related outcomes such as recall of noncore foods, positive attitudes toward noncore foods, negative attitudes toward core foods, increased purchasing of noncore foods and increased consumption of noncore foods. Furthermore, findings from the 2017 Youth Obesity Policy Survey found that adolescents' (11-19 years) awareness of food/drinks high in fat, sugar and salt (HFSS) food marketing activities is associated with greater HFSS foods consumption[151–154].

Internationally, various policy initiatives have tried to "rebalance the food marketing landscape"[155], whilst research has linked food advertising with children's health and food preferences[146–148,156,157]. In July 2017, the UK Government banned advertising of HFSS items in children's media, i.e. media that is directly aimed at children. This developed on pre-existing regulations for broadcast media (television & radio) prohibiting the advertisement of HFSS directly to children, thus ensuring that these products are not directly marketed to children at any point during the day. However, up to 50% of children's television viewing is as part of a family viewing experience, i.e. watching a programme with their older sibling and/or guardians[158] and advertising regulations are less strict for this programming; as such, HFSS products may be advertised indirectly to children during these programmes. Chapter 2 of the Childhood Obesity Action Plan acknowledged this, and called for a 9pm watershed for advertising of HFSS foods/drinks both on broadcast media (television & radio) and also online[46]. A recent modelling study[159] estimated the health impact of enacting the 9pm watershed, with results suggesting that enacting this policy would reduce numbers of children and adolescents (aged 5-17 years) classified as overweight by 3.6% and obese by 4.6%.

Whilst the influence of traditional media advertising is certainly important, an area of growing concern within the media sphere is social media. A recent report on UK media use and attitudes[160] stated by the time adolescents reach 13 years of age (the minimum age requirement for having a social media profile), more than half have a social media profile, while at 15 years old, almost all adolescents report having a social media profile. The food industry has responded, by utilising social media platforms for marketing of low-nutrient energy-dense foods. For example, content analyses of different social media platforms (e.g. YouTube, Instagram) indicates a strong presence of food marketing efforts[161–163]. Moreover, a content analysis of YouTube advertisements on videos specifically targeting children found that food and beverages accounted for the largest percentage of advertisements (38%), of which 56% promoted noncore foods[161]. Given that children and adolescents are consuming an increasing amount of content via non-traditional mediums[160] it is important that researchers and policy-makers keep pace with developments to social media platforms in order to mitigate against unhealthy influences on adolescent dietary behaviours.

In terms of the school environment, limited research has explored the role of media and advertising in influencing school food choices. A study by Scully et al.[164] looked at exposure to food marketing and subsequent food choices, and found that school food marketing was associated with sweet snack consumption. Kelly et al.[165] found that up to 25% of advertising within a 500m radius of Australian primary schools was for food, 80% of which was for non-core foods. Meanwhile, Molnar et al.[166] surveyed 313 US primary school officials, and found that over a third of schools participated in fundraising, almost a third participated in incentive programs and roughly 16% had exclusive agreements with a corporation that sold foods high in fat and sugar or foods of minimal nutritional value. Finally, UK based research by McSweeney et al.[14] found that advertising of healthy items in schools can also have a negative effect, as the concurrent availability and presence of less healthy foods may undermine these health messaging efforts within schools as students may interpret this as hypocritical.

1.4 The School Environment

The previous sections discussed adolescent dietary behaviours and the influences thereof more generally, with some references to school food. The following sections will narrow the focus to the school environment specifically, and discuss the current research on school food choices and adolescent dietary behaviour within the school environment.

1.4.1 Defining the School Environment

The United Nation's Food and Agriculture Organisation (FAO) defines the school food environment as "all the spaces, infrastructure and conditions inside and around the school premises where food is available, obtained, purchased and/or consumed, for example tuck shops, kiosks, canteens, food vendors, vending machines"[167]. As this definition indicates, the school environment encompasses much more than the classroom or canteen space, including nearby outlets and the school's wider community. As such, it is incumbent on school food researchers and policymakers to consider the role and (potential) influences of all actors (e.g. staff, students, parents, local vendors, catering staff, school leadership) and environmental contexts (e.g. school dining environment, nearby outlets, home environment) within the wider school environment.

1.4.2 Schools as Health Promotion Settings

As mentioned earlier, the UK Government has repeatedly highlighted schools as health promotion settings (e.g. in the childhood obesity plan[45,46], national food strategy[42,43]). There are several reasons why the school environment has received special attention and is considered a sound setting for research on adolescent health behaviours. For one, over 3 million adolescents attend secondary school in England alone[168]. Students also spend a considerable proportion of their time at school, second only to time spent at home. In the UK for example, students may spend up to 6-7 hours of their day and at least 190 days per year in school[169]. Students consume up to a third of their daily energy from food whilst at school[170]. Given that adolescents consume a substantial proportion of their daily energy from food within the school setting, establishing a healthy school environment could have a positive effect on students' dietary behaviours at school[171,172] and contribute substantially to their overall diet.

Another reason, and a key strength of the school environment as outlined in the Childhood Obesity Plan for Action[45,46], is its potential to mitigate against the effects of SES differences. Schools bring students together from varying SES backgrounds, while school food provision operates under national school food standards and should therefore be consistently healthy and nutritious. The availability of free school meal vouchers to students from lower SES backgrounds theoretically levels the playing field by giving all students access to a healthy school lunch (although admittedly, there could well be students coming from low-income families who miss out on FSM; e.g. a report by the Child Poverty Action Group and Covid Realities group[173] stated that 36% of school-aged children in poverty do not receive FSM) School settings also have the potential to provide healthy eating environments, in which students of different ethnic, religious, and socio-economic backgrounds can be empowered to make healthy food choices[174–176]. Moreover, school staff can look to positively influence students' food choices by encouraging certain items at the point of sale[177,178]. As emphasised in recommendation 3 of the national food strategy[43], inclusion of food and nutrition into the school curriculum can also help students to learn valuable cooking skills and nutritional knowledge to enable them to adopt healthy dietary behaviours.

From a researcher perspective, schools also make very useful public health research and/or intervention sites. The school environment provides the researcher with unparalleled access through continuous and intensive contact[179] and offers an effective and efficient way to reach a large section of the young population[180]. Schools also integrate adolescents from various socio-economic levels, ethnicities, genders and developmental stages[181]. Many secondary schools in the UK operate cashless catering systems, which provide a continuous, objective measure of students' food choices. As such, research in the school setting can capture data from a diverse, representative sample over short and longer time periods and, in doing so, facilitate comparison between different sub-samples. This enables researchers to explore potential differences in health behaviours between students of different genders, students with/without FSM entitlement, different year groups, different ethnicities etc.

Schools also provide an insulated and controlled environment, within which interventions and policies can be implemented and evaluated with relative ease. Researchers and policymakers can look to influence health behaviours via various methods (e.g. promotion of certain foods, changes to physical dining environment, school policy introduction, cost incentives for certain foods, bans on certain foods, social norms messaging etc.). Finally, schools operate within a wider community; thus, their influence can extend beyond the school gate to include school staff, parents and local stakeholders. For instance, researchers can take advantage of pre-existing links to contact parents of children, provide parents with information regarding their child’s dietary consumption and extend the scope of their research to include the home environment.

The 1986 Ottawa Charter[105] signalled a watershed moment for schools as health promotion settings; as part of the charter, the World Health Organisation introduced the Health Promoting Schools (HPS) framework as a tool to help foster healthy school environments globally. The HPS framework is a whole-school approach and has three core components: (1) integrating health education into the curriculum, (2) changing the school ethos and physical environment, (3) including families and the wider community in health promotion efforts. This framework has been widely advocated for; however, whole-school approaches can be challenging to implement, due to the multi-level complexity of the school food environment. Enacting whole-school food policies may include, for example, integrating healthy dietary habits into the teaching curriculum, ensuring consistent messaging across the curriculum and wider school environment, fostering an eating environment conducive to students making healthy food choices and having a clear and collaborative partnership with students, parents and the wider community. Achieving school food change is therefore contingent on the successful management of multiple, often-competing interests, including students’ food preferences and food choices, parents’ views and school resources.

One UK example of a whole school approach was the National Healthy Schools Programme (NHSP)[182], which ran from 1999 to 2011. The programme tried to support schools to achieve a whole school approach and become “healthy schools”. The status of “healthy school” was defined as performance under 41 criteria across 4 themes of Personal, Social and Health Education (PSHE), healthy eating, physical activity and Emotional Health and Well-Being (EHWB). The criteria encompassed key elements of the whole school approach, including school leadership, management, policy development, curriculum planning, school culture and environment, giving students a voice and partnership with parents/guardians and local communities. Local healthy schools programmes supported schools to self-review their own performance, identify and address any performance gaps and self-validate once the school felt they had met all 41 criteria. Local programmes also validated the performances of a sample of schools.

The programme’s aims were to develop healthy behaviours in students, raise student achievement, promote social inclusion and reduce health inequalities. However, a follow up evaluation after two years indicated that although schools are good settings for health promotion, successful implementation is difficult. The evaluation concluded that despite school staff reporting a positive effect of the programme, no significant differences were reported for students' health-related knowledge, attitudes or behaviour. After two years, some of the conclusions were that (1) NHSP implementation may take longer than two years, (2) NHSP can facilitate change at a school level but it is unclear how changes at school level can be translated into changes at a student level, (3) school's own priorities are a key facilitator/barrier for successful NHSP implementation, (4) schools work in an environment where there are powerful external influences on students' health behaviours, from parents and wider society, which are beyond schools' control.

1.4.3 School-based Interventions

Recognising the potential of the school environment, many researchers have selected the school environment as an intervention setting. Previous school-based interventions have adopted various approaches, including education interventions[27,28], choice architecture ("organising the context in which people make decisions"[183]) interventions[29,184,185] and health promoting school approaches[186–190]. Researchers have also looked to synthesise the findings of school-based dietary interventions in several systematic literature reviews[171,191–196], many of which reported positive findings.

For example, Racey et al.[193] reported that over 80% of school-based interventions were successful in modifying dietary behaviour immediately post-intervention. Wang & Stewart[194] found that nutrition promotion interventions, using a health promoting schools approach, increased participants' consumption of high-fibre foods and water, encouraged healthier snack choice, and reduced intake of low nutrient dense foods, breakfast skipping and selection of high fat and high sugar foods. Driessen[171] looked at the impact of school environmental changes on eating behaviours and BMI, and found a statistically significant increase in healthy eating behaviours or decrease in BMI of children post-intervention in 17 of 18 included studies. Stok et al.[30] evaluated the effectiveness of social norms-based interventions and found evidence for the effectiveness of norms-based interventions in influencing adolescent dietary behaviour; however, the review also found that these effects were not always consistent. Moderators of the association between norms and adolescent food intake included the participant's identification with the norm referent group, participant's pre-existing dietary habits, the type of food included in the norm, the specificity of the norm to the given context, and the forcefulness of the social norm.

Despite some evidence of positive effects, the long-term effectiveness of school-based dietary interventions (particularly in secondary schools) in influencing dietary behaviour remains uncertain. This can be due to (1) funding shortages and truncated intervention periods, (2) a lack of follow up measures reported in studies, (3) a lack of quality school-based interventions, (4) a conflation of adolescent and children studies and (5) a relative lack of solely adolescent focused research.

For example, Racey et al.[193] found that follow ups were only conducted in 21 of the 105 included studies, most of which reported a failure to maintain the initial post-intervention dietary behaviour change. Of the 21 studies reporting follow up measures, 6 conducted mid-term follow up analysis only (3 weeks to 4 months post intervention), 12 conducted a long-term follow up (6 months to 2 years post intervention) and 3 conducted both midterm and long-term analysis. Wang and Stewart[194] found just one study in their review that reported a sustained dietary behaviour change 2 years post-intervention. Meanwhile, in their review of European school-based dietary interventions, Van Cauwenberghe et al.[192] found evidence of post-intervention follow ups in 4 of 13 included adolescent studies. Of these four intervention studies, the first found no significant changes in school food consumption patterns at the 2 year post-intervention stage[197], the second study found no significant dietary change at 3 months follow up[198]; meanwhile, the third[199] and fourth[200] studies reported significant differences in dietary intake (fruit and water, respectively) at 3 and 2 months follow up, respectively

Intervention quality is another frequently mentioned limitation of school-based dietary intervention research. For example, of the 91 school-based intervention studies included in the review by Micha et al[191], a majority (48) were evaluated as low quality. Of the 18 studies included in a review by Driessen et al.[171], two studies were rated as strong, five were moderate and eleven were weak in quality. Moreover, just one study[201] received a strong rating in terms of study design, while only three studies[201–203] reported having a control group.

Another important consideration is the number of intervention studies focusing on children compared to adolescents. Many of the reviews mentioned thus far in this section[191,193,194] included children and adolescents in their review but failed to make a distinction when reporting their findings on intervention effectiveness. One exception is the review by Van Cauwenberghe et al.[192], which found the number of children studies(29) was more than double that of adolescent studies(13). A more recent 2018 review, evaluating the impact of school food environment policies on dietary habits, adiposity, and metabolic risk, found 47 intervention studies in primary schools, compared to 27 in secondary schools[191]. This suggests that whilst the discrepancy has diminished slightly, there is still a need for increased attention on secondary schools. Moreover, Van Cauwenberghe et al.[192] suggested that more children studies were of higher quality compared to adolescent studies. The result of this was more evidence of effect for interventions among children than among adolescents. For example, among the children studies, strong evidence of effect was found for multi-component interventions on dietary behaviour, particularly fruit and vegetable intake. Among adolescent studies, however, only limited evidence of effect was found for multi-component programmes on dietary behaviour, while moderate evidence of effect was found for education-only interventions on adolescents' dietary intake.

Another related example can be found in two reviews[195,196] investigating the impact of HPS approaches on students' health behaviours, namely physical activity and dietary behaviour. The first review[195] combined studies with children and adolescents and found evidence for a positive effect of HPS approaches on BMI, physical activity and fruit and vegetable consumption in children aged 5 - 18 years. The second review[196] focused solely on adolescent studies using a HPS approach. The review found some evidence to support HPS approaches in encouraging physical activity but evidence pertaining to dietary behaviours was limited. Moreover, of the 12 studies included in the review, only 4 were found to be of moderate to strong quality. This suggests a need for more high-quality interventions with adolescent samples, as others have previously noted[192,195,196], and a call for future reviewers to distinguish between adolescents and children when evaluating school-based health interventions.

1.4.4 Differences between Primary and Secondary School

The need for distinction between adolescents and children when evaluating school-based health interventions is apparent when considering the differences between primary and secondary schools. In the UK, school food provision and school environments differ greatly between primary and secondary schools. In primary schools, for example, students can choose from a limited number of options (typically 4 main meal options including vegetarian main meals, meat main meals, jacket potatoes and sandwiches, along with two dessert options), whilst in secondary school, students can choose from a wider array of options, including meat main meals, vegetarian main meals, jacket potatoes, sandwiches, pizzas, pastas, paninis, drinks and various sweet and savoury snacks.

Moreover, primary school menus may not change as frequently as secondary school menus, whereby main meals, pizzas and pastas often change day to day. Given that primary school menus are limited to more substantial meals (i.e. menu doesn't have sweet snacks available), the proliferation of grab-and-go choices is more specific to secondary schools. Whilst most secondary schools have closed gate policies, secondary school students also have much more access to food at nearby outlets compared to primary school students. For example, secondary students may be more likely than primary school students to travel to school independent of their parents (e.g. walking, cycling, getting the bus) and may therefore purchase foods on their way to school. This further widens the array of food options that secondary students can select from and marks a key point of distinction between primary and secondary school students.

Contextual factors of food choice may also differ between primary and secondary schools. For instance, lunchtime food choices made by children in primary schools may have greater parental input (e.g. pre-order systems in some primary schools give parents an opportunity to have input into what their child chooses for lunch; however children are typically the decision makers and most choose their lunch whilst in the classroom[204]), which is often associated with healthier choices, compared to adolescents in secondary schools[205]. Conversely, social aspects of school food (e.g. peer influence, and a desire to spend time and socialise with friends) has been highlighted as an important food choice factor for secondary school students[14,107,205,206]; however, this is a less prevalent factor in similar research with primary school students. Whilst students in secondary schools are thought to be under fewer organisational, spatial and social restrictions than their primary school counterparts[207], secondary school food choices may be more complex due to increased peer influences, greater food options and greater provision of less healthy options.

In addition, secondary school students typically make their food choices at the point of sale, in contrast to their primary counterparts who may select their lunch options the night before the school day, or at the start of the school day. This system in secondary schools may also leave students more vulnerable to impulsive food choices due to time pressures associated with queuing, food (un)availability[23,24,208–210] or peer influence[124,211]. Finally, secondary schools (965 students on roll) are much larger, on average, than primary schools (282 students on roll)[168], which may put extra pressures on catering staff and students in terms of preparing and choosing school foods. This complexity is evident in previous research in primary[212] and secondary schools[213], which together suggest that the school food standards were implemented more successfully in primary settings. This echoes related research which found that school food change is easier to implement in primary schools than in secondary schools, in terms of engaging students and parents, amenability of students to changes and managing the scale of change[214–216].

1.4.5 Secondary School Food

Secondary school food relates to any foods and drinks provided within the school gates. Responsibility for secondary school food provision can fall under the remit of private catering companies, local authorities or schools themselves. National data from the School Lunch Take-up survey (2013-2014) suggests that the minority (12%) of schools have in-house catering, whilst the vast majority of schools hold a contract with either their local authority (60%) (who may in turn work with a private catering company) or a private catering company (28%)[217]. Most secondary schools operate a 3-week menu cycle, which is repeated for half of the school year, after which a new menu cycle is introduced. Schools typically provide three services each day: breakfast, mid-morning break and lunch. Breakfast is usually the smallest service, in terms of both provision and uptake. Mid-morning break is generally a much busier service and includes many breakfast-type items (e.g. waffles, toast, pancakes) along with fruit and drinks items. Lunch is the busiest service time of the school day. At lunch, schools typically provide a range of foods, including a different main meal of the day, a vegetarian main meal and a main dessert item each day, along with various sandwiches, baguettes, pizzas and pasta items. At lunch, students can also purchase various drinks, dessert items, sweet snacks and fruit options.

1.5 UK School Food Policy

An ongoing discussion surrounding the school food environment is its use as a setting for food policy implementation. School food policies have typically looked to modify some or several aspects of the school food environment in an effort to facilitate healthier food choices[218,219]. The UK has a long-standing tradition of school food policy, with UK school food policy implementation dating back as early as the 19th century. The following sections provide a brief history of UK school food policy to illustrate how policy has changed and evolved to suit the changing motives and needs of the UK adolescent population.

1.5.1 History of UK School Food Policy (1879 - 1979)

Evans and Harper[220] have previously provided a detailed account of the history of UK school food policy. Given that this section describes the same events, much of the following section has been sourced from the aforementioned review. UK school meal provision dates back as far as the late 19th century. Manchester was the first UK city to establish school meal provision services, doing so in 1879; school meals were provided by charities to poorer and less nourished children. In 1904, the reportedly poor physique of British volunteers during the Boer War (1 October 1899 – 31 May 1902) was attributed to poorly fed children, and by 1920, one million UK children were taking school meals. 1941 was a watershed year as it saw the introduction of a National School Meals policy and the first set of nutritional standards for school meals. The Education Act (1944)[221] mandated all Local Education Authorities (LEAs) to provide school meals to any students who wished to have one. By 1947, the UK Government was fully funding school meals. The standards were consistently reviewed and revised over the next several years. For example, a 1955 mandate stated that school dinners must acknowledge and consider the nutritional deficiencies in a student's home food intake (Ministry of Education Northern Ireland, 1955). In 1966, the Department of Education (DfE) stated that the average school meal should contain 880kcal, 32g of fat and 29g of protein. In 1975, the first food-based standards for school meals were introduced.

1.5.2 History of UK School Food Policy (1980 - 2000)

The close of the 20th century saw deregulation of school food[222]. In an effort to reduce public expenditure on school meals, the Education Act (1980) removed the obligation for LEAs to provide school meals to all students. School meal provision was also demoted to a non-essential service, nationally standardised pricing was removed, and nutrient-based standards were discontinued. In 1986, the Social Security Act restricted free school meal entitlement to students whose parents were receiving supplementary benefit. Soon after, the Local Government Act (1988)[223] ushered in Compulsory Competitive Tendering which meant that all LEAs had to put school meal provision services out to tender. A ‘lowest bid wins’ ethos was adopted, private sector companies flooded the market and the process of deregulation of school meals was complete[222]. In 1998, ‘best value’ was adopted as the guiding principle for school meal service tendering and decisions regarding school meal provision became increasingly motivated by financial interests[222].

The result of these policies was that schools operated (and still do today) within a competitive framework. The prominence of large private catering companies in the market raises issues, as decisions on recipe formulation, food preparation and provision may all be influenced by financial parameters and anticipated financial returns. Catering companies are incentivised to provide items which they know students will eat. Students, meanwhile, can leverage their customer power within this competitive framework to incentivise caterers to provide desirable items. Tensions may arise as schools’ health interests compete with the catering companies’ financial interests. These tensions can be eased (i.e. if students choose healthier options) or exacerbated (if students choose less healthy options) by students’ food choice behaviours.

1.5.3 Mandatory Nutrient & Food-based Standards (2001 - 2012)

After a gap of 21 years, statutory guidelines for school food were re-introduced in 2001. The 2001 regulations instructed the provision of healthy options every day (e.g. fruit and vegetables). In 2004, the Department for Education and Skills (DfES), the Department of Health (DH), the Food Standards Agency (FSA) and the Department for Environment, Food and Rural Affairs (DEFRA) published the Healthy Living Blueprint for Schools[224]. The blueprint outlined their commitment to revise secondary school meal standards and review primary school meal standards. Later that same year, the white paper Choosing Health:

Making healthy choices easier[225], was closely followed by three delivery plans, including Choosing a Better Diet: a food and health action plan[226]. These stated the Government's commitment to make nutrition and physical activity essential elements of the healthy school programme from September 2005 and the ambition to make half of the schools healthy schools by 2006. The Government also reiterated its ambition to revise school meal standards and strong consideration was given to introducing nutrient-based standards.

Substantial media attention was given to school food in 2005, after celebrity chef Jamie Oliver's programme, Jamie's School Dinners, highlighted the poor quality of school food provision in England. Subsequently, the School Meals Review Panel (SMRP) was commissioned to review the nutritional standards of school food and school meal services. The resultant report, entitled Turning the Tables[222], called for the introduction of compulsory food and nutrient-based standards for school food. A Government advisory body, the School Food Trust (later called Children's Food Trust) (SFT) was established during this time to advise, support and monitor schools and parents on efforts to improve the nutritional quality of school meals. In 2006, based on recommendations from the SMRP and SFT, the Department for Education announced that new school food standards would be introduced over the following 3 years. These new guidelines would build on the previously established standards by encouraging healthier foods, restricting and prohibiting some less healthy foods (e.g. confectionary, soft drinks) and promoting the need to achieve a healthy balance of foods and drinks across overall school food provision. The new standards also introduced nutritional parameters based on age and sex specific energy and nutrient requirements as outlined by the Department of Health.

By 2009, mandatory school food standards were fully established in secondary schools[4]. Two sets of standards were introduced: food-based standards (FBS) and nutrient-based standards (NBS). The FBS outlined the types of foods and drinks that should be provided in schools over the menu cycle, along with what constituted appropriate provision quantities for each. The NBS specified maximum or minimum values or 'standards' for energy and 13 key nutrients that should be in an average lunch over the menu cycle. The nutrients were as follows: Fat, Saturated Fat, Sodium, Carbohydrates, Protein, Non-milk extrinsic Sugar (NMES), Fibre, Folate, Calcium, Iron, Zinc, Vitamin A, Vitamin C. The maximum and minimum values were established by adapting dietary reference values[9] and apportioning them for a school lunch (e.g. minimum standards for iron, calcium, zinc apportioned at 35% of the reference nutrient intake).

1.5.4 More Recent Policy Developments (2013 – 2021)

In 2012, the UK Government commissioned an independent review of school food. The review assembled an expert team of policymakers, teachers, academic researchers, public health specialists and politicians to find out how best to encourage students to choose healthy and nutritious lunches and how to increase school food uptake. The product of this review was the School Food Plan[227], published in 2013. The report marked a shift in England from a focus on FBS and NBS to solely FBS. The FBS were viewed as relatively easier for school catering teams to follow and adhere to[228]. For example, a 2011 evaluation found that for both local (LA) and non-local authority (non-LA) caterers, compliance with FBS was higher (96% for LA; 82% for non-LA) than for NBS (80% for LA catering; 75% for non-LA catering)[214]. The shift also echoed the sentiment that people consume foods, not nutrients and placed an emphasis on dietary patterns rather than nutritional intakes.

New school food standards[5] came into effect in January 2015 and are still in use today. The new standards focus solely on FBS (for all English maintained schools, free schools and academies, excluding academies established between 2010 and 2015). School foods and drinks are divided into 6 key groups: (1) starchy foods, (2) fruit and vegetables, (3) milk and dairy, (4) meat, fish, eggs, beans and other non-dairy sources of protein (5) foods high in fat, sugar and salt and (6) healthier drinks. The standards stipulate the appropriate provision (e.g. one or more portions of vegetables or salad as an accompaniment every day), restriction (e.g. no more than two portions of food that have been deep-fried, batter-coated, or breadcrumb-coated, each week) and prohibition (e.g. no confectionary, chocolate or chocolate-coated products) of foods and drinks over the menu cycle. Additional guidance documents are included to help schools to successfully implement the standards. These include a 25-item checklist for school lunch, a 14-item checklist for foods other than lunch, and guidance on appropriate portion sizes for different foods/drinks[229]. Finally, the standards highlight some additional aspects for consideration, including methods to bolster the calcium, iron and zinc content of foods and methods to foster a pleasurable dining experience for students along with a healthy culture and ethos towards school food. In 2017, the Children's Food Trust (formerly the School Food Trust), which was responsible for much of the monitoring and evaluation of school food was closed down due to a lack of funding.

1.6 Effectiveness of UK School Food Policy

1.6.1 Recent Policy Evaluations

Initial evaluations of the school food standards found evidence for their effectiveness. For example, a review of relevant evaluations, policies and national surveys conducted in 2012 found that the introduction of mandatory food and nutrient-based standards in 2007 (announced in 2006 with implementation over next three years) had improved the nutritional quality of foods served and consumed in secondary schools[230]. Two separate evaluations of school and packed lunches in secondary schools found that school lunches contained significantly higher levels of energy, protein, carbohydrates, folate, iron and zinc compared to packed lunches[231,232]. There was also evidence during this time of moderate increases in school food uptake[214] and statistically significant associations ($P = 0.034$) between attainment levels and increases in healthier school lunch take up[233]. However, these studies were conducted in 2012 and 2013, i.e. before standards shifted away from dual standards to solely FBS. As such, their relevance to the current state of school food provision is uncertain.

Moreover, despite moderate increases (secondary school take up increased from 35.0% of students in 2008/2009 to 39.8% in 2011/2012)[214], school food uptake still remains far below the targeted 50% uptake required to reach provision viability. Finally, given that the larger, long term goal of school food policy is reducing adolescent obesity[227], the observation that UK adolescent obesity has increased by 5% since 1995[234] suggests that continued and greater policy efforts are needed to successfully curb adolescent dietary habits and obesity rates.

1.6.2 Nutritional Composition of School Food

The announcement of school food standards in 2006 saw a number of research studies explore the nutritional composition of school food in the years that followed[212,231,232,235,236]. Packed lunches were not included in the standards and in 2006, Evans et al.[235] collected cross-sectional survey data from 1294 primary school children (8-9 years) across the UK, to explore the nutritional content of students' packed lunches. Findings indicated that packed lunches struggled to meet standards for free sugars and sodium levels, while just 1.1% of packed lunches met the school food standards. Evans et al.[236] conducted a related study the next year, carrying out a cross-sectional survey of 2709 English primary school students (6-8 years), to compare the nutritional content of school lunches and packed lunches. Findings indicated that students having school lunches had 11.0g fewer total sugars, 101mg less sodium, and higher levels of protein, fibre and zinc. In 2008, Haroun et al.[212] evaluated the nutritional composition of lunchtime provision in 136 English primary schools, and compared this to data collected in 2005. The study found that compared to 2005, schools in 2009 provided significantly more fruit, vegetables, salad and water, while providing significantly fewer starchy foods, snacks and confectionary.

Related research was also carried out in the secondary school sector during this time. In 2008, Pearce, Wood and Nelson[231] used weighed food records to explore the nutritional content of school lunches and packed lunches (as consumed) by 497 students (11-16 years) in a secondary school setting. Whilst neither school nor packed lunches met the nutrient-based standards, school lunches (as consumed) contained significantly higher levels of energy, protein, carbohydrates, free sugars, vitamin C, folate, iron and zinc. Nicholas et al.[213] collected cross-sectional data in 2010/2011 to assess the nutritional content of secondary school food provision over 5 days in 80 English secondary schools. In comparison to 2004, significantly more schools in 2011 provided main meals, vegetables, salads, water and fruit juice on four or five days of the week. Moreover, significantly fewer schools offered items not permitted under the standards on four/five days of the week in 2011, compared to in 2004. The average lunch provided met NBS for protein, non-milk extrinsic sugar (NMES), fat, saturated fat, sodium and vitamin C, but failed to meet NBS for energy, carbohydrates, fibre, vitamin A, folate, calcium, iron and zinc.

The study also compared the nutritional content of lunches as eaten by students between 2004 and 2011, i.e. before and after school food standards were introduced. Findings indicated that the standards had substantially improved the nutritional content of students' school food consumption; students having a school lunch in 2011 consumed significantly lower levels of energy, carbohydrates, NMES, fat, saturated fat and sodium, along with significantly higher levels of protein, fibre, vitamin A and calcium compared to students having a school lunch in 2004. In 2010/2011, Stevens et al.[232] used weighed food records to evaluate the nutritional content of school lunches (n=5925) and packed lunches (n=1805) as chosen by students (10-

19 years) in 80 English secondary schools. Findings revealed that neither school lunches nor packed lunches met the NBS; however, school lunches (as consumed) on average contained significantly higher levels of levels of energy carbohydrates, protein, fibre, vitamin A, folate, iron and zinc than packed lunches.

Some studies have also considered the impact of school food and school food standards in the context of adolescents' overall dietary intake. For example, Winpenny et al.[13] explored changes in students' overall diets (via food diaries over 4 days) between the ages of 10 (in 2007) and 14 (in 2011) and considered the findings in relation to the introduction of school food standards. Their findings suggested that adopting school lunches may not necessarily be accompanied by universal improvements in diet quality, as students consuming a school lunch were more likely to eat vegetables compared to students eating lunch from elsewhere, but the students consuming a school lunch were also more likely to eat fries. Moreover, students consuming school lunches were more likely than other students to have less confectionary and snacks, but also less fruit. The researchers also found limited associations between school lunch and overall diet, suggesting that changes in school food consumption may have little effect on students' overall diet, and also indicating a potential ineffectiveness of school food policy efforts, such as the school food standards.

Spence et al.[175] found similar results; in their study, students (11-12 years) completed three days of food diaries followed by an interview, enabling the researchers to examine the impact of school food standards on students' lunchtime and overall dietary intake. The researchers found that in both 1999/2000 and 2009/2010 (before and after the standards were introduced), students consuming school lunches had overall dietary intakes which were lower in percent energy from saturated fat, and mean levels of sodium and calcium compared to students consuming packed lunches. The study found limited evidence of associations between lunch type and students' overall dietary intake; no evidence of an association was found for mean energy or levels of NSP (non-starch polysaccharides), vitamin C or iron, while marginal evidence was reported for an association between lunch type and percent energy from NMES. In terms of overall diet, the study found that between 1999/2000 and 2009/2010 (before and after the standards were introduced), there were significant decreases in students' mean intakes of energy, sodium and increases in calcium and vitamin C, but also decreases in levels of NSP and iron. No changes were found in intakes of percent energy from NMES or saturated fat. These findings suggest minimal impact of school food standards in influencing students' overall dietary intakes.

In general, most of the studies discussed above indicate that since their introduction in 2006, school food standards have had a positive effect; research has found evidence for improvements in the nutritional content of school food, while school food appears to contain a healthier nutrient profile than either packed lunch or lunch purchased at nearby outlets. However, it is important to note that these studies were conducted before 2015, i.e. at a time when FBS and NBS were still in place. As mentioned earlier, the School Food Plan, published in 2013, ushered in a transition from FBS and NBS to solely FBS, and since 2015, English schools have operated solely under FBS. This was a pivotal moment in the context of school food and school food standards, and marked a shift in focus from foods and specific energy/nutrient quotas to a sole focus on foods/drinks groupings and general provision frequencies. Furthermore, since 2015, there has been a dearth of research evaluating the nutritional content of school food, either in a primary or secondary school context. This has left uncertainty and ambiguity regarding the current nutritional composition of school food, both as provided and as chosen.

The nutritional composition of school food is uncertain for a number of reasons, namely the nature of the new standards, the differences between NBS and FBS, and the monitoring measures currently in place. For example, the current standards focus solely on food groups rather than food groups along with energy and nutrient quotas (as was the case when FBS and NBS were in place); as such the exact nutritional composition of school food is unknown. In some respects, policymakers have forgone some of the precision and detail of the NBS for the greater ease of use and adherence associated with the FBS. There is some evidence to support this; for example, a 2013 report[228] compiled for the School Food Plan's standards panel evaluated the food-based standards and reported that school cooks and caterers found the solely food-based standards easier to understand and implement. The standards panel also analysed the nutritional composition of an average lunch for a 1 week menu cycle which only followed the FBS. In their findings, an average lunch, which complied with FBS, met the vast majority of the energy and nutrient standards outlined in the previous NBS, but failed to meet standards for calcium, iron, and zinc. This suggests a good, albeit not perfect level of efficacy for FBS in terms of ensuring nutritious and healthy lunches. However, the pilot study was carried out with a small number of secondary schools (n=13), whilst the analysis covered a 1 week period rather than the typical 3-week menu cycle. Finally, the timing of the pilot (2013) means that schools would still have been operating under the influence of both FBS and NBS; thus, the findings may not be indicative of current school food provision.

Another important consideration is that NBS were stricter and harder to adhere to than FBS. For example, a 2011 evaluation found that for both local (LA) and non-local authority (non-LA) caterers, compliance with FBS was higher (96% for LA; 82% for non-LA) than for NBS (80% for LA catering; 75% for non-LA catering)[214]. In 2008, Haroun et al.[237] assessed the nutritional content of school food as provided and as chosen, among 6696 students (3-12 years) from 136 English primary schools. Results indicated that many schools met FBS but did not meet NBS. Moreover, the average school lunch eaten by students was significantly lower in fat, saturated fat and sodium in schools that followed both the FBS and NBS for school lunches compared with schools that met only the FBS. Catering staff now operate under more flexible guidelines than previously, whilst operating under FBS and NBS. Moreover, there is potential that the nutritional content of school food may have worsened since the removal of NBS.

Another reason why the nutritional content of school food provision is unknown is that a formal, independent evaluation of secondary school food provision has not been carried out in the years since school food standards moved to solely FBS in 2015. Furthermore, whilst compliance with the current school food standards is encouraged, schools are not obligated to report their compliance, nor is it formally monitored or assessed. Instead, the Office for Standards in Education, Children's Services and Skills (Ofsted), which carries out nationwide school performance inspections and evaluations, states in its inspection framework that schools need to develop students' understanding of "how to keep physically healthy, eat healthily"[238]. However, there is no mention of school food provision or consumption in any more detail. Of course, as mentioned in section 1.2.1, the Government's recent Levelling Up white paper[44] suggests that more formal monitoring will be introduced, including testing approaches to support schools to comply with school food standards, and, in time, mandating schools to issue a statement on their school websites outlining their whole school approach to food. However, at present, it remains to be seen to what extent formal monitoring will be implemented nationally.

1.7 Adolescents' School Food Choices

Policies such as the school food standards have typically concentrated on the provision of school food. This focus on provision is not unfounded, as provision can directly influence choice by dictating what food and/or drink options are available, along with the nutritional quality of these options. A focus on provision may also be seen as a less intrusive way of influencing dietary intake than more overt measures such as introducing price (dis)incentives, for example. That said, healthy school food provision does not preclude unhealthy school food choices. For example, freshly prepared meals of the day are typically the most nutritious items provided by schools, and they form the cornerstone of the school food standards; however, students may choose not to select these items, in which case the intended benefits of providing these meals (i.e. enabling students to consume healthy, nutritious school food) goes unrealised.

Furthermore, whilst school food standards have been moderately successful in bolstering uptake (secondary school uptake increased from 35.0% of students in 2008/2009 to 39.8% in 2011/2012)[214], most students (circa 60%) still choose to not have school food[214]. Instead, students may choose to purchase foods from nearby fast-food outlets, bring packed lunches from home, or skip lunch entirely, in effect circumventing the school food standards. Research also indicates that purchasing lunch from nearby outlets is associated with poorer food choices[26] and decreased diet quality[17] compared to either school lunches or packed lunches, whilst school lunches appear to contain a healthier nutrient profile than packed lunches[231,232]. These points all illustrate how regardless of provision, or policies focused thereon, it is important to understand adolescents' school food choices, along with the parameters adolescents use.

1.7.1 School Food Choice - Theoretical Considerations

Food choice is influenced by a variety of interdependent and dynamic factors. A number of theoretical models and approaches are applicable to the food choice process. Among the most pertinent of these to adolescent food choices within the school environment are the socio-ecological model (SEM)[31], the food choice process model (FCPM)[32] and the social norms approach[33,239]. These models/approaches are relevant to school food choice as they acknowledge the complexity of making food choices within an environment and consider the role environment can play in guiding one's food choices.

The SEM identifies multiple interdependent levels of influence and encourages the researcher/practitioner to consider interactions across levels of influence. This is particularly relevant when considering intervention development. For example, adolescent food choice interventions targeting the intrapersonal level (e.g. individual food attitudes/ beliefs) of change should acknowledge the influence of interpersonal factors also (e.g. peer influence, social networks). Moore, Silva-Sanigorski, & Moore[240] have previously advocated for the application of socio-ecological principles to school food interventions/policies; they reviewed case studies of school-based dietary interventions and concluded that "the long-term effects of policies and interventions in real-world implementation can depend hugely on mediators and moderators acting at different levels". Meanwhile, Townsend and Foster[179] applied the socio-ecological model to food choice in UK schools. Findings indicated an association between (1) interpersonal factors and food choices made inside of school, and (2) intrapersonal factors and food choices made outside of school. School food rules and policies were associated with unhealthy food choice, whilst the community nature of the school was associated with healthy food choices.

Similar to the SEM, the food choice process model (FCPM)[32] describes the various factors and processes involved in food choice. However, the FCPM posits the individual as an active decision maker within the food choice process. Food choice decisions are constructed by the individual, and are informed by the integration of three components; (1) life course events and experiences, (2) influences and (3) personal food system. This model benefits from the inclusion of a life course approach and highlights how food choices are highly complex, involving the management of various influences (e.g. ideals, resources) and negotiation of personal values (e.g. tradition, familiarity, ethics).

The social norms approach[33,239] does not describe the same breadth of factors outlined in the SEM or FCPM, but instead looks to explore how norms, and norm-misperceptions influence behaviour. Social norms are unwritten rules of behaviour, established and governed by one's social group, which give individuals in the group an expected way to behave. The social norms approach centres around social, descriptive and injunctive norms and the associated differences. Taking student fruit consumption as an example, a social norms approach could explore differences between social norms (students' fruit consumption), descriptive norms (a student's perception of peers' fruit consumption) and injunctive norms (e.g. a student's perception of peers' attitude toward fruit consumption).

Adolescence is a time at which social norms become increasingly influential to food choices[241], thus consideration of the social norms approach may provide valuable insight into students' food choices. Previous research has indicated a strong association between descriptive norms and dietary behaviour among secondary school students[211,242]. Evidence also suggests students may misperceive descriptive and injunctive norms, overestimating peers' food/drink intakes and positive attitudes towards snacks and sugar-sweetened drinks and underestimating peers' consumption of and positive attitudes toward fruit and vegetable consumption, both within the school context[211] and in general[242]. Norms-based interventions can therefore look to influence behaviour by highlighting differences between descriptive, injunctive and actual norms.

1.7.2 School Food Choice - Research Evidence

Previous research on school food choices has highlighted how students' food/drink choices are not evenly distributed across what is provided in schools, but instead typically bias toward quick, grab-and-go items and energy-dense, micronutrient-poor options[14–16]. For example, a focus group study by McSweeney et al.[14] found that students frequently chose convenient items such as pizzas, paninis and pastas. Ensaff, Russell and Barker[15] examined students' food choices in two English secondary schools and found that the most nutritionally preferable "dishes of the day" constituted just 8.3-8.7% of students' choices, while pizzas and sandwiches were much more popular. Interestingly, research by Stevens et al.[232] examined the school food choices of 5925 adolescents across 80 English secondary schools and found that 38.1% of students having a school lunch selected main dishes (which are typically the more nutritious meals), while only 8.9% chose pizzas. Results also showed that desserts were selected by 31.8% of students having a school lunch, while fruit and water were selected by just 3.1% and 5.9% of students respectively.

Ensaff, Russell and Barker[16] explored students' selection of beverages in two secondary schools; students' choices were dominated by juice-based drinks (school A, 38.6%; school B, 35.2%), while students' selection behaviours (along with what is provided) led to high intakes of NMES from beverages alone (school A, 16.7 g/student-day; school B, 12.9

g/student-day). Pearce et al.[231] looked at lunchtime food and nutrient intakes, and found that 41% of the students who chose a school lunch had cakes and biscuits as part of their lunch. In contrast, much fewer students opted for vegetables (11%), salad (6%) or fruit (5%) as part of their lunch[231]. Finally Gould, Russell and Barker[243] analysed the school food choices and associated intakes of 74 secondary school students across 3 schools, and found that their school food choices caused them to have lower intakes of calcium ($P < 0.01$ for S2), iron ($P < 0.01$ for S1, S2), folate ($P < 0.01$) and zinc ($P < 0.01$ for S1, S3), and higher intakes of fat ($P < 0.01$ for S1, S3) and saturated fat compared to an optimum lunch choice (i.e. the most favourable lunch that could be chosen from what was provided).

Recognising the importance and impact of school food choices and food choice behaviours, research has endeavoured to uncover the key factors which determine adolescents' school food choices. Evidence suggests that many of the same factors which influence adolescents' dietary behaviours generally (see section 1.3.2) are also evident within the school environment, notably socio-economic status[140,145], social norms[211,242], and habits[244]. For example, a cross-sectional study[244] of 11,392 adolescents (10-17 years) from secondary schools across nine European countries (The Netherlands, Belgium, Germany, UK, Finland, Denmark, Poland, Portugal and Romania) found that habit strength was positively associated with unhealthy snacking behaviour, irrespective of participants' healthy eating intentions, while habit strength increased with age. Kamar, Evans and Hugh-Jones[24] used SenseCam technology and interviews to explore the factors influencing UK adolescents' intake of whole grains in schools; availability, lack of awareness of whole-grain foods, and social norms surrounding whole-grain intake were key factors determining adolescents' school food choice behaviours.

Research in secondary schools has also highlighted the influence and presence of competitive nearby food outlets[25,210,245]. For example, Browne et al.[25] conducted focus group discussions with students, and highlighted the relevance of cost and social norms in terms of students choosing to eat lunch at nearby outlets. Interestingly, the findings highlighted a number of incongruities between Irish secondary school students and teachers regarding school food choices and school food uptake. When considering how to encourage more students to choose school food, students emphasised the importance of the school environment, noting the importance of social and temporal aspects of their lunchtime experience. Contrastingly, social aspects did not feature in teachers'/principals' discussions.

Instead, teachers and principals stressed the potential of additional educational efforts to encourage healthier student choices. Students meanwhile felt that they had adequate nutrition knowledge, and identified the environment as the priority rather than education. This aligns with previous research showing that educators often (and perhaps naturally) turn to educational approaches rather than the school environment when trying to promote healthy eating behaviour [246–248].

Caraher et al.[245] conducted focus groups with adolescents in London, and found that many adolescents choose to have lunch at nearby outlets due to increased food availability, affordability, convenience and the "coolness" of eating at nearby outlets. Kelly, Callaghan and Nic Gabhainn[210] conducted focus groups with Irish adolescents (n=95) in 6 secondary schools, exploring their perception of the external school environment. Cost, convenience and available choices were cited as key factors influencing students' preference for food outlets. Quality and healthiness of food were mentioned as important factors, but affordable healthy food was reported as being difficult to find in or around schools. Finally, Shephard et al.[23] conducted a systematic review to explore the barriers and facilitators to healthy adolescent dietary behaviours; barriers included poor school meal provision, along with ease of access to cheaper and tastier fast food. Facilitators included availability of healthy foods, individual will-power and a desire to look after one's appearance.

Previous research on school food choice has also identified factors which are more specific to the school environment and considered the role of the school environment in adolescents' food choices. For example, previous qualitative research has highlighted how, in primary school settings at least, school catering staff can influence students' choices by encouraging them to choose certain items at the point of service, or providing more food to some students who they perceive need more[177,178,188]. McSweeney et al.[14] conducted focus groups with students and interviews with school staff in secondary schools and found that students reportedly chose the same options each day (e.g. pizzas, paninis, pastas). This was due to a lack of awareness of the school daily menu, speed of purchases and familiarity with those food prices.

Townsend[249] conducted a multilevel analysis to explore the independent association between the length of lunchtime services in secondary schools (n=64) and students' lunchtime food choices; results indicated that longer lunch periods were associated with higher odds of students choosing fruit for lunch (2·20; 95 % CI 1·18, 4·11), and lower odds of students eating unhealthy foods on a daily basis (0·44; 95 % CI 0·24, 0·80). Mixed methods research by Wills et al.[136] examined adolescents' food purchasing patterns in school and the factors underpinning these purchases. In line with other school food research[25,210,245], cost (i.e. value for money), taste, and the healthiness of the food were found to be prominent factors in adolescents' school food choices. Interestingly, results indicated that the relevance of certain food choice factors was closely linked with the SES of that school, as cost and value for money was a dominant factor in lower SES schools, whilst health was only mentioned as a driver of food choice by students at a high SES school.

The above paragraphs highlight how adolescents' school food choices may be influenced by several factors, some of which are factors for adolescents generally (e.g. SES[140,145] and increased peer influence[124,211]), and some which are more specific to the school environment (e.g. catering staff[177,178,188], length of school lunch[249]). Moreover, the above research suggests that school food choice factors (and the relevance/salience thereof) cannot be disentangled from other overarching factors, such as SES[136] and social norms. This illustrates how school food choices are a deeply complex process, which may involve the integration and management of several food choice factors and influences. As such, further research may be needed to understand (1) what the most salient factors to adolescents' food choice process are, (2) how different factors are considered, and (3) how researchers, school leaders and policymakers can help to make healthier choices easier choices.

1.7.3 Measuring Students' Food Choices

In terms of collecting food choice data, the school environment poses its own unique set of challenges and opportunities to researchers. For example, students may choose foods/drinks from the school canteen, from home or from a nearby food outlet. Secondly, adolescents may be less interested in longer term health-related issues than other age groups (e.g. adults) and as such research with adolescents may face greater challenges in terms of participant recruitment and retention[250]. These challenges should be considered by any researcher endeavouring to measure school food choice via self-report measures. That said, schools also present some useful opportunities in terms of collecting food choice data. For example, school meal services occur at set times each day, while UK school food provision typically operates on a three-week menu cycle, which is then repeated for half the school year. As such, there is a degree of predictability and consistency regarding the provision (and nutritional composition) of school food. This lends itself to measurement of food choice and dietary intake via observational methods. Secondly, many schools work with large catering companies and thus there is a level of commonality across schools in terms of ingredients bought, recipes used etc. As such, inferences made regarding students' school food choices are scalable (i.e. data collected over a 3-week period can be extrapolated for up to half the school year, at least in theory). Many secondary schools in the UK are also part of school trusts, therefore recruitment of one member of the trust can often assist in recruitment of other schools within the trust.

When considering food choices, it is important to acknowledge the different ways in which food choice data is collected and how it is measured. Some previous studies have used approaches traditionally reserved for assessing dietary intake, including food frequency questionnaires (FFQs)[251], school food recalls[136,252] and meal observations[245,253]. For example, Hermans et al.[251] explored the associations between adolescents' (n=726) school food purchasing patterns and their perceived relationship support and maternal monitoring; the researchers used food frequency questionnaires to gather data on how frequently adolescents purchased school foods. Kapetanaki et al.[252] developed a purchasing recall questionnaire (PRQ) to explore the factors influencing UK adolescents' food/drink purchasing (and later consumption) habits outside schools at lunchtime. The same PRQ was also used in a related study by Willis et al.[136] to look at UK adolescents' food purchasing practices at lunchtime, and the key factors related to these purchases within and around schools. Finally, Caraher et al.[245] used paired observation and recording of adolescents' food purchases in food outlets near their schools to collect food choice data.

The previous paragraph provides evidence of the use of dietary intake measures for collecting food choice data. However, each of these approaches have strengths and limitations in terms of cost (e.g. FFQs typically cheaper than school food recalls), feasibility with large samples (e.g. FFQs easier to implement with large sample than school food recalls), feasibility with prolonged implementation (e.g. FFQs easier to implement long-term than school food recalls), participant burden (e.g. food recalls are more burdensome than observations) and accuracy of data collected. Finally, observer effects[254] and social desirability biases[255] may influence the participants' responses or behaviours for many of these approaches (e.g. they may underreport their selection of less healthy foods when talking to a nutrition researcher, they may choose different foods when being observed).

One possible remedy to these issues when measuring school food choice is to collect cashless catering data. Many UK schools use cashless catering systems, which provide a continuous record of all food/drink items purchased in the school. A small number of studies have explored this in the UK context (e.g. Ensaff et al.[15]). However, this remains a greatly under-utilised resource as this provides an exact record of students' school food choices. As Woodside et al.[256] point out, exploration of this data could help to plan research with routine outcome assessment, and facilitate potential linkage to educational, welfare and health outcomes. Furthermore, this continuous stream of automatically generated data enables researchers to track food choice longitudinally and observe food choice trends over time (e.g. researchers could explore how food choice develops throughout adolescence; researchers could observe the impact of policy and/or interventions on food choice). Vitally, in terms of interventions (and evaluations), the automated nature of cashless catering data enables long-term follow up, thus alleviating a common issue with school-based dietary interventions, a lack of adequate follow ups[192,193].

1.8 Summary

Adolescent obesity is a significant and growing issue in England and unfavourable dietary behaviours are among the main contributors to this. The relevance of various influences has been highlighted in the literature, most notably socio-economic status, parental influences, peer influences, social norms and a growing influence of various media platforms. That said, much remains unknown in terms of how adolescents manage these various food choice influences or how these influences can be directed towards positive dietary behaviours.

The school environment has been identified as a sound setting to explore adolescent dietary behaviours and also for adolescent dietary interventions. Previous research has revealed many drivers of adolescent dietary behaviour within the school environment; however, this knowledge has yet to be successfully implemented insofar as intervention development and design. Furthermore, the SLRs discussed in this chapter indicate that more intervention research and more high-quality intervention research has been conducted in primary schools than in secondary schools. Given the various differences between primary and secondary settings and between children and adolescents, there is a need for more high-quality interventions which are tailored specifically to adolescents and secondary schools. Beforehand however, there is a need for further high-quality research in secondary schools to deepen our understanding of adolescents' food choice processes and inform effective intervention/policy design and development within the secondary school context.

The last two decades have seen a renewed focus on school food provision and the school food environment. Policy-level initiatives have looked to improve the nutritional profile of school food provision and improve students' dietary behaviour. Despite these efforts, there remains much to do, and clarification is needed at all stages of the school food chain. For example, the departure from food and nutrient-based standards[4] to solely food-based standards[5], in conjunction with a subsequent lack of formal evaluations has left uncertainty regarding the nutritional composition of current school food provision. This warrants urgent clarification. The nutritional composition of students' school food choices is also an under-investigated area. Finally, there remains a lack of adequate/actionable understanding of how and why adolescents make their food choices within the school environment. Examination of students' school food choices is needed to fully understand what students are choosing, why they are making these choices and finally, the nutritional implications thereof.

1.9 Research Aims and Objectives

This thesis is concerned with exploring the food choices and dietary behaviours of English secondary school children within the school environment. The aims and objectives of the thesis are as follows.

Aims:

- To gain valuable and needed insight into how school food is prepared and provided in secondary schools.
- To examine food provision in English secondary schools and evaluate the nutritional composition thereof.
- To examine the school food choices of English secondary school students using the canteen, and the nutritional composition thereof.

- To explore how students make their food choices within the school environment, how they interact with their environment, and what their school lunchtime experience is like, from their perspective.

Objectives:

1. To conduct immersive observations in English secondary school kitchens and dining areas to gain insight into school food preparation and provision practices
2. To assess the nutritional composition of English secondary school food provision and compare to dietary reference values, apportioned for a school lunch.
3. To collect food choice datasets from two English secondary schools and examine adolescents' school food choices. To link this food choice data with nutritional composition data and evaluate the nutritional composition of adolescents' school food choices.
4. To conduct focus group discussions with students to gain insight into their lunchtime experience, how and why they make their school food choices within the school environment, and identify key opportunities and barriers to promoting healthy school food choices.
5. To conduct focus group discussions with students to discuss their lunchtime experience, their school food choices, and the role that family and friends play in said food choices.
6. To synthesise findings from the quantitative and qualitative studies and identify key areas of consideration, with regards to English secondary school food preparation, provision and adolescents' food choice behaviours.

Chapter 2. Thesis Design

2.1 Overview of Thesis Design

This chapter outlines the design adopted for the thesis, in order to achieve the aims and objectives stated in section 1.9. A mixed methods approach was chosen, to collect a breadth and depth of data on school food, and on students' dietary behaviours within the school environment. The thesis design looked to investigate school food choice on multiple fronts; the observation visits explored catering practices and food preparation and provision, the analysis of cashless catering data and nutritional composition tables explored school food as provided and as chosen, and the focus group studies explored students' views on their food choices and food choice processes. The design is described across four key components:

1. Three-week observations in two secondary schools. Immersive observations conducted, to gather detailed information into how school food is prepared and provided. Information gathered during the observation period informed the development of food preparation tables. The observation periods were also used to gather insights into school catering practices, including staff views on school food and school canteen practices during service times.
2. Nutritional composition of food provision in two secondary schools. Creation of food preparation tables for each school from data collected during the observation periods, which was used to develop a nutritional composition for each food/drink item provided by the schools. Nutritional composition values were calculated to reflect the nutritional composition of foods/drinks as provided and as chosen. School food provision was assessed in comparison to dietary reference values (DRVs)[9] apportioned for a school lunch (in effect a revised NBS, along with some additional nutrients).
3. Analysis of food choice data from two secondary schools. Collection and analysis of large datasets of school canteen purchasing data from the three weeks preceding the observation visits. Canteen purchasing data was linked to nutritional composition data of school foods/drinks as chosen, in order to evaluate the nutritional composition of students' food purchases/choices.
4. Analysis of students' food choice behaviours. Focus groups with secondary school students were conducted to explore how and why students make their food choices.

Two schedules were developed, and two separate sets of discussions took place, one in each school.

Figure 2.1 outlines how the thesis components are described across the study chapters (chapters 3-7 inclusive). The figure also indicates how each component relates to the next. The methodology for each study is described in much greater detail within the study chapters themselves. This chapter focuses instead on the overall thesis design, describing the thinking behind the design taken and considering how each component of the thesis looked to contribute to existing knowledge, both in the context of the thesis and for broader research purposes. Figure 2.2 provides a timeline of each study phase, outlining the labour and time involved in collecting and analysing the different forms of data.

Component 1 (Chapter 3)

- 3-week observations in 2 secondary schools
- Observant participant approach used to gather data on school food preparation & provision for full 3-week menu cycle
- Insights into school catering practices

• Food Preparation data for all school foods/drinks

• Insight into catering practices

Component 2 (Chapter 4)

- Develop nutritional composition tables for all school foods/drinks
- Examine nutritional composition across categories, subcategories of foods/drinks
- Assess nutritional composition of an "average lunch", all lunch combinations and typical lunches
- Assess provision in relation to FBS & reference values

• Nutritional composition of provision in both schools

• FoP nutrient profile for all foods/drinks provided in schools

• Assessment of school food provision

Component 3 (Chapter 5)

- Link nutritional composition data to cashless catering data
- Explore students' choices over 3 week period across food/drink categories/subcategories
- Explore the nutritional composition of food choices across gender, year group and FSM/non FSM - eligibility

• Objective assessment of students' school food choices

• Nutritional composition of students' school food choices

• Exploration of group differences in school food choices & nutritional implications thereof

Component 4 (Chapters 6 & 7)

- Gather FG data to explore Year 8 and 9 students' perspectives on how they make their food choices throughout the school day and how they manage their different environments as they make food choices
- Gain insight into the main drivers and barriers of students' choices within the whole school environment
- Engage students as thought-leaders by asking what their perspectives and suggestions are pertaining to school food

• Insight into how and why students make their school food choices

• Student perspective on opportunities and barriers to influence school food choices

Figure 2.1. Outline of the thesis design including study chapters and outcomes for each

	2018-2019			2019-2020			2020-2021			2021-2022		
Activity	Sep-Dec	Jan-Apr	May-Aug	Sep-Dec	Jan-Apr	May-Aug	Sep-Dec	Jan-Apr	May-Aug	Sep-Dec	Jan-Apr	May-Aug
Ethics												
School Recruitment												
Observations												
Food Preparation Table Development												
Nutritional Composition Table Development												
Analysis of school food provision												
Focus Group Schedule Development												
Focus Group Data Collection												
FG Study 1 Analysis												
FG Study 2 Analysis												

Cashless catering data collection												
Linking Cashless catering data to nutritional composition data												
Analysis of school food choices												
Thesis Write-up												

Figure 2.2. Thesis timeline

2.2 Mixed Methods Approach

The thesis uses a mixed-methods approach. Mixed-methods approaches explore phenomena through quantitative and qualitative means, in order to gain a more complete perspective[257–259]. Given the complexity of the school food environment, and adolescents' food choices therein, this approach was considered particularly appropriate in terms of gathering rich and contextual data.

Quantitative methods derive findings using standard statistical procedures, whereby data is numerical. They assume that findings are objective and can, with appropriate sampling and robust statistical techniques, produce findings that are representative of the wider population. Qualitative methods, on the other hand, derive findings via researcher interpretation of context-specific phenomena, whereby data can be text, audio or visual. Qualitative approaches assume that findings are subjective and context-specific; they produce findings that are rich in detail and reflect the lived experience of the subjects.

Mixed methods approaches utilise both quantitative and qualitative methods, and can be considered the third research paradigm. A key strength of this approach is its ability to compensate for the limitations of solely quantitative or qualitative approaches. For example, quantitative research typically focuses on "what" type questions and can consequently struggle to explain why or how certain phenomena arise. Qualitative research, meanwhile, focuses on "how" or "why" type questions, and can therefore complement quantitative inquiries by gathering insights and contextual considerations in a way that quantitative approaches cannot. That said, undertaking qualitative research can require substantial researcher skill in order to avoid observer effects[254] where people change their behaviour because they are watched, or social desirability biases[255], whereby participants volunteer responses that they think are more socially acceptable, rather than ones which reflect their reality during data collection, and also to analyse and interpret the data correctly. Moreover, qualitative studies typically have small sample sizes, often focusing on specific demographics; as such, qualitative findings are context specific and may not be generalisable in the same sense that quantitative findings with large, representative sample sizes are. Through a mixed methods approach, quantitative findings can provide generalisable, objective and numerical support to qualitative findings, while qualitative findings can help provide must-needed context and deeper insight to quantitative findings.

The PhD thesis used a convergent parallel mixed methods approach. In this approach, both quantitative and qualitative aspects are given equal priority and are conducted independently at the same time[260]. Findings from each strand are synthesised, while the researcher notes points of convergence and/or divergence between the findings. Discussion of these points of convergence/divergence helps to illuminate the nature of the phenomena in question, along with exploration of the mechanisms underlying said phenomena.

As indicated in the aims and objectives (section 1.9, chapter 1), the thesis explores school food from multiple perspectives, including policy, catering staff, school staff and students, with the main focus being those of students and caterers. A mixed methods approach was identified as the most suitable approach to achieve these aims and incorporate these multiple perspectives. In terms of the thesis, mixed methods would enable the researcher to pursue greater clarity (e.g. what is the nutritional composition of school food provision and students' school food choices?) and insight (what is the nature of school food preparation practices? How do students make their school food choices?) with regards to school food and adolescent dietary behaviour. In doing so, the researcher could carry out a clear and detailed assessment of school food.

2.3 Component 1 – Observation Visits (Chapter 3)

Three-week observation visits were planned in each school within the first year of the PhD. The primary aim of the observation visits was to gather as much detailed information as possible into how school foods/drinks are prepared and provided. This included ascertaining written recipes, brand information and weights for all ingredients, preparation methods and portion sizes. This information would then be used to develop a food preparation table, which in turn would inform the development of a nutritional composition table for school food provision and school food choices. The second aim of the observation visits was to gather insights into school catering practices. Insights could include any potential deviations from written recipes, staff views on school food and school canteen practices during service times.

2.3.1 Rationale for Conducting Three-week Observation Visits

An observant participant approach to data collection, based on ethnography, was chosen for the observation visits. This approach was chosen for a number of reasons. First, by spending three weeks on-site in the schools, and for the full food service day (i.e. from the time preparation begins in the morning until cleaning is finished after lunch) the researcher would have sufficient time to collect data at the ingredient level (e.g. brand, weight, back of pack nutritional information, manufacturer etc.), note any deviations from written recipes and weigh foods as they were being prepared (e.g. weighing of baguette before and after adding butter, ham, cheese). It was thought that this would facilitate a more rigorous assessment of school food provision and choices. Given the current ambiguity surrounding UK secondary school food, and the relatively limited amount of relevant research thereon, it was imperative that the research, and particularly the data collection approach, be as rigorous and meticulous as possible.

Secondly, the immersive aspect of the observation visits, together with the prolonged duration would enable the researcher to ingratiate himself to the catering teams and gather more detailed data. As a temporary part of the catering team, the researcher could also look to have discussions with staff regarding school food. Whilst the thesis predominantly focuses on students and students' food choices, by having these continuous observations, and discussions with catering staff, the researcher could consider perspectives from both sides of the counter. This immersive aspect of the data collection could therefore give the researcher a greater knowledge of the context within which school food and drinks are prepared and provided, and facilitate a more nuanced assessment of school food. The observation visits looked to expand knowledge in the following ways:

- Gather detailed food preparation data over a full three-week menu cycle to inform the development of nutritional composition tables.

- Gain insight into food preparation practices throughout the school day and over a prolonged, continuous period. This would enable the researcher to observe how school food standards are put into practice and note any potential shortcomings of the standards in terms of implementation efficacy.

- Get the perspective of catering staff members regarding school food preparation, provision and students' dietary behaviours.

2.4 Component 2 - Analysis of school food provision (Chapter 4)

As mentioned earlier, the primary aim of the observation visits was to gain sufficient information in order to facilitate the development of food preparation and nutritional composition tables for each school. Based on the information gleaned from the observation visits and the resultant food preparation tables, nutritional composition tables would be developed to reflect school food as provided and as chosen. Component 2 of the thesis focuses on the nutritional composition of school food as provided and looked to expand current knowledge in the following ways:

- Evaluate school food over the full three-week menu cycle. Most previous evaluation studies of school food provision and intake[228,231,232,237] have collected data over five consecutive days or fewer, therefore this chapter would look to provide a more comprehensive assessment of school food provision by considering provision over the full menu-cycle.

- Explore school food provision across categories and sub-categories. This would enable the identification of "problematic" or less favourable food/drinks categories, thus giving a focus to any implications/recommendations resulting from the study. Moreover, the incorporation of front-of pack (FoP) labelling would aid dissemination to wider audiences as people are accustomed to and familiar with interpreting front-of pack labels.

- Assess food provision in relation to reference values. Reference values used in this thesis refer to dietary reference values[9], apportioned for a school lunch. In practice, these reference values equate to the previous NBS for some values. NBS previously consisted of 14 maximum and minimum NBS values; this chapter looked to expand this by introducing 6 additional nutrients (Magnesium, Potassium, Iodine, Vitamin B6, Vitamin B12, Vitamin D) and updating the NBS in light of recent SACN (Scientific Advisory Committee on Nutrition) recommendations regarding free sugars[261], fibre[261] and vitamin D[262]. School food provision was also considered in relation to current FBS. The inclusion of both sets of standards enables the researcher to explore what compliance or non-compliance with FBS looks like in terms of energy and nutrient content.

2.5 Component 3 – Analysis of school food choices (Chapter 5)

Component 3 of the thesis focuses on adolescents' school food choices, and the nutritional composition of these choices. Cashless catering data, which is automatically collected and includes details for each transaction, would be downloaded from both schools for the current and previous school year, to enable analysis of students' food choices over a full three-week menu cycle. A single three-week period was isolated for each school. In both schools, the data for the three weeks prior to the observation visit would be used, to remove any observer effects[254] which may have influenced students' school food choices during the three weeks of observation. Cashless catering data and nutritional composition data could then be linked to establish a working dataset consisting of every food/drink item sold during the three weeks, along with its corresponding nutritional composition. Similar to the analysis of school food provision, the exploration of school food choices looked to expand current knowledge in the following ways:

- Explore frequencies of food/drink items sold across the student population and also across food/drinks categories and subcategories. This would provide a breakdown of students' choices throughout the school day and across the menu cycle.

- Ascertain number of lunches sold, calculate an average lunch for each school and compare it to reference values. This would build on the provision findings by describing the nutritional content of students' school food choices over the three-week menu cycle. When NBS were still in use, average lunches were based on provision, rather than choices; however, calculation of an average lunch based on choices could contribute to the existing knowledge by indicating how students' actual choices relate to reference values (and by proxy, DRVs).

- Compare energy and nutrient intakes for the three weeks across various sub-groups; comparisons would be made between age cohorts (young, middle, older adolescents), gender (male/female) and FSM students/those spending below FSM value/those spending above or equal to FSM value. Year 7 and 8 students represent younger adolescents, year 9 and 10 represent middle adolescence, while years 11-13 correspond to older adolescents. These comparisons may help to pinpoint potentially vulnerable groups, explore group differences in school food choices and describe the nutritional implications thereof.

- Calculate energy and nutritional values for students' choices across the entire school day. These values can show how the food and drink choices adolescents make contribute towards their daily requirements. Whilst choice is not consumption, this would still give an indication of how school food choices correspond to daily requirements (e.g. the average student chooses foods which contain up to X% of their daily recommended amount of sodium). This would also provide additional context to the average lunch findings and shed more light on the food choices across the school day, not just the average lunch consumed.

The analysis of school food provision and school food choices would mostly be done at the descriptive level, with some simpler inferential statistical tests also included. A strength of such analysis is that it enables the researcher to reach findings that are easily communicable to both research and wider audiences (e.g. school staff leadership staff, catering teams, policymakers). Chapter 1 highlighted the ambiguity and uncertainty surrounding the current state of school food; therefore, an overarching aim of the thesis was to provide an up-to-date account of school food, both as provided and as chosen. Descriptive-level statistics are useful in this regard, as they enable the researcher to provide a clear and simple picture of school food, lay a foundation for future work and identify worthwhile next steps.

2.6 Component 4 – Focus Group Discussions (Chapters 6 & 7)

The last component of the thesis focuses on the collection of qualitative data. Focus groups were chosen as they offer a naturalistic environment in which students can speak candidly. When compared to other qualitative data collection methods, particularly interviews, focus groups can hold advantages by providing greater anonymity and helping participants to discuss topics freely[263]. This can help generate richer, more detailed data[264]. Considering the age of the participants (12-14 years), the research team also felt that students may have felt more comfortable speaking as part of a group discussion, as opposed to in a one-on-one interview setting. Finally, focus groups enable the incorporation of multiple voices and multiple viewpoints. As such, topics can be discussed from different perspectives and the group can come to consensus/agreement/disagreement naturally by themselves. In this way, focus groups could enable the researcher to delve deeper into the subject of school food and get a more nuanced perspective.

As mentioned earlier, focus groups, and qualitative approaches generally, can provide valuable context and insight to quantitative findings; as such, the thesis design looked to conduct focus group discussions in each school. The inclusion of focus groups within the thesis would enable the researcher to gather insights into the students' perspectives on school food and gain a better understanding of how they make food choices throughout the school day. Different schedules were chosen for each school as the team felt that (1) there was enough data to reach data saturation in both studies, and (2) the use of two different schedules would enable description of students' school food choices in a broad sense, but also exploration of specific aspects of food choice which were of interest to the research team.

2.6.1 Inductive/Deductive Approaches

Focus groups are typically approached either inductively or deductively[265], in terms of schedule development and analysis. An inductive approach can also be termed a bottom-up thematic analysis. During schedule development, the researcher does not overly look to previous work or existing theories on the subject matter; instead questions are composed out of personal interest, while the focus group discussions operate from a "fresh" starting point. As such, the content of the focus group discussions may differ from the questions originally posed. Inductive approaches are useful in that they are a purely data-driven form of thematic analysis and can provide fresh perspectives and insights. Deductive or top-down approaches, meanwhile, are theoretically rooted and are supported by previous research. During schedule development, the researcher can utilise pre-existing models or theories to structure the order and list of questions, while participants' responses, in turn, can be considered in relation to the pre-existing theoretical framework. Deductive approaches are useful as they can be used to expand or refine pre-existing theoretical presuppositions and, in doing so, can progress the development of research on that particular topic.

In terms of the design of the qualitative component of the thesis, the research team remained flexible in their approach. Whilst both FG studies incorporated both deductive and inductive reasoning, they each leaned more so towards one approach in order to achieve their respective aims. For example, the aims of Chapter 6 were much more theoretically driven than the aims of Chapter 7 and looked to explore the school food environment and barriers and facilitators to students choosing a school meal, topics which previous research has already discussed. Moreover, previous research has explored similar topics in relation to prominent theoretical models of food choice, most notable the socio-ecological model[31,266,267]. Therefore, Chapter 6 would take more of a deductive approach, with particular attention paid to socio-ecological aspects of school food choice. Meanwhile, the approach chosen for Chapter 7 would be more of an inductive approach, being more explorative in nature compared to Chapter 6. This distinction is important and is consistent with the aims of each study; the study in chapter 6 aimed to explore students' experiences within the school environment, while the study in chapter 7 aimed to explore students' school food choices and the potential role played by home and peer influences. Knowledge contribution for component 4 was as follows:

- Gain further insight into student's lunchtime canteen experience and explore how adolescents make their food choices within the school environment.

- Explore how adolescents make their food choices throughout the school day and how they engage with their environments during the food choice process. This involves the exploration of wider aspects of adolescents' school food choices, including peer influence, adolescent development, family dynamics and the influence of outside environments on school food choice.

2.7 Summary

School food and school food choice is a pertinent issue in the UK public health sphere. One of the key strengths of the thesis design is that it facilitated investigation of school food choice on multiple fronts; the observation visits explored catering practices and food preparation and provision, the analysis of cashless catering data and nutritional composition tables explored school food as provided and as chosen, while the focus group studies explored students' views on their food choices and food choice processes. The design included a hands-on immersive approach to collecting primary data within the schools themselves. Given the complexity of student food choices, schools and school food, it was important that the researcher be on the ground level in order to pick up on important contextual factors, explore some of the minutiae surrounding school food, and perhaps most importantly, facilitate the most rigorous assessment of school food provision and school food choices as possible. Finally, by collecting quantitative and qualitative data, using recognised school food standards as a reference and employing descriptive and simpler inferential statistical tests, the thesis could produce findings which would be easily communicated and digested by a variety of stakeholders, including policymakers, researchers, public health practitioners, school staff, catering companies, catering staff, parents and students. This dissemination of communicable findings, based on rigorous data collection and development, would hopefully maximise the potential impact of this thesis amongst both academic and wider audiences.

Chapter 3. Observation Visits in Schools

3.1 Introduction

Chapter 1 outlined how policy initiatives, such as the school food standards, relate to school food provision and illustrated how policy intentions can be mediated by different priorities along different organisational (e.g. national policy, local education authority, school leadership, catering companies) and individual levels (e.g. school staff priorities, students' food choice behaviours). School food can be viewed as a complex and dynamic issue, with influences positioned along multiple levels. These include macro (e.g. national school food policies, commercial tendering for school food services), meso (e.g. the school environment, school ethos toward food) and micro level influences (e.g. in-kitchen preparation and provision methods, students' food choices). Initiatives acting along any of these levels may involve the intersection of policy-makers, health advisers, researchers, commercial entities, catering staff, teachers, and students. An adequate assessment of school food must therefore consider the intersection and interplay of these potentially conflicting interests, values, perspectives, and motivations.

Ethnography is a research approach whereby the researcher conducts fieldwork and observes people within their cultural environment, to see how individuals interact with each other within the environment, and how individuals interact with the cultural and social environment itself[268]. Ethnographic approaches have previously been used to conduct research in the UK primary school sector. Such approaches have been used to collect data on UK primary school lunchtime food service and setting[269], explore students' food experiences across the school day[270], consider how social learning can impact students' eating behaviours[271] and inform the development of a school food self-evaluation tool[272]. These studies have promoted insight and knowledge generation into UK school food and the enactment of school food policy in the everyday experience of primary school food. Moreover, ethnographic approaches have highlighted how "the everyday experience of food in schools is much more complicated than the policy suggests"[273].

Given the lack of recent research on secondary school food provision, and the current uncertainties regarding how school food is prepared and provided (as outlined in chapter 1), it was important that the researcher gather the most accurate data as possible, in order to give a fair/valid/objective depiction of school food provision and school food choices. It was also important that the researcher not make any assumptions in terms of how school food is prepared, provided or chosen. For these reasons, the observational approach to data collection, based on ethnography as defined above, was integral to the overall thesis. This chapter details the observation visits that the researcher carried out in each of the two schools, including the approach taken, the types of data and insights collected, and a reflection on how the observation visits impacted the thesis as a whole.

3.2 Aims of the Observation Visits

Addressing the first aim of the thesis, the primary aim of the observation period was to gather detailed information with regards to how English secondary school foods are prepared and provided, to inform the development of a nutritional composition table for school food provision and school food choices. A secondary aim of the observation period was to gain valuable insights into how school kitchens operate day to day. This chapter describes the researcher's experience conducting the observation visits and outlines the key insights gathered during this time.

3.3 Methods

3.3.1 Recruitment

Recruitment for all the studies in the thesis took place in the same time period, i.e. during recruitment, schools were asked to facilitate observation visits, provide information to aid the examination of school food provision (via observations, written recipes, and discussions with the research team) and choices (via cashless catering data), and facilitate focus group discussions with students in school. This enabled efficient collection of data, while having the same schools involved facilitated comparison across the different arms of the project (e.g. insights generated in the qualitative studies could be directly considered with respect to the cashless catering data).

All secondary schools within a local authority in the Yorkshire area were identified and listed, alongside key data relating to school size, FSM profile, percentage of students for whom English is an additional language, percentages of different ethnicities and religions represented in student population. Initially, schools were listed in order of closeness to national averages for free school meal entitlement (FSM) percentage and number of pupils on roll. Schools were subsequently ranked, based on whether they worked with a national catering company or not, with priority given to schools who did. These schools were prioritised, in an effort to recruit schools that used the same catering company. As these large catering companies operate on a national scale, the recruitment of these schools would also, in theory, increase the generalisability of the findings.

Schools were approached initially via telephone enquiry and then via follow up email. The email included a single page project outline, giving the school supplementary information on the project, including brief background to the project, the aims of the project, what would be asked of the school and the catering team (hosting researcher for 3 weeks) and the scope of the activities. The research team also visited each school, to meet the school staff (catering managers, catering team, safeguarding officers and senior staff), discuss the project and answer any questions staff members had. Schools were offered the following incentives: £1000 compensation, certificates for focus group participants and a school report outlining the results for that school.

Two secondary schools were recruited, both from the same local authority in Northern England. School 1 was a large secondary school, with approximately 1100 students (age 11-18) on roll. At the time of recruitment, the school had a below average free school meal (FSM) profile; circa 9% of students were eligible to claim FSM compared to the national average of 14%[168]. The percentage of students with English as an additional language (circa 6%) fell below the national average of 16.9%[168] at the time of recruitment. School 2 had an FSM% of circa 20% and over 900 pupils on roll at the time of recruitment. Meanwhile, the percentage of students with English as an additional language (circa 4%) was below the national average of 16.9%[168] at the time of recruitment.

Once schools were recruited, students and parents of students were sent tailored (addressed to them specifically) information sheets, which described what the study was about, what the participants would be asked to do, how the data would be collected and stored, and what would be done with participants' responses, in terms of dissemination (see Appendix 1). For the focus group studies, due to ethical considerations (i.e. safeguarding participants and researchers alike by avoiding direct correspondence between researcher and underage participants), school staff were responsible for direct recruitment of students, with researcher instruction (i.e. requesting mixed groups, recruiting year 8/9 students). Opt-in consent was sought from all focus group participants, while opt-out consent was requested from the parents of students; an opt-out consent form was included in the parent information sheet. During the focus groups, students were reminded of their freedom to stop or not participate at any time. The research team also identified and contacted the appropriate school staff members responsible for student welfare (e.g. school counsellor) prior to conducting the focus groups, just in case students became distressed during the discussion and needed support.

3.3.2 Ethical Approval

Ethical approval for the thesis project as a whole was first sought from the Faculty Research Ethics Committee on 25/10/2018. The initial application was not approved but after addressing committee comments, the application resubmitted and ethical approval was granted on 25/01/2019 by the Faculty Research Ethics Committee (MEEC FREC 18–012) at the University of Leeds.

3.3.3 Use of an observant participant approach

Participant observation involves "the process of learning through exposure to or involvement in the day-to-day or routine activities of participants in the research setting"[274]. A recent trend has been to invert participant observation and transition to observant participation[34,35,275–278]. In order to transition from participating observer to observant participant, the researcher must become more immersed in the environment and familiarise themselves with the cultural minutiae therewithin. Whilst the participant observer is accommodated and holds a transient role within the environment, the observant participant embraces an active role in the environment[279]. Put simply, an observant participant approach[34,35] is one whereby the researcher moves from *frontstage*, where informants' behaviours are a performance, to *backstage*, where informants' behaviours are more authentic[280]. As an observant participant, the researcher becomes immersed in the environment and gains detailed information and insight which may not have been attainable otherwise. Observant participant approaches have been used to explore a variety of different research topics, including intravenous drug use[281], medical care practices in a women's prison setting[276], religious education practices in an American Catholic secondary school[282] and how pastoral care and discipline is enforced in Hong Kong secondary schools[283]. An observant participant approach was used throughout the observation visits. To the author's knowledge, this signalled the first time an observant participant approach was used to collect food preparation/provision data and nutritional composition data in a UK secondary school setting.

3.3.4 Preparation for Observation Visits

Daily observation visits were conducted for a period of three consecutive weeks in each school in May and June 2019. Before commencing the observation visits, the researcher and research team took a number of preparatory measures. For example, during the recruitment stage the researcher conducted a single day observation visit and was able to meet some of the catering staff, brief them on what the study and the observation visits involved and answer any questions they had. The researcher also pre-developed the spreadsheets for the food preparation tables and nutritional composition tables. This helped to crystallise what information the researcher would need to glean from the observation visits, and helped the researcher identify details of interest such as the weight of all ingredients, how often an item was provided during the three weeks, the brand information for ingredients etc. As school 1 worked with a national catering company, the researcher was able to ascertain some typical menu cycles via online searches, become familiar with the menu cycle and highlight how items were categorised (e.g. meals of the day identified individually, sandwiches identified as umbrella term on written menu).

The researcher also designed an observation protocol, which outlined the times and locations where the observation visits would occur, how the researcher would travel to and from each school, and details of a contact person whom the researcher would check in with each day to confirm safe travel to and from the school. Finally, the researcher tabulated an initial checklist of food/drink items, based on the single observation visit and online searches, for which preparation information (e.g. ingredients, weights of ingredients, brands used, preparatory methods, provision frequency etc.) was needed. The research team met frequently during this time, to discuss the development of these preparatory materials. Furthermore, as one of the research team had prior experience collecting data in schools, she was able to impart her knowledge and experiences at this stage also.

3.3.5 Daily Routine

There was a clear routine to the observation days, and this is detailed below:

Each day, the researcher arrived in the kitchen for 7am. At this time, only the catering manager would be in the kitchen. The researcher observed how the day started in each kitchen. During this early morning stage, the researcher helped to put deliveries away. The researcher also used this time to speak directly with the catering manager in the schools, discussing topics such as school recipes, how foods are ordered on the online system and the intricacies of managing a kitchen (e.g. stock management, monitoring staff preparation standards, managing food delivery errors, working with the school). Catering managers also provided written recipes for the meal of the day items provided each day.

Once additional staff members arrived, the researcher observed how the food preparation process started, including how staff managed available stock, planned the day's provision (particularly for sandwich items, break items, i.e. items not explicitly defined on the menus) and assigned jobs to each staff member depending on number of staff members available that day. In school 2, the researcher also had tea with the staff each morning. Throughout the day, the researcher made efforts to become a team member, primarily by carrying out daily kitchen tasks such as stocking fridges, sweeping floors, cleaning surfaces and putting away food deliveries. Each day, after the lunch service, the researcher swept the floors and cleaned the tables with the staff members. Afterwards, the researcher ate lunch with the staff. The researcher also frequently engaged with the staff in general conversation, making a concerted effort to establish a rapport.

Efforts to connect with the catering staff served an important function within the observant participant method of data collection. Establishing rapport and camaraderie with staff members enabled the researcher to ask questions and observe the staff whilst they worked without appearing obtrusive or, critically, without seeming judgemental. The researcher approached the data collection as an inquisitive friendly researcher, interested in gaining as much detail and knowledge about foods on offer and their preparation as possible. Given that this part of the project involved assessing the nutritional composition of school food, in essence examining the catering staff and their provision, it was important that the researcher adopt such an approach.

By approaching data collection in this way, the researcher became immersed in the environment, ingratiated himself to the catering staff, and gained first-hand knowledge of how the kitchens operated. In this way, the researcher transitioned from participant observer to observant participant[34,35]. As an observant participant, the researcher had rich and informative conversations with several catering staff members. Staff discussed how they prepare foods (e.g. weighing ingredients using a scale or judging by eye) and allowed the researcher to weigh ingredients and take photographs as food was being prepared (e.g. weighing bread before and after adding margarine, then again before and after adding ham, cheese). Staff granted the researcher access to fridges and stock rooms to document the nutritional information and brand information for all ingredients. The researcher was also able to shadow staff during breakfast, break and lunchtime services, observing how the canteen operates (e.g. how long service times are, how long the queues are, how students order foods/drinks, how items are entered on the till etc.) and witnessing the interactions between staff and students.

3.3.6 Reflexivity

Reflexivity refers to the repetitive practice of reviewing, considering and revising the researcher's beliefs and practices during the research process[284]. Reflexivity is important in maintaining quality and rigour in observations and/or qualitative research[285–289]. Given the substantial level of researcher involvement in the data collection process, it was important that the researcher and research team enacted reflexive practices throughout the observation period. During the observation visits, the researcher was aware of his potential influence and tried to minimise any potential observer effects[254]. The researcher did this by ingratiating himself to the catering staff, helping out with daily kitchen tasks and trying to become a part of the catering team. Observations were also guided; a daily reflection log was maintained, including notes on how foods were prepared each day, insights acquired during each day's observation, along with questions to ask the following day (see Appendix 2 for example). The researcher also used memos and the reflection log to check for any preconceptions or presumptions that could impact on the data collection.

A checklist of items was tabulated and marked complete once the researcher had observed that food being prepared and collected the requisite preparation information for that item (e.g.

ingredients, weights of ingredients, brands used, preparatory methods, provision frequency etc.). The research team also met frequently (2 - 3 times per week) throughout the observation periods to discuss the researcher's experiences in the schools, go through the researcher's reflection notes, and outline aims for subsequent guided observation days.

3.4 Findings

The researcher conducted a full three weeks of observations in each of the two schools, amounting to 90 hours of observations in each school. Both schools operated a 3-week menu cycle, which is the norm for UK schools. Three services occurred every day: breakfast, mid-morning break and lunch. Breakfast was much smaller, with very little student uptake. Mid-morning break was a much busier service and included many breakfast-type items (e.g. waffles, toast, pancakes) along with fruit and drinks items. Lunch was the busiest service time during the school day. At lunch, schools provided a different main meal of the day, a vegetarian main meal alternative and a main dessert item each day, along with various sandwiches, baguettes, pizzas and pasta items. At lunch, students could also purchase various drinks, dessert items, sweet snacks and fruit options.

3.4.1 Data Gathered During Observation Visits

The observation periods successfully provided valuable data on how food is prepared and provided, which informed the development of the nutritional composition tables. Prolonged observation periods enabled collection of data in great depth (e.g. multiple measurements taken for most ingredients to account for variation between individual staff members) and also in great breadth. For illustration, data collected during the observation periods included the following types:

- Photographs (see Appendix 3)
- Reflection notes
- Ingredient information for each food item
- Brand information for each ingredient
- Weights of all ingredients in each item
- Portion size information for all items

- Limited nutritional information for most ingredients (to serve as standard for selection of nutritional composition data. In cases where this standard wasn't obtained during the observation period, it was retrieved from manufacturer websites and/or direct manufacturer correspondence)
- Product codes for most ingredients (again, in cases where the product code wasn't obtained during the observation period, it was retrieved from manufacturer websites and/or direct manufacturer correspondence)
- Qualitative data via conversations with staff and note-taking
- Limited till information (i.e. photographs of display screen along with notes on how items are described on till)
- Manual tallies of daily provision for items described broadly/generally on menu (e.g. sandwich items, drinks items)
- Manual tallies for students' choices of sides with meal of the day items
- Manual tallies of daily sales for items described broadly/generally on menu (e.g. sandwich items, drinks items)

3.4.1.1 Development of Food Preparation Table

A key outcome of the observation visits was the development of the food preparation table. This was a table outlining details (ingredient weights, brands, food recipes, number of portions provided by each recipe, portion sizes, day of week served, time of day served etc.) for all ready-made foods/drinks bought into the school and all foods/drinks prepared in the school (the majority of items) over the 3-week menu cycle.

The food preparation table was populated during the 3-week observation visits and was completed prior to the observation visits ending. Information and insights gathered during this time informed the development of the food preparation table for each school. The starting point was the menu cycle which provided information on which meals of the day, desserts and pastas were provided each day over the three weeks. Other items (e.g. pizzas, sandwiches, sweet snacks) were described broadly on the written menu under an umbrella term, while break and breakfast items were not on the menu, as it only referred to lunchtime provision. For these items, their provision over the three weeks was documented manually by the researcher during the observation period; manual tallies were taken for all sandwich items provided, to establish how often each sandwich type was provided (e.g. ham sandwich provided every day). For any foods/drinks prepared in the school, the method of preparation (including cooking methods, ingredients used, and portion sizes) was detailed and documented in the food preparation table. At this point, portion sizes were calculated by simply combining the weights of ingredients for each food/drink. For drinks, the total volume was taken as the portion size.

3.4.1.2 Categories & Sub-categories

During the observation periods, the research team also classified all school foods and drinks into categories and sub-categories. Food and drink items were classified into 6 categories (Main Meals, Break Items, Sweet Snacks, Fruit, Drinks, Dessert Main Meal) and 19 constituent sub-categories. Items were grouped based on their broader characteristics (e.g. a food/drink item, a snack/meal item, a sweet/savoury item), what time they were served (e.g. at break or at lunch), along with their identification on the written menu (i.e. described specifically on menu as a meal of the day or subsumed under broader sandwich items description). Table 3.1 provides a list of the categories and sub-categories, with descriptions and examples provided for each.

Table 3.1. Categories and sub-categories of food/drink items

Category	Sub-Category	Description	Examples
Main meals	Meals of the Day	Freshly prepared main meals; meat and vegetarian options	Roast pork with Stuffing and Apple Sauce, Sweet Potato & Squash Casserole, Chicken Korma
	Sandwiches	Sandwiches, wraps, rolls, baguettes	BBQ Chicken Wrap, Ham Baguette, Cheese Sandwich, Tuna & Cucumber Soft Roll
	Pastas	Freshly cooked pasta with sauce and cheese	Pasta with Bolognese Sauce, Chicken Mayo Pasta Pot, Tomato & Basil Pasta Pot
	Paninis*	Baguettes, oven baked and filled	Ham & Cheese Panini, Cheese & BBQ Chicken Panini
	Pizzas	Pizza slices and small pizzas	Pepperoni Pizza, Margherita Pizza, BBQ Chicken Pizza
	Jacket potato	Jacket potatoes with beans and/or cheese	Jacket Potato with Beans and Cheese

Sweet snacks	Cookies, Muffins, Traybakes	Small baked sweet items	Chocolate flavoured cookie, Plain Muffins, Flapjacks, Iced Finger
	Dessert Misc.	Dessert items available some days	Jelly, Chocolate Mousse, Yoghurt
Dessert Main Meal	Dessert Main Meal	Main dessert, freshly prepared	Strawberry Swirl Sponge, Apple Crumble, Summer Berry Sponge
Savoury snacks	Savoury Snacks	Grab and go savoury items (provided at breakfast and break)	Bacon Sandwich, Waffle, Bagels, Cheese Toast
Fruit	Fruit Cups	Cups of chopped fruit (mixed or single fruit)	Watermelon cup, grapes cup, mixed fruit cup
	Whole Fruit	Whole fruit	Apple, banana, orange
Drinks	Juice-based	Juice-based drinks made up of pure fruit juice (circa 45%) and water	Radnors, Juice Bursts
	Flavoured Milk	flavoured milk drinks	VIVA chocolate flavoured milk
	Milk	Semi-skimmed milk	Semi-skimmed milk
	Pure juice	Pure juice offered throughout the school day	Calypso Juice Cartons
	Water	Water and flavoured water drinks	Bottled Water
	Slush	Slushies dispensed from a machine	Vimto Tropical Slush, Mixed Fruit Slush
	Cream-based‡	Ice-cream shakes dispensed from machine	Slurp Strawberry/Chocolate Ice-cream shake

* only at S1; ‡ only at S2

3.4.2 Insights Gathered During Observation Period:

Aside from the data collected, the immersive nature of the observation visits, and the adoption of an observant participant approach in particular, enabled the researcher to gain some valuable insights into school food catering practices and school food preparation and provision. The following sections outline the key insights from the observation visits. These insights are based on the observation notes, reflections, photos, memos and discussions with catering staff during the three weeks of observations, and are grouped under three headings: Student-Staff Interaction, Kitchen Push-Pulls and Catering Practices.

3.4.2.1 Student-Staff Interaction:

In both schools, staff spoke of growing attached to students, knowing several students by name and establishing a rapport with individual students. It was apparent that staff were an integral part of the school community. Staff also spoke about feeling a sense of care for students and often took note of students who appeared tired or hungry. Some staff mentioned having previously notified school leadership about students who appeared noticeably hungry or tired or students whom staff feared were having issues at home. It was also apparent during the observation visits that staff occasionally tailored their portions to specific students. For example, the researcher observed staff providing larger portions to certain students whom they felt had larger appetites or needed more food. Staff were also seen encouraging students whom they perceived to be undernourished to have extra sides (e.g. extra potatoes, carrots etc.).

The catering team also used their experience and knowledge of students' likes/dislikes to inform their food preparation and provision methods. For example, school 1 staff provided muffins with icing, believing students would not eat them without icing. Staff in school 2 ordered wholemeal rolls, as they found students were more amenable to eating wholemeal bread if presented in the shape of a round roll but were unlikely to choose wholemeal bread in the form of sliced bread. School 2 staff also provided sweetcorn as a vegetable side option more often than other vegetables, believing that students were more likely to choose sweetcorn compared to other vegetables.

3.4.2.2 Kitchen Push/Pulls (Conflicting Interests):

Kitchen push/pulls can be described as a relationship between three parties: (1) the school, (2) the catering company/catering team and (3) the students. The catering and teaching staff in both schools expressed a desire and interest in providing healthy school food/drink items to students and reported trying to encourage students to choose more fruit and vegetables. Catering staff also exhibited an awareness of school food standards and were keen to know how they could improve the quality of their provision. During the observation visits, several staff inquired about the weights of certain ingredients and shared their views on potential areas of improvement for school food provision. For example, some staff members cited the primary school model of provision as preferable to secondary school. In primary school, students are given a limited number of options (typically 4 main meal options including a vegetarian main meal, a meat main meal, a jacket potato and sandwich options) and can choose one option. Staff in the present study highlighted a key benefit of limiting students' options as granting greater control and influence on students' food choices to school food providers.

However, whilst general school staff (administrative staff, teachers, school leaders etc.) and most catering staff expressed a desire to provide healthy meals, many catering staff members lamented that students rarely chose the more substantial meals of the day, opting instead for convenient (and typically less healthy) grab-and-go items (e.g. waffles, sweet snacks, pizza items). This preference for grab-and-go items was reportedly only worsened by the time pressures placed on both staff and students, due to long queues and short lunch periods (30 minutes). Staff mentioned preparing certain food items (e.g. meals of the day, fruit items), and knowing they wouldn't be chosen and would most likely go to waste. In contrast, some other staff members commented that schools need to be realistic and provide foods which they know students will eat.

Staff noted that schools, if looking to maximise profits, could increase provision of popular items. However, the school instead enacted policies to try and reduce provision of the more popular unhealthy items (e.g. cookies and muffins never provided on the same day) and increase uptake of healthy foods (e.g. mandatory salad provided with pizzas). Moreover, staff noted that students can take advantage of this and admitted that students hold a level of power and influence as customers.

In acknowledging that students' food choices can leave their preparation/provision efforts futile, staff illustrated how students' choices can encourage or discourage provision of popular/unpopular items. Moreover, as school food provision exists in a competitive sphere, kitchens can be placed in an awkward position between meeting sales targets/expectations of the catering company and ensuring students receive a healthy lunch. This was especially evident in school 1, where catering staff reported tensions between the catering company's priorities (selling popular items and meeting sales targets) and the school's priorities (selling more nutritionally preferable items, reducing uptake of unhealthy items). An interesting example was where the school itself adopted a policy to provide a side salad with all pizzas. Catering staff were instructed by school leadership to provide a mandatory side salad with all pizza items, regardless of whether students ate the salad or not. Many students opted to not eat the salad, throwing it into the bin almost immediately. This was a source of frustration for the catering staff, due to the wasted time and effort to prepare the salad, the resultant food waste and the costs associated with providing the salads. A second example, also in school 1, refers to the provision of cookies and brownies. Due to their popularity with students, these particular sweet snacks were never provided on the same day, thus serving as a compromise between economic and health interests. This potential conflict of interest was pertinent as catering staff acknowledged that they report directly to their catering company rather than the school leadership. This point illustrates how there can be mixed priorities regarding school food provision and how catering staff may be required to balance financial and health interests.

3.4.2.3 Catering Practices:

Catering practices varied both within and across the two schools. Variation was observed within schools for a number of ingredients (e.g. mayonnaise, cheese, margarine), with different individual staff members adding different quantities of ingredients during food preparation. Use of personal discretion was evident during food preparation, with many staff members deviating from written recipes and instructions. Several ingredients were weighed by eye, rather than using weighing scales, thus potentially leading to measurement errors. For example, in school 1 preparation instructions stipulate 150g of cheese per margherita pizza. However, after taking an average of 5 margherita pizzas, they were found to contain 279g of cheese. Staff were unknowingly adding extra cheese and once aware, they rationalised that the stipulated amount (150g) of cheese was too little for students to enjoy the pizza, thus justifying the larger amount added. Discretion was also evident in some cases when portioning food to students; an extreme case was when one staff member noted that students liked to be served by her, as she gave students larger slices of cake. This staff member felt that the pre-cut slices were too thin and spoke of giving students two slices instead of one as a result.

Variation was also observed in the provision of similar foods across schools. For example, school 1 offered pasta without sauce, while school 2 added sauce to pasta during preparation. School 2 offered smaller pizza pies along with pizza slices, while school 1 only offered pizza slices. In school 1, all pizza items were provided with a mandatory side salad, whilst in school 2 salad was optional. Many of the school 2 dessert items were served with custard (optional) or cream, while this was not the case in school 1 where dessert items were served without any additional toppings/sauces.

Finally, catering practices in both schools were influenced by a consideration and disapproval of food waste. Examples of food waste prevention included selling potato wedges at break to use up stock, preparing and selling sausage sandwiches on Monday to use up uncooked sausages from the previous Friday and using ingredients with the most imminent expiration dates. In school 1, the researcher was encouraged to bring home unsold sandwiches which had an imminent expiration date and could not be sold on the next school day. School 2 also monitored and documented daily food waste, while unsold food was given to a local homeless charity at the end of each week.

3.4.2.4 Compliance with School Food Standards:

Compliance with the current school food standards was not explicitly assessed as part of the observation visits. However, upon review of the observation visits, it was decided to consider the standards as a measure or "litmus test" for food provision and kitchen operations. Compliance with the standards was considered across the menu cycle, according to guidelines as stipulated, i.e. using the checklist for school food lunches, the checklist for foods other than lunch and the guidance for portion sizes and food groups[229]. This involved a breakdown of the menu cycle, along with consideration of the preparation methods, ingredients used and provision mix (i.e. number of servings) of each item throughout the menu cycle. The culture and ethos towards healthy eating in each school was also considered, albeit only anecdotally based on observations/conversations with catering staff.

Observation visits indicated that provision in school 1 met all 26 criteria set out in the checklist for school food lunches, checklist for foods other than lunch and the guidance for portion sizes and food groups[229]. Indications from school 2 were that provision met 25 of the 26 criteria; the research team did not observe provision of a serving of oily fish over the 3-week observation period. Both schools provided one or more portions of fruit and vegetables every day, one or more portions of starchy foods every day and no more than two portions of batter-coated food per week. Furthermore, both schools exhibited efforts to create a culture and ethos of healthy eating, such as having water readily available, having large dining areas and encouraging students to choose more fruit and vegetable options. However, as no robust, objective data was collected pertaining to school culture/ethos, it is difficult to make a definitive statement regarding the overall school culture/ethos. However, overall, indications were that school 1 provision was compliant with the school food standards, while provision in school 2 was largely, albeit not fully compliant.

3.5 Discussion

School food is a highly complex issue; therefore, an exploration of UK school food required a meticulous, multi-component approach to data collection. The observation periods successfully provided valuable data on how food is prepared and provided. The observation periods also uncovered valuable insights into the inner workings of school kitchens. Results indicated that overall, staff in both schools wanted to provide healthy, nutritious foods to their students. Staff expressed a duty of care for students and considered the relevant importance of a school meal as contributing to students' overall daily intake. These observations echo findings from previous research in primary schools, which found that catering staff express genuine concern for students' welfare and often encourage students to make more favourable food choices[177,178]. Moreover, evidence suggests that catering staff recognise the importance of school meals in that they may be the only hot meal certain students have that day[14].

Interestingly, indications were that overall provision in both schools complied with the current food-based standards (FBS), while similar to previous research[14,290], staff in the current study mentioned the importance of school food standards and the value of following them. Whilst staff in the current study tried to follow the standards and provide compliant school foods/drinks, students often chose less favourable grab and go items (e.g. cookies, pizzas, drinks), a finding which has also been shared in previous quantitative[15] and qualitative[14,20,25,291] research. Staff were aware of the relevance and importance of students' food choices and lamented how provision did not directly correspond to choices. This lament was due to (1) the wasted efforts made to prepare the foods, (2) the relatively unhealthy nature of students' choices and (3) the food waste caused by foods not being chosen. These findings highlight a limitation of the current standards, which are too heavily focused on provision over the menu cycle and may not adequately consider students' food choice preferences or students' consumer power. For instance, the opportunity for students to purchase less favourable items can easily negate the intentions of school food standards, along with the best efforts of the catering staff. Moreover, students' ability to purchase multiple “regulated” items (e.g. students can buy multiple high sugar items such as cookies, waffles, juice-based drinks) only widens the gap between (hypothetical) compliant provision and real-life student food choices[14]. Finally, the availability and presence of these less healthy foods may undermine health messaging efforts within schools as students may interpret this as hypocritical[14].

During the observations, catering staff referred to students’ influence and power as customers, with some even altering aspects of food preparation and provision to align more with students’ preferences. For example, school 1 provided muffins with icing as they believed students were more likely to select muffins if icing was applied, school 2 provided wholemeal bread rolls as students reportedly would eat wholemeal bread rolls but not wholemeal sliced bread. This corroborates previous research, which indicates that students may influence catering staff’s decisions regarding food preparation and provision at the point of service[14,290]. Research suggests students’ influence also extends to decision-makers at local authority (LA) levels, whereby foods’ inclusion on school menus is partly based on the likelihood of students choosing them[290]. This illustrates students’ power and influence as customers[292,293]. According to the School Food Plan[227], school meals can be financially stable if schools achieve over 50% uptake, after which schools can look to establish economies of scale, whereby food prices can decrease and school food quality can increase. However, a previous survey of student uptake, carried out in 2012, indicates that uptake in secondary schools is 39.8%[214], while more recently, Taher et al.[17] listed uptake at 41.1%. This places pressure on schools to provide popular items to ensure the viability of school food provision. Furthermore, mixed priorities concerning school food provision (financial versus health priorities) can be viewed as an impediment to healthy school food choices[177,290].

The observation visits also highlighted staff use of personal discretion during the preparation and provision of school food, promoting differences between planned and actual provision. Catering staff have been described as “the final arbiters” of school food[290], having the last say on ingredient quantities, preparation decisions for broadly defined items (e.g. sandwich items), food presentation and serving strategies. Discretionary practices may arise for various reasons, including personal choice, disagreement with guidance materials (e.g. amount of cheese added to school 1 pizza items) or lack of awareness. For example, previous qualitative research has highlighted how staff want students to have enough food for the school day and may therefore give some students more food, which can promote larger portion sizes and excessive energy intakes for some students[177]. This illustrates how personal discretion, even if well-intentioned, can lead to deviation from school food standards and may impede students from receiving a healthy, nutritious lunch.

Previous research has also identified the social interaction between catering staff and student as a critical factor in determining what the student actually chooses and consumes[290]. Despite this, catering staff are not supported to manage this interaction and positively influence students' choices[177,290]. Previous qualitative research with school staff illustrated how catering staff operate under substantial time and financial pressures and may not have available time or resources to encourage healthy student choices[294]. Whilst there have been some calls for educating catering staff in how to effectively encourage healthy food choices[177,290], given the strict time-pressures that staff and students already operate under at point of service, approaches which facilitate healthy choices but with lower associated cognitive demands may be more beneficial[295]. Such approaches could incorporate elements of nudge theory/food choice architecture. Previous research within the primary[184] and secondary[185] school sector suggests such approaches can help increase uptake of healthier foods (e.g. fruits & vegetables) by increasing their visibility and convenience to students. However, further research is needed to elucidate the efficacy of such approaches within a UK secondary school context.

3.6 Strengths & Limitations of Approach

There were several strengths to collecting data via immersive observation visits. For one, the prolonged and immersive nature of the observation visits enabled collection of data in great depth (e.g. multiple measurements taken for most ingredients to account for variation between individual staff members) and breadth (e.g. collection of detailed food preparation data, collection of insights from catering staff, tabulation of manual tallies of items described broadly on the till). The collection of varied, in-depth data, in conjunction with the reflexive approach taken throughout the data collection process, enabled the research team to reflect back on the observation period when developing the nutritional composition tables. For example, manual tallies were taken during the observation periods for the daily provision of sandwich items. These tallies were later used to inform the menu cycle weighting assigned to reflect provision of each individual sandwich item over the three week menu cycle.

This approach also has some limitations and the findings from this chapter should be considered within this context. For one, it was quite labour-intensive and time-consuming. As such, it may not be the easiest approach for other researchers to replicate and, if enacted on a wider scale, would require substantial manpower and resources. In addition, the approach meant that only 2 schools were included in the study. This is a consequence of collecting in-depth data in that it may limit the sample size, which calls the representativeness of the findings into question. That said, neither school was considered atypical; both schools approximated national averages in terms of size and FSM%. Furthermore, some insights gained through these means (e.g. tensions between school, catering company and kitchens, use of personal discretion during food preparation) have been echoed in similar research[14,177,178,290] and can be viewed as applicable to several schools. Secondly, while the immersive nature of an observant participant approach and reflexive practices adopted throughout was intended to help minimise any observer effects[254], this still remains a possibility. For example, catering staff may have consciously (or even unconsciously) altered their food preparation and provision practices due to being observed. Whilst the researcher endeavoured to take the approach and demeanour of an objective, interested observer, the researcher's presence, and granularity of the data collection (e.g., collecting up to 5 weight measurements for ingredients added during preparation) may have made catering staff feel pressured to give a good impression (e.g. show a duty of care, or extra diligence in preparation) during the observations.

3.7 Impact of Observation Visits on the Thesis

The insights gained during the observation period had a lasting impact on the PhD thesis. For instance, the observations enabled the researcher, who had never previously been in an English secondary school to learn a great deal about how English secondary schools function day to day and see how and where students have their school lunch. This benefited the researcher in carrying out each of the 4 subsequent studies. For example, the researcher could more effectively communicate with students during focus group discussions as he was aware of the layout of the schools (e.g. if students spoke of having lunch in the small hall, the researcher could visualise their experience) and had first-hand experience of lunchtime services. The insights gathered also included information unique to each school; for example, school 1 pizzas were all served with a side salad, while school 2 pizzas were not. This information was also not available on the written menu and thus could only be obtained through direct observation.

Finally, the observation periods made the researcher aware of variation between schools, which served as a precursor to and explanation for some of the differences found in the nutritional composition of common items across the 2 schools. The nutritional composition findings did present a number of instances of inter-school variation for common sub-categories (e.g. pizza items, pasta items, dessert main meal). However, consultation with the observation notes was often sufficient to explain how these differences arose (e.g. vitamin C content in school 1 pizzas was substantially greater than school 2 pizzas, as a consequence of the peppers included in mandatory side salads with school 1 pizzas. Several school 2 dessert items were provided with custard, which contributed to a large difference in their energy content between school 1 and school 2 dessert items) (this will be outlined in the next chapter). In this way, the observation visits proved to be extremely valuable in terms of (1) introducing the researcher to the English school environment, (2) showcasing how school food operates from both sides of the counter, and (3) gaining valuable insights and information which would have otherwise been missed. This refined development of the nutritional composition tables and supplied a greater level of nuance and detail to the PhD thesis overall.

3.8 Conclusion

Direct and prolonged observation periods provide a useful method to explore school catering practices and gather detailed, rich data on school food preparation and provision. Prolonged, immersive observations also facilitate exploration of the contextual factors and nuances associated with school catering, and collection of insights which may not be attainable through other approaches. National school food policies may filter down to the ground level, however their impact can be diluted by various contextual factors active within schools (e.g. availability of less healthy options, students' consumer power, staff use of personal discretion, students' food choices) or competing priorities along any of the lower organisational levels (e.g. LA policy, school policies, catering companies). In line with the observant participant approach, it is important that school food researchers engage school and catering staff in open discussions, foster reciprocal collaborations, and consider the real-life context of school food preparation/provision.

Chapter 4. Assessing the Nutritional Composition of Secondary School Food Provision

4.1 Introduction

As highlighted in chapter 1, schools hold great potential as health promoting settings and can provide a good setting to examine adolescent dietary behaviour and contribute towards insights into adolescent obesity. In terms of adolescent dietary behaviours and food choice, one way in which schools can influence this is through the foods/drinks they provide, as this sets the parameters within which students make their choices. For example, a study by Gould, Russell and Barker[243] found that even if students chose the most favourable options, they still fell short in comparison to NBS. This finding highlights the importance of school food provision, and points to the importance of nutritious school food provision in facilitating nutritious school food choices. Finally, adolescents consume a substantial proportion of their daily energy from food whilst at school; therefore, provision of healthy foods/drinks can positively influence adolescents' dietary behaviours at school[171,172] and overall.

Previous research has reported positive findings insofar as the nutritional composition of school food provision. For example, a previous evaluation of school food provision found it largely met NBS (except iron, calcium, zinc) which are derived from DVRs[228]. Meanwhile, research also suggests that choosing school lunch is preferable, in terms of nutritional composition, over purchasing lunch from nearby outlets[17,26,296], along with bringing packed lunch from home[231,232].

However, the literature review in Chapter 1 also described how the shift from food and nutrient-based standards (FBS & NBS) to solely food-based standards (FBS), combined with a lack of follow up evaluations and monitoring of compliance left ambiguity and uncertainty regarding the nutritional composition of current secondary school food provision. Chapter 1 also highlighted a lack of awareness regarding school food preparation and provision methods, along with how preparation methods may have an impact on the nutritional composition of school food provision. This ambiguity and lack of knowledge served as the motivation for study 1 of the thesis. Chapter 3 described the findings from the first part of study 1; gathering insights and information into how school kitchens operate through immersive observations and developing the food preparation table. This chapter focuses on describing the nutritional composition of UK secondary school food provision. Carrying out this assessment was important for a number of reasons, including: (1) giving some clarity with regards to the current state of school food provision, (2) exploring how FBS (non)compliance translates to energy and nutritional content of school food as provided and (3) establishing a starting point from which to consider students' food choices and the nutritional composition thereof. Findings are discussed in relation to FBS and nutrient reference values (based on previous NBS and DRVs apportioned for a school lunch) whilst implications are described for policy and practice.

4.2 Aims

The aims of the work described in this chapter were (1) to examine the foods and drinks provided in English secondary schools, (2) to evaluate the nutritional composition of school food provision, and (3) to gain insights into school food provision and related catering practices.

4.3 Methods

4.3.1 The Schools

School 1 had an FSM% of circa 9% and over 1100 pupils on roll, school 2 had an FSM% of circa 20% and over 900 pupils on roll. Both schools were close to national averages in terms of school size, while the two schools fell on either side of national averages for FSM%; at the time of recruitment, the national average for FSM% stood at 14.1%, while the average secondary school had 965 pupils on roll[168]. School 1 worked with a national catering company, while school 2 used in-house catering but previously (the previous year) had worked with the same national catering company as school 1. This is somewhat different to national trends, which indicate that the minority (12%) of schools have in-house catering, while the vast majority of schools hold a contract with either their local authority (60%) (who may in turn work with a private catering company) or a private catering company (28%) (although these figures relate to primary and secondary schools combined)[217]. Both schools operated a 3-week menu cycle, with the cycle repeated for half the school year (at which point a second cycle was introduced) which is the norm for UK schools. Both schools offered a different main meal of the day, a vegetarian main meal alternative and a main dessert item each day. The schools also provided various sandwiches, baguettes, pizzas and pasta items, along with different drinks, dessert items, sweet snacks and fruit options.

4.3.2 Study Design

The study had a cross-sectional design. Three-week observations informed the development of nutritional composition tables for all food/drink items provided in each school. As discussed in the previous chapter, an observant participant approach[34,35] was chosen for this study. This data collection approach was chosen to facilitate a rigorous assessment of school food provision. Figure 4.1 outlines the design for the study and illustrates how the observation visits, and the data collected during this time, fed into the development of the food preparation table and the nutritional composition table. This chapter will outline the process undertaken to develop the food preparation table and the nutritional composition table.

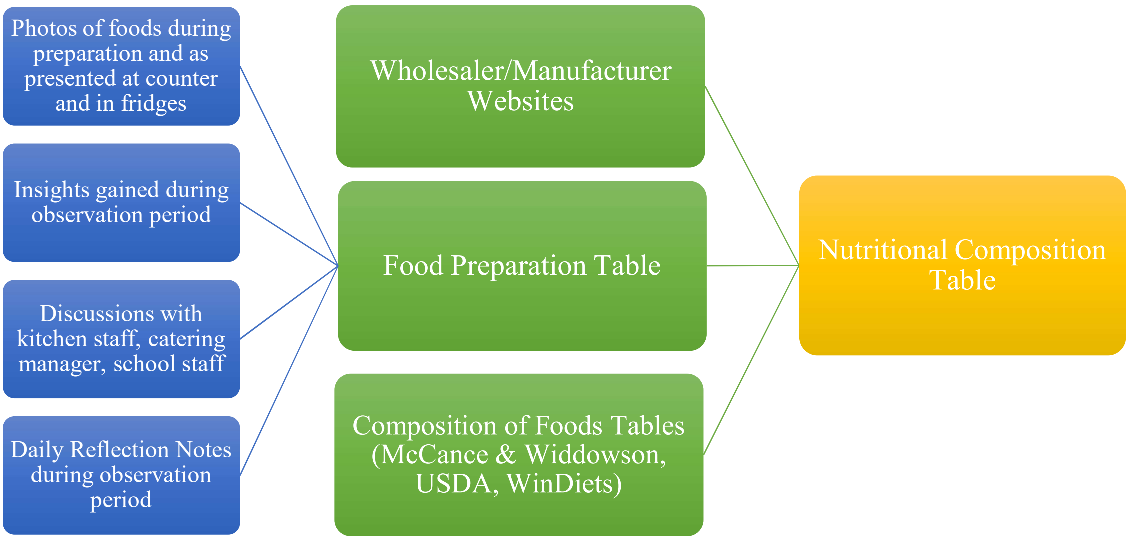

Figure 4.1. Conceptual Model of Study Design

4.3.3 Nutritional Composition Tables

The next step was to conduct nutritional composition analysis. The nutritional composition table was developed to hold the nutritional composition for all foods and beverages provided in each school. From the observations, and the food preparation table, each food and drink was listed in an excel sheet, along with its constituent ingredients. Relevant nutritional composition databases were then consulted, to assign nutritional composition information to all of the school foods and drinks. Figure 4.2 provides a flowchart outlining the steps taken to develop the nutritional composition tables and the key decisions made along the way.

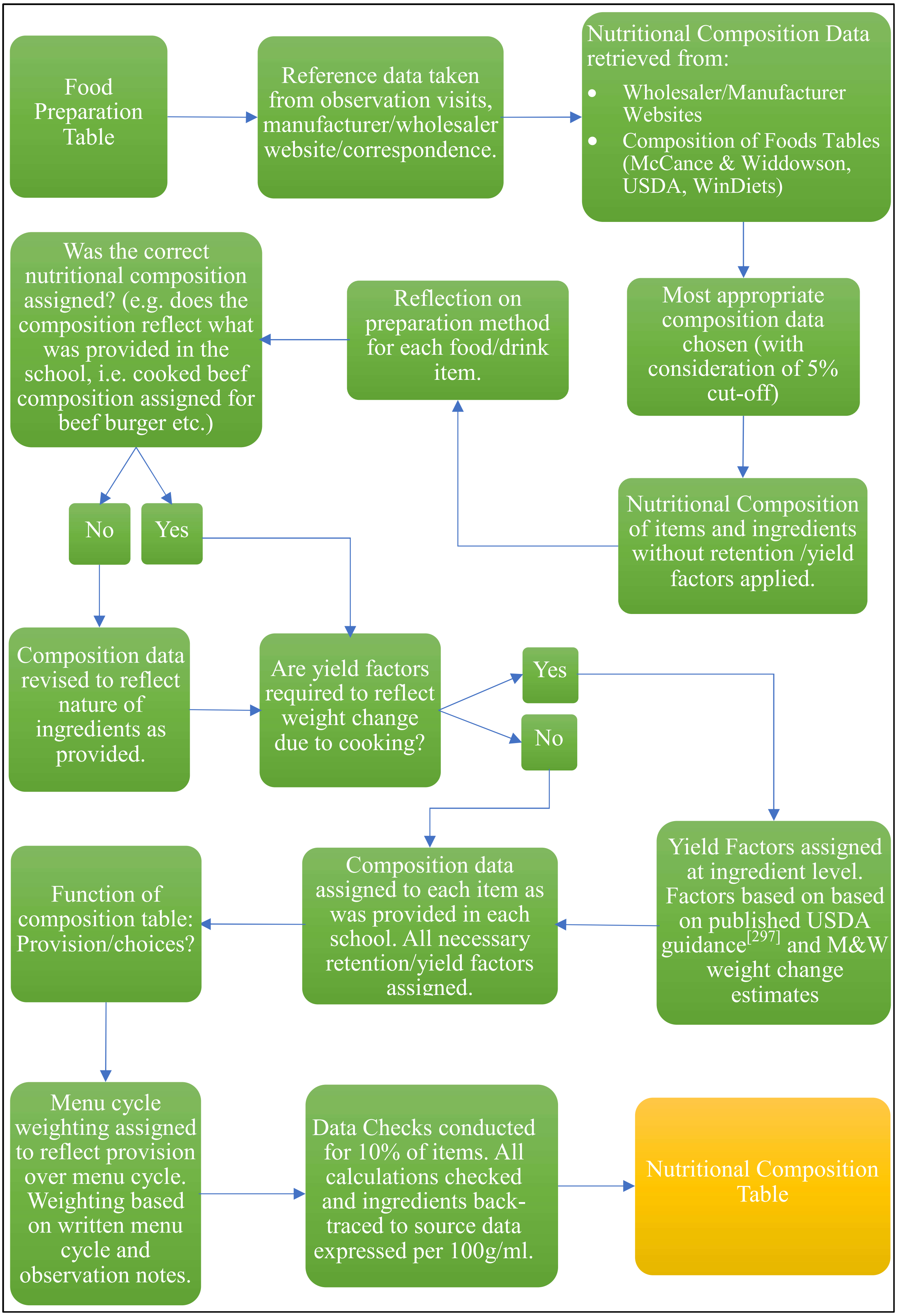

Figure 4.2. Flowchart outlining the development of nutritional composition tables for each school, based off of the food preparation table

Different foods were provided at different frequencies over the menu cycle (e.g. fish & chips were provided every Friday); therefore, a menu-cycle weighting (i.e. number of days each item was provided within a 3-week menu cycle) was calculated for all items and provided in the nutritional composition table. Weightings were initially assigned based on number of days provided, i.e. weights ranged from 1 to 15 inclusive (3-week menu cycle X 5 days per week). For example, items which were provided every day (e.g. waffles, water etc.) received a weighting of 15, whilst items which were only provided once over the 3-week menu cycle (e.g. Chicken Shawarma Flatbread, Chicken Korma etc.) were assigned a weighting of 1. For items not listed on the menu (e.g. items provided at break service) or items which were included under an umbrella term on the menu (e.g. sandwich items, break items), a weighting was assigned based on observation notes, photos (savoury snacks) and manual tallies taken during the observation periods (e.g. sandwiches). A rationale was developed for each weighting assigned to the items and this was included in the nutritional composition table.

The next stage involved obtaining reference data (energy and macronutrient information from back-of pack information or product website pages) to use for selecting the nutritional composition data. Limited reference data was obtained from the back-of pack nutritional information available on products observed in schools. Photographs were taken of products in the schools also, for the researcher to refer back to later on. In cases where reference data was not obtained on-site, the researcher contacted manufacturers directly and requested any nutritional information available. The researcher also obtained reference data from company and wholesaler (e.g. Brakes, Debriar) websites, which both schools used. In cases where this was not available, generic information was taken by searching for the item on the Brakes website and using the information available. Product codes and website links were documented and included in the nutritional composition table, to aid data interpretation and promote transparency. Generic ingredients such as vegetables and water were identified as such. Where possible, multiple sources were accessed and considered (e.g. Brakes website, photographs taken on site and manufacturer websites), to help verify accuracy of the websites and ensure that the chosen reference data would provide the best possible standard upon which to base selection of nutritional composition data.

The next stage was to conduct the compositional analysis for ingredients, which was done using McCance and Widdowson's (M&W) Composition of Foods Integrated Dataset (CoFID)[6], the United States Department of Agriculture (USDA) FoodData Central searchable website[7] and the Global extra foods table included in the WinDiets Standard 2016 suite[8]. Data was also obtained directly from manufacturers, through website searches and email enquiries. Nutritional composition data was required to fall within ± 5% of the energy and macronutrient information as seen on the ingredient packaging (seen in school or from manufacturer websites/correspondence). In cases where this 5% limit was exceeded, the ingredient was searched for across the 3 composition datasets and the next most appropriate ingredient was selected.

Consideration was also given to how the food was prepared. For any ingredients that underwent cooking/baking/boiling etc. the prepared version of the ingredient (e.g. toasted bread, boiled rice) was selected when assigning nutritional composition data. This removed the need for any retention factors (proportion of food/drink that is retained in terms of nutrient content after preparation) as the inclusion of cooked ingredient composition data takes this into account. For any items that were already prepared before being brought into the school (e.g. waffles, drinks) or items which were provided without any cooking (e.g. sandwiches), composition data could be assigned to constituent ingredients in a straight-forward manner, by consulting the composition datasets (M&W, USDA FoodData Central, WinDiets) and choosing the most appropriate composition, following the steps outlined above.

The next step was to consider yield factors, i.e. the proportion of the food/drink that is retained in weight after food treatment or preparation. This was an important step as the ingredient weights listed for written recipes (i.e. for meals of the day) were for the raw ingredient. Once again, the food preparation table and the researcher's observation notes were reviewed, to ascertain which items and constituent ingredients had undergone weight change due to preparation (i.e. was the ingredient baked/boiled/fried etc.). Where relevant (e.g. for meals of the day, dessert items, pasta sauces), yield factors were applied to account for weight changes (e.g. water, rice, pasta, raw meats etc.) due to cooking. Yield factors were applied at the ingredient level, rather than at the recipe level, as it was thought this would translate to a more accurate portion weight and nutritional composition than if a yield factor was applied at the recipe level (e.g. for golden rice and beans, most of the weight change is as a result of boiling the rice). Yield factors were estimated based on published USDA guidance[297] and M&W weight change estimates. Listed portion weights from written recipes were also used; yield factors were adjusted/calibrated so that the summed cooked ingredients matched the portion weight as seen on the written recipes. Components (ingredients) were summed in a separate excel worksheet, which outlined how portion weights were arrived at. A meals of the day calculation sheet was also developed, which outlined how aggregate compositions were calculated to take account of the multiple sides provided with some meals of the day (e.g. roast beef provided with variety of different vegetables, including carrots, red cabbage, sweetcorn, broccoli, cauliflower cheese). Composition data was expressed per portion and per 100g/100ml. This facilitated easy comparison to original source data (e.g. M&W) and enabled the researcher to assign front-of pack nutrient profiling to each item.

In line with reflexive practices, the research team met frequently during this time, to discuss the weights and their associated rationale. Discussions and revisions continued until a clear rationale was assigned for each food/drink item and the rationales were consistent within item groupings (e.g. baguettes, soft rolls). In cases where a rationale was based on a manual tally, the resultant weights followed the ratios outlined in the manual tallies.

The final step in developing the nutritional composition tables was to check the data. This involved first checking all formulas in the components summed sheets, the meals of the day calculation sheets and the front of pack nutrient profiling worksheets. Data were imported from excel into SPSS (Statistical Package for Social Sciences), to facilitate statistical analyses. All excel worksheets and SPSS data files were then checked for any missing, inconsistent or unexpected values. All foods and drinks in the nutritional composition table were traced back to original source to ensure consistency. This involved checking all constituent ingredients for each food/drink item against their source composition database (i.e. M&W/USDA, WinDiets, Manufacturer), to ensure consistency, and also with written recipes, to ensure weights for each ingredient and food/drink item was correct. Before finalising the nutritional composition tables, the research team held multiple data check meetings to go through all the formulae, independently back trace items down to constituent foods and ingredients and compare ingredient composition data to the original source. These checks for missing, inconsistent or unexpected values and detailed review of the data helped to ensure robust data entry and handling.

4.3.4 Energy & Nutrient Values Considered

In putting together the nutritional composition, energy, macronutrients and micronutrients were considered; 14 values (energy + 13 nutrients) corresponding to the NBS[4] along with Total Sugars and six new values: Magnesium, Potassium, Iodine, Vitamin B6, Vitamin B12 and Vitamin D, chosen by the research team as specifically relevant to adolescent nutrition. Magnesium intake is associated with adolescent externalising behaviours[298], potassium can help to counteract the negative effects of high sodium intake on adolescent blood pressure[299,300]. Low intake of iodine and Vitamin B12 is associated with impaired cognitive development[301–303], while previous research indicates that over two-thirds of UK adolescent girls present some level of iodine-deficiency[304]. Reduced intake of folate and Vitamin B6 is linked with higher internalising behaviours[305]. Vitamin D helps to promote healthy bone ossification and neuromuscular function[306], while Vitamin D deficiency is associated with the pathogenesis of various adverse mental health outcomes in adolescents[307]. In the UK, 19.7% of male and 24.4% of female adolescents have low vitamin D status (defined as blood plasma 25(OH)D concentration < 25 nmol/L)[262]. Five of these six new values were derived using DRVs[9] apportioned for a lunch at 35%, aligning with NBS. The one remaining standard, vitamin D, followed the recent SACN recommendation of 10 micrograms/day[262]; 35% of daily intake was taken as a reasonable amount for a school lunch.

4.3.5 Free sugars calculation

An important reference value included in the analysis was free sugars. Free sugars replaced NMES in the UK as recommended in the UK Scientific Advisory Committee on Nutrition's (SACN) report *Carbohydrates and Health*[261]. SACN describe free sugars as "all monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and unsweetened fruit juices"[261]. This definition echoes that put forward by the World Health Organisation the same year[308]. Given that free sugars are not listed in any of the food composition databases used in the study (M&W, USDA, WinDiets), the research team was responsible for estimating free sugar content for all ingredients. "A definition of free sugars for the UK"[309], published by Public Health England in 2018, served as the primary basis for the decision-making rationale. Table 4.1 outlines the "rules" or "principles" put forward by Public Health England, which were adopted and used to inform decision-making on free sugar estimations in this project.

Table 4.1. Sugar sources included and excluded from the estimation of free sugars for the purposes of the PhD. Adapted from “A definition of free sugars for the UK”[309], published by Public Health England in 2018.

Included in the definition of free sugars	**Excluded from the definition of free sugars**
All added sugar in whatever form, including honey, syrups and nectars whether added to products during manufacture or by the consumer during cooking or at the table. This includes ingredients such as malt extract and glucose syrup	Ingredients not included in the definition of sugar as it appears on the nutrition panel, such as maltodextrins, oligofructose and sugar substitutes such as polyols (sorbitol)
Lactose and galactose added as an ingredient to foods or drinks, including lactose in whey powder added as an ingredient	Lactose and galactose when naturally present in milk and dairy products including milk powder
All the sugars naturally present in fruit and vegetable juices, concentrates, smoothies, purees, pastes, powders and extruded fruit and vegetable products This includes pureed legumes (hummus), pureed dried fruits and juice or syrup present in canned fruits/vegetables	All the sugars naturally present in fresh and most types of processed (dried, stewed, canned, frozen) fruit and vegetables except for juices, smoothies, purees, pastes and extruded products Fruit and vegetables were defined in line with the definition used for 5 A Day so the sugars in powdered and pureed potatoes and other starchy staples were excluded from free sugars
All sugars in drinks except for milk and other dairy-based drinks. Including: - all sugars in unsweetened fruit and vegetable juices, fruit and vegetable juice concentrates and smoothies - all sugars in alcoholic drinks - all sugars naturally present in dairy-alternative drinks such as soya, rice, oat and nut-based drinks	Lactose and galactose naturally present in milk and other dairy-based drinks
	All sugars naturally present in cereal grains including rice, pasta and flour), regardless of processing (other than cereal-based drinks)
	All sugars naturally present in nuts and seeds regardless of processing (other than nut-based drinks). This includes coconut milk consumed as an ingredient and nut butters

The rationale for free sugar estimation was also informed by the NDNS methodology for estimating free sugars in the NDNS Nutrient Databank[310]. Management of the NDNS was taken on by Public Health England in 2013. Thus, the methodology outlined for the NDNS adopts many of the same principles as those put forward by PHE in 2018. The researchers included some additional rules and assumptions from the supplementary methodology guidance provided alongside the NDNS, for the purposes of this thesis. These are as follows:

> **Assumption #1:** Sugars in herbs and spices were generally excluded from the free sugars calculation, as their contribution would be negligible. In products where herbs were present in larger quantities such as pesto they were taken into account.

Assumption #2: All sugars in jams, marmalades and fruit spreads have been included in the estimation of free sugars on the basis that the cellular structure of the fruit in such products is largely broken down.

Assumption #3: For soups containing vegetables it was assumed that all the vegetables were pureed or blended (as in a smooth soup) and so any sugar in these items was considered free sugar. This is unless it was feasible to estimate the proportion of intact vegetables based on knowledge of the range of products available. The same approach was used for fruit yogurts and similar products.

Rule #1: For manufactured goods/products bought in to schools (e.g. mayonnaise, flavoured milk), the ingredient list was consulted to estimate the proportion of the product made up of each constituent ingredient (e.g. chopped tomatoes was 45% tomato sauce, the sugar of which can be considered free sugar).

Rule #2: For manufactured goods/products bought in to schools (e.g. mayonnaise, flavoured milk), free sugar calculations were conducted for each relevant ingredient (e.g. tomatoes, tomato sauce in can of chopped tomatoes) and then summed to generate a free sugar value for the overall product.

For manufactured products (e.g. mayonnaise, flavoured milk) or more complex ingredients (e.g. chopped tomatoes in sauce, pear halves in juice) the researcher first consulted the ingredients list to ascertain what percentage of contents were made up of added sugar. For example, the packaging on all flavoured milk drinks indicated that there was 3.8 g added sugar per 100ml. For products containing fruit in juice/sauce (e.g. canned pear halves in syrup, chopped tomatoes in tomato sauce), ingredients were listed to ascertain percentage of product made up of sauce/juice (e.g. chopped tomatoes – 45% of contents is tomato sauce per ingredients list). These percentages were then used to estimate how much of the total sugar could be considered free sugar (in the case of chopped tomatoes, it was estimated at 50%). Manufacturing processes were also taken into account. For example, the maltose, fructose and glucose values present in bread products were deemed to be present naturally during fermentation, while naturally occurring sucrose was presumed to have been acted upon rapidly by invertase enzyme during the manufacturing process; therefore, any sucrose present in the finalised nutritional composition was considered free sugar. Total sugar content for all components, along with the values for individual sugars (glucose, sucrose, galactose, maltose, fructose, lactose) was documented in an excel sheet. A free sugars estimate was inserted thereafter, along with an accompanying rationale. Free sugars estimates were considered and discussed amongst the research team until all members were satisfied that the calculations were based on a sound rationale.

4.3.6 AOAC Fibre Calculation

Another important reference value included in the analysis was fibre. Intake of dietary fibre is associated with several health benefits, including improved insulin sensitivity, reduced risk of developing type 2 diabetes, decreased risk of cardiovascular disease, and decreased risk of developing depression or anxiety[311]. When NBS were still in place in England, dietary fibre was based on the dietary reference value for fibre (defined as NSP), set by the Committee on Medical Aspects of Food and Nutrition Policy (COMA) in 1991[9]. However, in their report *Carbohydrates and Health*[261], SACN recommended that this definition be replaced with the definition of dietary fibre in accordance with the Association of Analytical Chemists (AOAC) method of measurement. The AOAC definition extends the NSP definition of dietary fibre to include the total amount of non-digestible polysaccharides and resistant starches. The AOAC definition of fibre was used in this work. They also recommended increasing the daily recommended amount to 25g of dietary fibre per day for 11-16 year olds and 30g for 16 years and older. Wherever possible, AOAC fibre values were taken from McCance and Widdowson's composition of foods integrated dataset (CoFID)[6]. AOAC values were also available in the United States Department of Agriculture (USDA) FoodData Central searchable website[7]. However, this information was limited. For ingredients where this information was not available, AOAC fibre values were ascertained by taking the NSP value and converting this to an AOAC value.

4.4 Analysis

The analysis for this study can be broken into 4 sections:

(1) Analysis of categories and sub-categories, examining energy and nutritional composition.

(2) Front-of pack nutrient profiling of school foods/drinks.

(3) Analysis of "typical" lunches in each school.

(4) Analysis of an average lunch and all possible lunches.

(1) Analysis of categories and sub-categories, examining energy and nutritional composition.

For sections 1 and 2, food and beverage items were analysed individually, without any menu-cycle weighting (i.e. weighting assigned to reflect how many times the item was provided across the three week menu cycle). Energy and nutrient content (median and IQR) were calculated across categories and sub-categories. Kruskal-Wallis tests with Dunn's post-hoc tests (two-tailed) tested for differences across sub-categories, while Mann-Whitney U tests were used to determine if there were significant differences between common categories and sub-categories across school 1 and school 2. Significance was accepted at $P < 0.05$.

(2) Front-of pack nutrient profiling of school foods/drinks.

Front-of pack (FoP) nutrient profiling was conducted for all items using published guidelines[312]; all items were classified as either low, medium, or high for levels of fat, saturated fat, sugar and salt. Fisher's exact tests were conducted to assess associations between Main Meals sub-categories, Drinks sub-categories and the proportion of their constituent items profiled as low, medium and high for fat, saturated fat, total sugar and salt. Significance was accepted at $P < 0{\cdot}05$, while Cramer's V values were used to consider strength of associations. Interpretation of Cramer's V was considered in accordance with the parameters stipulated by Rea & Parker[313]: (0.0 – 0.1 = negligible association, 0.1 – 0.2 = weak association, 0.2 – 0.4 = moderate association, 0.4 – 0.6 = relatively strong association, 0.6 – 0.8 = strong association, 0.8 – 1.0 = very strong association).

(3) Analysis of "typical" lunches in each school.

Menu-cycle weighting (i.e. number of days each item was provided over the 3-week menu cycle) was applied for sections 3 and 4 of the analysis. The researchers also wanted to explore some of the different lunches which students might typically choose. Published guidance[314] stipulates that a student's lunch should include a main meal item, a drink and a snack; however, observations indicated that students more often chose a main meal item with either a snack or a drink. Based on this, eight "typical" lunches emerged, i.e. one of four main meal types (meals of the day, pizza, pasta or sandwich) with either a drink or sweet snack. Mean values were calculated for all possible combinations of these "typical" lunches across the menu cycle, e.g. for typical lunch 2 in school 1 (pizza & drink), mean values were calculated for all combinations of pizzas plus drinks, weighted across the three week menu cycle, totalling 5760 combinations.

Mean values for energy and nutrients for each of the typical lunches were then compared against reference values; these reference values constituted the 14 original NBS, along with the six additional nutrient values (Magnesium, Potassium, Iodine, Vitamin B6, Vitamin B12, Vitamin D), derived using the dietary reference values apportioned for a lunch at 35%[9]. Whilst no longer in place, NBS still provide a good indicator of nutritional quality and were therefore used to compare school food provision against. These "typical" lunches were also evaluated in terms of degree of difference from each reference value, ranging from less than 5% difference to greater than or equal to 20% difference. A colour coding system was employed to illustrate this; amber = < 5% difference, orange = ≥ 5% difference, light red = ≥ 10% difference, dark red = ≥ 20% difference.

(4) Analysis of an average lunch and all possible lunches.

Energy and nutrient values were also estimated for an average lunch. The energy and nutritional composition of an average lunch was calculated using the below definition, taken from a guide to the standards produced by the School Food Trust[314]:

> Average Lunch = (total amounts of energy and nutrients provided by all school lunches in a menu cycle) ÷ (number of lunches provided)

Provision quantities for each food and drink item were estimated using published examples of a compliant menu cycle for a secondary school with a three week menu cycle[314]. This menu cycle example gave provision totals for broad groupings of items (main meals, drinks, sandwiches, jelly). For each grouping, menu-cycle weighting was used to assign a provision amount for each individual food/drink item. From here, ratios from the menu-cycle weighting were used to assign a provision amount for each individual item (e.g. if menu cycle weighting was equal for each item in the grouping, then the total provision amount listed in the example menu for that grouping was divided by the number of items in that grouping). The number of lunches was estimated based on published guidance, stipulating that a students' lunch should include a main meal item, a drink and a snack[314]. Therefore, the total number of lunches was estimated by combining the total number of "full lunches" (main meal item + drink + snack) with the surplus snacks and drinks items.

The final aspect of the analysis was to compare mean values for all main meal combinations (i.e. every main meal item + a sweet snack/drink/dessert/fruit item provided over the three weeks, with weighting assigned) to the reference values. Two sets of Wilcoxon one sample signed ranks tests compared an average lunch and all lunch combinations to reference values in each school. Due to the large sample size, significance was accepted at $P < 0.01$.

Non-parametric tests were chosen for the analysis of categories/sub-categories and comparisons of average lunches and all lunch combinations to NBS. This was decided after considering the tests for normality (Shapiro-Wilk & Kolmogorov-Smirnov tests) and histograms for energy and nutrient values and observing that the data was not normally distributed. Some researchers have claimed that assumptions regarding normality distributions can be ignored when working with large samples[315–317]. This is based on the central limit theorem, which postulates that in large samples, the sampling distribution is often normal, regardless of the shape of the data. Despite this, non-parametric tests were selected for the analysis, with respect to the nature and origins of the data. For example, non-parametric tests were deemed more appropriate for the analysis of categories/sub-categories, as these often compared very different food/drink groupings (e.g. main meals and fruit items were 2 of the 6 main categories) of different sizes (e.g. 243 main meal items compared to 10 fruit items). Finally, whilst large datasets were used to calculate all lunch combinations data and an average lunch, they were not normally distributed and also had some extreme outliers. Moreover, these combinations represent permutations of what could be chosen from what is provided, thus the data is more hypothetical in nature (i.e. it wasn't generated by an actual person being provided these options and choosing). For these reasons, non-parametric tests were chosen, so as to be conservative in terms of outlining the findings and drawing conclusions. Data was organised using Microsoft Excel, while IBM SPSS Statistics 26 was used to conduct all analyses.

4.5 Results

4.5.1 Nutritional Composition

Main Categories:

Across the two schools, 334 foods (S1: 146; S2: 188) and 39 drinks (S1: 22; S2: 17) were provided. Table 4.2 outlines the median energy and nutrient values and interquartile ranges for each of the 6 categories in school 1 and 2. The largest category in both schools was main meals (S1: 104 items, S2: 139 items). In school 1, energy content was highest in the main meals category (455.3 kcal); in school 2, energy content was highest for dessert main meals (447.5 kcal), followed by main meals (433.0 kcal).

In both schools, main meals were higher than other categories for levels of protein, fibre, folate, calcium, zinc, iron, magnesium and potassium. This is to be expected, given that main meals encompass the larger, more substantial items compared to other categories, which are predominantly made up of smaller grab-and-go items (e.g. drinks, sweet snacks). Free sugars were high in both schools for a number of categories, most notably dessert main meal (S1: 16.4g, S2: 26.9g), drinks (S1: 16.0g, S2: 8.6g) and sweet snacks (S1:15.5g, S2: 16.9g). Considering that NBS stipulate a maximum 8.6g of free sugars per lunch, the median numbers found amongst these three categories (especially drinks and sweet snacks which are popular items)makes them especially noteworthy.

Comparison across schools indicated a few differences between schools for common categories. For example, Mann-Whitney U tests indicated that school 2 main meals were significantly ($P < 0.05$) lower than school 1 main meals for levels of protein, total sugar, fibre, calcium, iron, zinc, magnesium, potassium and folate. School 2 dessert main meal items were significantly ($P < 0.05$) higher than their school 1 equivalent for energy content, along with levels of fat, free sugars and sodium. Savoury snacks varied across schools for levels of protein and sodium, while free sugar levels varied substantially for drinks items across the two schools. However, these differences were not statistically significant and aside from free sugar content, the drinks category was generally quite similar across the two schools, as was the fruit category.

Table 4.2. Energy and nutrient content (median and interquartile ranges) per portion for foods and drinks categories in school 1 and school 2

	School 1						School 2					
	Main Meal (n=104)	*Main Desserts (n=14)*	*Savoury Snacks (n=12)*	*Sweet Snacks (n=10)*	*Fruit (n=6)*	*Drinks (n=22)*	*Main Meal (n=139)*	*Main Desserts (n=13)*	*Savoury Snacks (n=14)*	*Sweet Snacks (n=18)*	*Fruit (n=4)*	*Drinks (n=17)*
Energy (kcal)	455.3 (379.7-520.8)	238.1* (214.7-318.1)	211.3 (160.8-363.6)	242.8 (133.0-320.6)	56.7 (40.6-85.0)	78.0 (71.0-108.0)	433.0 (352.2-603.8)	447.5* (397.5-453.3)	282.4 (177.1-365.0)	256.9 (175.8-331.4)	61.3 (43.7-78.2)	85.8 (4.0-137.6)
Energy (kJ)	1923.1 (1607.0-2193.3)	1001.0* (899.9-1341.8)	892.4 (672.2-1534.8)	1024.8 (565.2-1318.8)	240.6 (173.2-361.9)	326.0 (295.8-456.0)	1822.6 (1476.3-2513.5)	1883.0* (1674.3-1908.1)	1186.9 (745.5-1534.9)	1074.3 (742.6-1384.7)	259.8 (186.1-332.7)	353.1 (18.0-581.6)
Fat (g)	15.6 (11.3-19.8)	10.2* (8.1-17.6)	8.8 (5.0-12.7)	10.1 (1.6-14.6)	0.2 (0.1-0.5)	0.0 (0.0-0.1)	17.3 (9.6-27.2)	19.0* (17.2-19.2)	10.8 (4.0-15.9)	13.4 (7.9-18.9)	0.3 (0.1-0.6)	0.0 (0.0-3.2)
Saturated Fat (g)	3.5 (2.1-7.8)	4.0 (2.2-6.7)	1.8 (1.0-4.7)	1.4* (0.9-3.5)	0.1 (0.0-0.1)	0.0 (0.0-0.0)	4.3 (2.3-8.0)	6.3 (4.6-11.9)	4.4 (1.9-7.9)	5.1* (2.6-9.2)	0.1 (0.0-0.1)	0.0 (0.0-1.4)
Protein (g)	22.0* (18.6-26.0)	3.5* (3.1-5.0)	6.1 (4.7-10.8)	3.9 (3.1-5.1)	0.8 (0.7-1.3)	0.3 (0.2-0.6)	19.8* (15.9-25.5)	6.6* (5.3-8.3)	11.0 (5.6-17.1)	3.2 (2.2-4.1)	1.0 (0.6-1.5)	0.2 (0.0-6.6)
Carbohydrate (g)	58.2 (48.7-64.9)	31.0* (26.4-43.8)	34.6 (17.9-46.1)	38.3 (21.5-43.3)	12.9 (9.1-21.4)	17.0 (15.5-20.0)	59.1 (35.0-68.9)	65.4* (61.0-69.3)	32.3 (23.6-40.5)	31.0 (22.8-49.1)	13.8 (10.2-19.3)	17.4 (0.0-25.3)
Total Sugars (g)	6.4 (4.0-10.3)	19.8* (16.7-23.8)	2.2 (1.4-12.5)	19.1 (15.3-29.4)	12.9 (9.1-19.7)	16.9 (14.1-18.1)	5.2 (3.2-9.0)	34.2* (21.4-41.9)	2.2 (1.5-3.1)	17.1 (9.5-26.0)	13.8 (10.1-17.6)	17.0 (0.0-23.8)
Free Sugars (g)	1.5 (0.6-2.7)	16.4* (12.6-21.2)	0.2 (0.0-4.6)	15.5 (14.9-23.2)	0.0 (0.0-0.0)	16.0 (8.4-18.1)	1.0 (0.3-3.2)	26.9* (21.1-36.0)	0.1 (0.0-1.0)	16.9 (9.5-25.9)	0.0 (0.0-0.0)	8.6 (0.0-21.7)
Fibre (g)	5.7* (4.2-7.4)	0.9 (0.6-2.2)	2.3 (1.2-2.4)	1.4 (0.0-1.8)	1.6 (1.1-1.9)	0.0 (0.0-0.0)	4.2* (3.5-6.4)	1.2 (1.0-1.9)	2.0 (1.4-2.9)	1.0 (0.8-1.6)	1.5 (0.4-2.2)	0.0 (0.0-0.0)
Sodium (mg)	585.3 (480.4-826.8)	83.9* (62.8-150.5)	279.4 (85.2-409.8)	180.2 (96.6-234.6)	1.5 (0.0-7.6)	6.6 (4.0-6.6)	649.0 (427.4-877.8)	239.5* (208.9-335.8)	442.7 (219.5-750.4)	173.9 (151.3-215.6)	0.3 (0.0-1.4)	4.0 (0.0-84.6)
Calcium (mg)	212.8 (95.4-340.3)	73.0* (38.6-95.8)	54.5* (8.6-111.8)	39.8 (32.2-106.1)	12.8 (7.5-19.7)	9.9 (9.9-10.5)	158.8 (105.3-288.3)	149.7 (83.6-192.0)	131.7* (80.0-264.0)	33.9 (27.3-61.8)	8.0 (6.8-27.8)	9.9 (0.0-235.5)
Iron (mg)	2.7* (2.2-3.4)	0.7* (0.2-0.9)	0.8 (0.7-1.7)	0.9 (0.9-1.0)	0.3 (0.1-0.4)	0.0 (0.0-0.1)	2.2* (1.7-2.9)	1.0* (0.8-1.1)	1.0 (0.8-1.7)	0.7 (0.5-1.1)	0.1 (0.1-0.2)	0.0 (0.0-0.0)

Zinc (mg)	2.5* (1.8-3.1)	0.4* (0.3-0.6)	0.5 (0.4-1.4)	0.4 (0.3-0.7)	0.1 (0.0-0.2)	0.0 (0.0-0.0)	2.0* (1.4-2.7)	0.7* (0.6-0.9)	1.4 (0.4-2.0)	0.3 (0.3-0.5)	0.0 (0.0-0.1)	0.0 (0.0-0.0)
Magnesium (mg)	65.0* (44.5-77.9)	15.9 (10.7-23.7)	20.2 (9.6-26.5)	18.0 (13.0-28.6)	10.7 (9.0-16.4)	3.3* (3.3-7.9)	51.3* (39.7-71.5)	20.6 (19.6-22.4)	24.3 (16.2-29.3)	11.8 (10.3-22.4)	9.2 (6.2-23.4)	0.0* (0.0-3.7)
Potassium (mg)	466.1 (333.2-837.7)	154.6 (117.8-229.5)	137.8 (76.9-261.1)	98.1 (82.1-309.8)	189.0 (140.4-310.0)	72.6* (65.5-159.4)	381.4 (303.8-725.7)	229.9 (157.7-250.0)	209.9 (100.1-259.9)	101.8 (61.6-146.3)	156.6 (113.4-293.6)	0.0* (0.0-72.6)
Iodine (μg)	12.8 (8.8-18.8)	8.5* (5.6-20.0)	0.5 (0.0-22.7)	0.0 (0.0-15.8)	1.6 (0.0-4.0)	0.0 (0.0-0.4)	10.3 (7.7-18.5)	34.4* (14.5-37.4)	7.7 (2.8-11.4)	0.0 (0.0-0.1)	2.6 (0.5-5.5)	0.0 (0.0-0.0)
Vitamin A (μg)	112.3 (29.3-252.4)	90.3* (32.9-163.5)	55.3 (39.5-101.3)	0.1 (0.0-3.5)	4.0 (2.1-15.6)	0.0 (0.0-0.0)	65.0 (26.2-143.7)	220.1* (194.2-239.0)	71.1 (20.5-124.1)	0.1 (0.0-83.7)	4.0 (2.8-11.8)	0.0 (0.0-0.0)
Vitamin B6 (mg)	0.3 (0.2-0.5)	0.1* (0.1-0.1)	0.1 (0.0-0.1)	0.0 (0.0-0.1)	0.1 (0.1-0.2)	0.0* (0.0-0.1)	0.3 (0.2-0.5)	0.1* (0.1-0.2)	0.1 (0.1-0.2)	0.0 (0.0-0.0)	0.1 (0.1-0.3)	0.0* (0.0-0.0)
Folate (μg)	62.2* (39.2-87.9)	12.4 (7.0-16.7)	14.1 (10.8-23.8)	6.6 (3.3-12.1)	8.8 (2.1-20.5)	3.3 (2.0-7.0)	46.4* (27.1-67.5)	16.8 (13.7-23.2)	19.9 (12.1-26.5)	5.8 (3.8-7.8)	7.2 (0.0-38.5)	0.0 (0.0-3.7)
Vitamin B12 (μg)	0.8* (0.3-1.3)	0.3* (0.1-0.5)	0.1 (0.0-0.8)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.6* (0.1-1.0)	0.8* (0.6-1.4)	0.6 (0.0-1.0)	0.0 (0.0-0.2)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Vitamin C (mg)	6.6 (0.0-25.2)	2.6 (0.0-11.2)	0.0 (0.0-0.7)	0.0 (0.0-0.0)	9.7 (7.0-31.0)	0.0 (0.0-2.0)	1.8 (0.4-7.7)	1.7 (0.9-3.9)	0.5 (0.0-2.1)	0.0 (0.0-0.0)	12.2 (7.9-60.2)	0.0 (0.0-0.0)
Vitamin D (μg)	0.2 (0.1-0.6)	0.7 (0.3-1.7)	0.4 (0.3-0.6)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.2 (0.1-0.4)	1.9 (0.2-2.2)	0.1 (0.1-0.4)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)

* indicates significant difference (P < 0.05) for common category between School 1 and School 2.

Main Meal Sub-Categories:

Table 4.3 provides the energy and nutrient values for all main meal sub-categories. Both schools provided several main meal options, including meals of the day, pizzas, pastas and sandwiches. School 1 also had two further options, paninis and jacket potatoes. Meals of the day serve as the cornerstone of the school menu cycle and are typically viewed as having the highest nutritional quality.

Kruskal Wallis H tests found significant differences ($P < 0.05$) across school 1 main meal sub-categories for almost all energy and nutrient values, the exceptions being for free sugars and vitamin B12. Significant differences ($P < 0.05$) were found across school 2 main meal sub-categories for all energy and nutrient values. Dunn's post-hoc tests indicated significant differences ($P < 0.05$) between main meal sub-categories for several nutrient values. In school 1, meals of the day had higher levels of carbohydrates, fibre, iron and vitamins A, B6, C and D, compared to the other main meals. School 2 meals of the day had the highest levels of carbohydrates, protein, fibre, calcium, iron, zinc, potassium, magnesium, iodine and all A, B, C and D vitamins considered. These values indicate that meals of the day may provide students with the most micronutrients. However, school 2 meals of the day were found to be high in levels of fat, saturated fat and sodium, exceeding their respective reference values. School 1 pizza and panini items exceeded maximum values for saturated fat and sodium, while school 2 pizza items exceeded the maximum sodium value.

Inter-school variation was evident across common sub-categories (e.g. levels of energy, fat and sodium for meals of the day, pizzas, pastas). For example, Mann-Whitney U tests indicated that meals of the day in school 2 were significantly ($P < 0.05$) higher in levels of fat, saturated fat and sodium compared to meals of the day in school 1. School 2 pizzas were significantly ($P < 0.05$) lower in fat, saturated fat and all B, C and D vitamins considered compared to school 1 pizzas. This is most likely the result of a compulsory side salad that was provided with all pizzas in school 1 but not in school 2, along with the large amounts of cheese added to school 1 pizzas. Finally, school 2 sandwiches were significantly ($P < 0.05$) lower than school 1 sandwiches for energy content and several nutrient values, including fibre, protein, carbohydrates, free sugars, calcium, iron and zinc.

Table 4.3. Energy and nutrient content (median and interquartile ranges) per portion for main meal sub-categories in school 1 and school 2

	School 1						*School 2*			
	Meals of the Day (n=38)	*Sandwiches (n=48)*	*Pastas (n=6)*	*Paninis (n=4)*	*Pizzas (n=4)*	*Jacket Potato (n=4)*	*Meals of the Day (n=37)*	*Sandwiches (n=69)*	*Pastas (n=18)*	*Pizzas (n=15)*
Median Portion Size (g)	**432.9** (358.4-506.1)	**192.0** (172.7-214.8)	**302.8** (173.5-336.6)	**180.7** (167.7-196.6)	**307.4** (299.6-340.1)	**228.7** (118.2-339.2)	**444.3** (346.4-613.6)	**175.0** (136.0-221.3)	**319.0** (235.0-353.0)	**213.9** (208.0-214.0)
Energy (kcal)	**470.5**^{ac} (384.9-596.1)	**452.2** (388.4-519.2)	**318.9**^{cd} (250.5-404.0)	**517.3**^{bd} (483.3-574.5)	**481.6** (455.1-527.2)	**256.5**^{ab} (140.2-372.8)	**653.9**^{ab*} (536.3-676.5)	**359.6**^{a*} (287.8-471.3)	**436.2**^{b} (333.4-478.1)	**423.2** (398.4-568.6)
Energy (kJ)	**1983.9**^{ac} (1619.9-2502.2)	**1901.9** (1634.5-2184.9)	**1346.6**^{cd} (1063.3-1700.3)	**2174.3**^{bd} (2032.0-2409.8)	**2026.4** (1916.5-2219.5)	**1082.7**^{ab} (593.1-1572.3)	**2752.1**^{ab*} (2254.6-2851.6)	**1516.6**^{a*} (1214.9-1982.9)	**1735.1**^{b} (1414.2-2013.8)	**1783.2** (1681.4-2399.3)
Fat (g)	**14.6** (10.4-21.6)	**16.9** (12.0-19.8)	**8.2** (1.6-14.0)	**20.8**^{a} (18.3-28.0)	**18.0** (17.1-20.7)	**6.3**^{a} (0.5-12.2)	**27.5**^{abc*} (16.7-31.2)	**16.5**^{c} (9.0-25.1)	**13.0**^{b} (3.1-19.8)	**14.6**^{a*} (11.8-16.8)
Saturated Fat (g)	**3.5** (2.2-7.3)	**2.8**^{a} (1.8-7.2)	**4.2** (0.2-7.8)	**11.5**^{a} (9.9-15.7)	**8.1** (7.9-9.2)	**3.7** (0.2-7.2)	**9.9**^{ab*} (3.1-12.1)	**3.3**^{b} (2.2-4.6)	**2.9**^{a} (0.6-7.8)	**5.4*** (4.3-6.3)
Protein (g)	**22.2**^{a} (19.4-24.5)	**22.8**^{c} (18.6-26.7)	**14.2**^{abc} (9.4-19.0)	**27.4**^{bd} (24.8-32.8)	**20.3** (18.8-29.0)	**11.9**^{d} (4.8-19.1)	**27.7**^{abc*} (20.6-35.6)	**18.3**^{c*} (15.2-23.1)	**15.8**^{a} (12.3-20.1)	**17.6**^{b} (16.7-21.7)
Carbohydrate (g)	**64.0**^{a} (50.4-79.2)	**58.1**^{a} (46.3-62.5)	**53.4** (47.9-54.5)	**55.3** (55.2-57.6)	**60.3** (60.2-63.1)	**40.3** (24.9-55.7)	**72.3**^{c} (61.7-87.1)	**35.0**^{abc*} (30.9-42.3)	**61.1**^{a*} (58.2-63.1)	**59.4**^{b} (59.1-87.3)
Total Sugars (g)	**10.7**^{abc} (7.6-14.0)	**4.9**^{b} (3.7-6.6)	**6.2**^{c} (0.8-6.3)	**3.0**^{a} (2.9-4.9)	**8.7** (8.7-11.0)	**6.5** (1.6-11.4)	**11.5**^{c} (7.9-18.2)	**3.4**^{abc*} (2.5-4.5)	**9.3**^{a*} (2.3-11.6)	**7.2**^{b*} (6.7-7.3)
Free Sugars (g)	**1.5** (0.1-5.2)	**1.5** (0.7-2.2)	**2.0** (0.0-2.4)	**0.0** (0.0-2.0)	**3.7** (3.7-6.0)	**4.3** (0.0-8.6)	**1.8**^{c} (0.5-4.2)	**0.3**^{abc*} (0.1-1.0)	**3.4**^{a*} (1.3-4.2)	**4.1**^{b} (1.6-4.1)
Fibre (g)	**8.5**^{ab} (6.2-9.3)	**5.2**^{b} (3.3-6.1)	**6.4** (5.0-7.1)	**2.8**^{a} (2.8-2.8)	**4.7** (4.6-4.7)	**7.9** (2.9-12.9)	**8.9**^{bc} (7.6-11.8)	**3.5**^{ab*} (3.0-4.1)	**5.1**^{a*} (4.1-5.6)	**3.8**^{c*} (3.8-4.6)
Sodium (mg)	**553.1**^{d} (423.9-717.0)	**635.5**^{a} (537.3-828.4)	**169.7**^{abcd} (15.6-282.7)	**903.0**^{b} (834.5-1025.8)	**928.4**^{c} (849.5-988.2)	**385.4** (60.0-710.8)	**877.8**^{ab*} (528.4-1245.7)	**575.3**^{bde*} (424.5-765.9)	**290.4**^{ace} (216.9-531.1)	**904.0**^{cd} (855.6-939.8)
Calcium (mg)	**153.3**^{b} (91.7-244.4)	**213.6** (101.3-349.7)	**177.4**^{a} (55.4-316.6)	**562.6**^{ab} (502.9-680.4)	**343.0** (342.3-347.0)	**173.4** (33.6-313.2)	**271.8**^{a} (108.8-456.8)	**149.6**^{c*} (108.0-183.7)	**78.0**^{ab} (42.0-288.3)	**215.1**^{abc*} (213.8-311.1)

Iron (mg)	**3.3**[ab] (2.8-4.8)	**2.6**[b] (2.1-3.0)	**2.8** (1.7-3.4)	**1.9**[a] (1.8-2.0)	**2.2** (2.1-2.3)	**2.2** (0.7-3.7)	**3.8**[bd] (2.7-5.2)	**2.0**[cd*] (1.6-2.3)	**1.4**[ab*] (1.1-2.1)	**2.4**[ac] (2.3-2.9)
Zinc (mg)	**2.8**[a] (2.2-3.6)	**2.1**[a] (1.5-2.6)	**2.4** (1.9-3.5)	**3.2** (3.1-3.8)	**2.6** (2.4-2.8)	**1.7** (0.7-2.7)	**3.0**[ab] (2.4-4.1)	**1.5**[b*] (1.3-2.0)	**1.4**[a] (1.1-2.3)	**2.1**[*] (1.9-2.5)
Magnesium (mg)	**77.1**[a] (63.0-99.4)	**62.4**[a] (37.3-69.5)	**71.4** (58.5-81.1)	**44.8** (41.8-49.8)	**44.5** (42.9-53.8)	**65.1** (32.1-98.2)	**91.3**[abc*] (72.9-108.5)	**46.5**[c*] (36.8-55.8)	**44.2**[b*] (40.0-64.1)	**36.5**[a*] (34.7-41.5)
Potassium (mg)	**949.8**[ab] (722.9-1140.0)	**351.9**[bd] (285.9-419.6)	**503.6** (164.2-534.6)	**260.2**[ac] (206.7-347.0)	**514.8** (489.5-625.8)	**952.0**[cd] (667.2-1236.8)	**1160.9**[abc*] (998.9-1539.7)	**335.6**[c] (286.0-463.4)	**141.1**[b] (78.3-537.5)	**333.3**[a*] (310.1-358.5)
Iodine (µg)	**11.5** (6.9-16.5)	**13.8** (10.1-21.6)	**7.7** (3.1-14.6)	**20.6**[a] (18.5-24.8)	**13.7** (12.8-15.4)	**5.9**[a] (1.1-10.7)	**18.0**[ab] (9.2-24.1)	**9.3**[b*] (7.6-14.7)	**11.5** (8.0-16.1)	**7.9**[a*] (7.1-9.0)
Vitamin A (µg)	**241.6**[a] (78.5-445.5)	**41.1**[a] (10.8-108.9)	**158.1** (96.3-274.3)	**193.6** (160.6-253.5)	**211.5** (211.5-217.0)	**66.2** (2.1-130.3)	**158.1**[a] (32.0-528.7)	**46.8**[ab] (23.1-82.3)	**112.9** (7.1-135.1)	**126.8**[b*] (126.8-143.7)
Vitamin B6 (mg)	**0.4** (0.3-0.5)	**0.3** (0.2-0.5)	**0.3** (0.1-0.3)	**0.2** (0.1-0.3)	**0.2** (0.2-0.4)	**0.3** (0.1-0.4)	**0.7**[abd*] (0.4-0.9)	**0.3**[cd] (0.2-0.4)	**0.2**[b] (0.1-0.3)	**0.2**[ac*] (0.1-0.2)
Folate (µg)	**77.9**[ab] (59.1-104.5)	**56.0**[b] (37.3-75.9)	**35.3**[a] (20.5-45.4)	**47.0** (46.4-49.5)	**61.5** (60.5-64.3)	**54.5** (22.3-86.7)	**69.1**[ade] (57.7-153.1)	**48.1**[bce] (39.4-65.8)	**17.9**[ab*] (11.4-28.6)	**20.8**[cd*] (19.8-24.8)
Vitamin B12 (µg)	**0.7**[d] (0.3-1.2)	**1.0**[c] (0.4-1.6)	**0.5**[abcd] (0.0-0.9)	**1.3**[b] (1.1-1.7)	**0.9**[a] (0.9-1.1)	**0.4** (0.0-0.8)	**0.9**[ab] (0.4-1.5)	**0.4**[b*] (0.1-1.0)	**0.2**[a] (0.0-0.8)	**0.7**[*] (0.7-0.8)
Vitamin C (mg)	**29.6**[ab] (20.2-42.7)	**0.0**[b] (0.0-0.4)	**18.7** (0.0-20.4)	**0.0**[a] (0.0-0.0)	**20.7** (20.7-20.8)	**6.6** (6.6-6.6)	**24.7**[abc] (10.8-46.2)	**0.4**[b*] (0.0-5.1)	**0.0**[a] (0.0-5.3)	**2.5**[c*] (1.0-2.5)
Vitamin D (µg)	**0.3** (0.1-0.8)	**0.2** (0.1-0.6)	**0.1** (0.0-0.1)	**0.2** (0.1-0.2)	**0.1** (0.1-0.2)	**0.0** (0.0-0.1)	**0.3**[bd] (0.1-0.7)	**0.3**[ac] (0.2-0.4)	**0.1**[ab] (0.0-0.1)	**0.1**[cd*] (0.1-0.1)

[a b c d e] indicates significant difference ($p < 0.05$) found from Dunn's post-hoc tests (pairwise comparisons) between main meal sub-categories within each school separately, with Bonferroni adjustment for multiple comparisons. Matching symbols used to indicate significant differences between specific pairs.
* indicates significant difference ($P < 0.05$) for common sub-category between School 1 and School 2.

Drinks Sub-Categories:

Table 4.4 provides the energy and nutrient values for all drinks sub-categories. Both schools provided a range of drinks, including water, juice-based and milk-based drinks. The nutritional composition findings indicated variation across drinks sub-categories. Kruskal Wallis tests found significant differences (P < 0. 05) across school 1 drinks sub-categories for energy content and almost all nutrient values, the exceptions being for total sugar, carbohydrates and fibre. In school 2, significant differences (P < 0. 05) were found across drinks sub-categories for all energy/nutrient values, except vitamin A. In both schools, milk and flavoured milk drinks were higher than juice-based drinks for levels of energy, saturated fat and sodium. However, milk and flavoured milk drinks were also higher than juice-based drinks for levels of protein, calcium, iodine, folate and vitamin D. Juice-based drinks were higher than other drinks sub-categories for levels of free sugars, more than doubling the maximum free sugar value (8.6g) for a school lunch.

In contrast to the previous two sections, drinks sub-categories were largely similar across the two schools in terms of nutritional composition. No statistically significant variation was found for common items across the two schools. That said, inter-school variation was observed for semi-skimmed milk, which varied substantially across schools for a number of values, including energy, fat, iodine and vitamin A. These differences were due to school 1 providing a larger portion (250 ml) compared to school 2 (189 ml).

Free sugar content was consistently high across drinks sub-categories. When compared to NBS, several drinks sub-categories including juice-based drinks (S1: 17.9g, S2: 18.5g), flavoured milk drinks (S1: 7.6g, S2: 7.6g), pure juice drinks (S1: 13.7g), cream based drinks (S2: 25.4g) and slush (S1: 8.6g, S2: 9.2g) either approximated or exceeded the maximum free sugar value (8.6g) for a school lunch. Indeed, only two drinks sub-categories, milk and water, had a free sugar content which was not excessively high.

Table 4.4. Energy and nutrient content (median and inter quartile ranges) per portion for drinks sub-categories in school 1 and school 2 (excluding water and flavoured water)

	School 1					*School 2*				
	Juice based (n=14)	*Flavoured milk (n=3)*	*Milk (n=1)*	*Pure juice (n=2)*	*Slush (n=1)*	*Juice based (n=5)*	*Flavoured milk (n=2)*	*Milk (n=1)*	*Slush (n=2)*	*Cream based (n=2)*
Median Portion Size (ml)	**330.0** (297.5-330.0)	**200.0** (200.0-200.0)	**250.0** (250.0-250.0)	**150.0** (150.0-150.0)	**200.0** (200.0-200.0)	**330.0** (200.0-330.0)	**200.0** (200.0-200.0)	**189.0** (189.0-189.0)	**200.0** (200.0-200.0)	**200.0** (200.0-200.0)
Energy (kcal)	**78.0** (72.6-99.8)	**124.0** (124.0-130.0)	**115.0** (115.0-115.0)	**54.8** (54.0-55.5)	**66.0** (66.0-66.0)	**85.8** (73.0-145.2)	**127.0** (124.0-130.0)	**86.9** (86.9-86.9)	**78.0** (68.0-88.0)	**230.0** (228.0-232.0)
Energy (kJ)	**326.0** (303.8-417.7)	**520.0** (520.0-546.0)	**487.5** (487.5-487.5)	**232.5** (229.5-235.5)	**272.0** (272.0-272.0)	**353.1** (307.0-617.1)	**533.0** (520.0-546.0)	**368.6** (368.6-368.6)	**323.0** (280.0-366.0)	**968.0** (958.0-978.0)
Fat (g)	**0.0**[a] (0.0-0.0)	**3.2**[a] (3.2-3.4)	**4.3** (4.3-4.3)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**0.0** (0.0-0.1)	**3.3** (3.2-3.4)	**3.2** (3.2-3.2)	**0.0** (0.0-0.0)	**5.6** (5.4-5.8)
Saturated Fat (g)	**0.0**[a] (0.0-0.0)	**2.2**[a] (2.2-2.4)	**2.7** (2.7-2.7)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**2.3** (2.2-2.4)	**2.0** (2.0-2.0)	**0.0** (0.0-0.0)	**1.4** (0.8-2.0)
Protein (g)	**0.3** (0.3-0.3)	**6.6** (6.6-7.2)	**8.8** (8.8-8.8)	**0.8** (0.2-1.4)	**0.0** (0.0-0.0)	**0.3** (0.1-0.3)	**6.9** (6.6-7.2)	**6.6** (6.6-6.6)	**0.0** (0.0-0.0)	**8.9** (8.8-9.0)
Carbohydrate (g)	**18.3** (16.7-23.4)	**17.0** (17.0-17.4)	**11.8** (11.8-11.8)	**13.7** (12.9-14.6)	**15.8** (15.8-15.8)	**20.0** (18.3-33.0)	**17.2** (17.0-17.4)	**8.9** (8.9-8.9)	**18.3** (15.8-20.8)	**34.7** (33.8-35.6)
Total Sugar (g)	**17.9** (16.3-22.7)	**17.0** (17.0-17.0)	**11.8** (11.8-11.8)	**13.7** (12.9-14.6)	**8.6** (8.6-8.6)	**18.5** (17.9-32.7)	**17.0** (17.0-17.0)	**8.9** (8.9-8.9)	**9.2** (8.6-9.8)	**32.2** (31.6-32.8)
Free Sugars (g)	**17.9** (16.3-22.7)	**7.6** (7.6-7.6)	**0.0** (0.0-0.0)	**13.7** (12.9-14.6)	**8.6** (8.6-8.6)	**18.5** (17.9-32.7)	**7.6** (7.6-7.6)	**0.0** (0.0-0.0)	**9.2** (8.6-9.8)	**25.4** (25.0-25.9)
Fibre (g)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**0.0**[a] (0.0-0.0)	**0.0**[b] (0.0-0.0)	**0.0** (0.0-0.0)	**0.0**[c] (0.0-0.0)	**2.4**[abc] (2.4-2.4)
Sodium (mg)	**6.6** (6.0-6.6)	**88.0** (87.9-109.2)	**107.5** (107.5-107.5)	**3.0** (1.5-4.5)	**0.0** (0.0-0.0)	**6.6** (2.0-43.3)	**98.6** (88.0-109.2)	**81.3** (81.3-81.3)	**0.0** (0.0-0.0)	**120.0** (120.0-120.0)
Calcium (mg)	**9.9** (9.9-9.9)	**248.6** (244.2-248.7)	**300.0** (300.0-300.0)	**10.5** (9.0-12.0)	**0.0** (0.0-0.0)	**9.9** (9.9-11.0)	**246.5** (244.2-248.7)	**226.8** (226.8-226.8)	**0.0** (0.0-0.0)	**360.0** (356.0-364.0)

Iron (mg)	**0.0** (0.0-0.0)	**0.1** (0.1-0.3)	**0.1** (0.1-0.1)	**0.1** (0.1-0.1)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**0.2** (0.1-0.3)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)
Zinc (mg)	**0.0**[a] (0.0-0.0)	**1.0**[a] (1.0-1.1)	**1.0** (1.0-1.0)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**1.1** (1.0-1.1)	**0.8** (0.8-0.8)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)
Magnesium (mg)	**3.3** (3.3-3.3)	**22.0** (22.0-33.8)	**27.5** (27.5-27.5)	**9.8** (6.0-13.5)	**0.0** (0.0-0.0)	**3.3** (2.7-3.7)	**27.9** (22.0-33.8)	**20.8** (20.8-20.8)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)
Potassium (mg)	**72.6**[a] (65.5-72.6)	**323.0**[a] (322.8-355.1)	**390.0** (390.0-390.0)	**185.3** (133.5-237.0)	**0.0** (0.0-0.0)	**72.6** (38.0-72.6)	**339.0** (323.0-355.1)	**294.8** (294.8-294.8)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)
Iodine (µg)	**0.0**[a] (0.0-0.0)	**58.5**[a] (58.5-58.9)	**75.0** (75.0-75.0)	**0.8** (0.0-1.5)	**0.0** (0.0-0.0)	**0.0**[a] (0.0-0.0)	**58.7**[a] (58.5-58.9)	**56.7** (56.7-56.7)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)
Vitamin A (µg)	**0.0**[a] (0.0-0.0)	**0.0**[b] (0.0-0.0)	**50.0**[ab] (50.0-50.0)	**5.3** (0.0-10.5)	**0.0** (0.0-0.0)	**0.0** (0.0-115.0)	**0.0** (0.0-0.0)	**37.8** (37.8-37.8)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)
Vitamin B6 (mg)	**0.0**[a] (0.0-0.0)	**0.1**[a] (0.1-0.1)	**0.2** (0.2-0.2)	**0.1** (0.1-0.1)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**0.1** (0.1-0.1)	**0.1** (0.1-0.1)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)
Folate (µg)	**3.3** (3.0-3.3)	**18.1** (18.1-18.9)	**22.5** (22.5-22.5)	**17.3** (1.5-33.0)	**0.0** (0.0-0.0)	**3.3** (2.7-3.7)	**18.5** (18.1-18.9)	**17.0** (17.0-17.0)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)
Vitamin B12 (µg)	**0.0**[a] (0.0-0.0)	**1.6**[a] (1.6-1.6)	**2.3** (2.3-2.3)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**1.6** (1.6-1.6)	**1.7** (1.7-1.7)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)
Vitamin C (mg)	**0.0**[a] (0.0-0.0)	**2.0** (2.0-2.0)	**5.0** (5.0-5.0)	**49.5**[a] (39.0-60.0)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)	**2.0** (2.0-2.0)	**3.8** (3.8-3.8)	**0.0** (0.0-0.0)	**0.0** (0.0-0.0)
Vitamin D (µg)	**0.0**[a] (0.0-0.0)	**2.2**[ab] (2.2-2.2)	**0.0** (0.0-0.0)	**0.0**[b] (0.0-0.0)	**0.0** (0.0-0.0)	**0.0**[b] (0.0-0.0)	**2.2**[abc] (2.2-2.2)	**0.0** (0.0-0.0)	**0.0**[c] (0.0-0.0)	**0.0**[a] (0.0-0.0)

[a b c] indicates significant difference ($p < 0.05$) found from Dunn's post-hoc tests (pairwise comparisons) between drinks sub-categories within each school separately, with Bonferroni adjustment for multiple comparisons. Matching symbols used to indicate significant difference between a specific pair.

4.5.2 Nutrient Profiling

Figures 4.3 and 4.4 show the breakdown of main meals according to FoP categories (low/med/high) for fat, saturated fat, salt and total sugar. A substantial percentage of meals of the day (S1: 26.3%; S2: 73.0%) and paninis (S1: 50.0%) were high in fat. Fisher's exact tests indicated significant associations between main meal sub-category and level of fat in school 1 ($P < 0.01$, $\varphi c = 0.4$) and school 2 ($P < 0.01$, $\varphi c = 0.5$). Significant associations were also found between main meal sub-category and saturated fat in school 1 ($P = 0.02$, $\varphi c = 0.3$) and school 2 ($P < 0.01$, $\varphi c = 0.4$), while substantial percentages of meals of the day (S1: 31.6%; S2: 67.6%), pizzas (S1: 100.0%; S2: 80.0%) and paninis (S1: 100.0%) were high in saturated fat. Significant associations were found between main meal sub-categories and level of salt in school 1 ($P < 0.01$, $\varphi c = 0.5$) and school 2 ($P < 0.01$, $\varphi c = 0.5$). Across both schools, all paninis and pizzas were high in salt. No significant association was found between school 1 main meal sub-categories and total sugar. A significant association was found between school 2 main meals and total sugar ($P < 0.05$, $\varphi c = 0.2$). Across both schools, the vast majority of main meal items were low in total sugar.

The nutrient profiling results also illustrated variation across schools for select sub-categories. Examples of this included the percentages of high saturated fat items found within meals of the day (S1: 31.6%; S2: 67.6%), or the percentages of high salt items found for meals of the day (S1: 23.7%; S2: 62.2%). The results also highlighted some sub-categories of note (e.g. level of saturated fat, sodium in pizza and panini items).

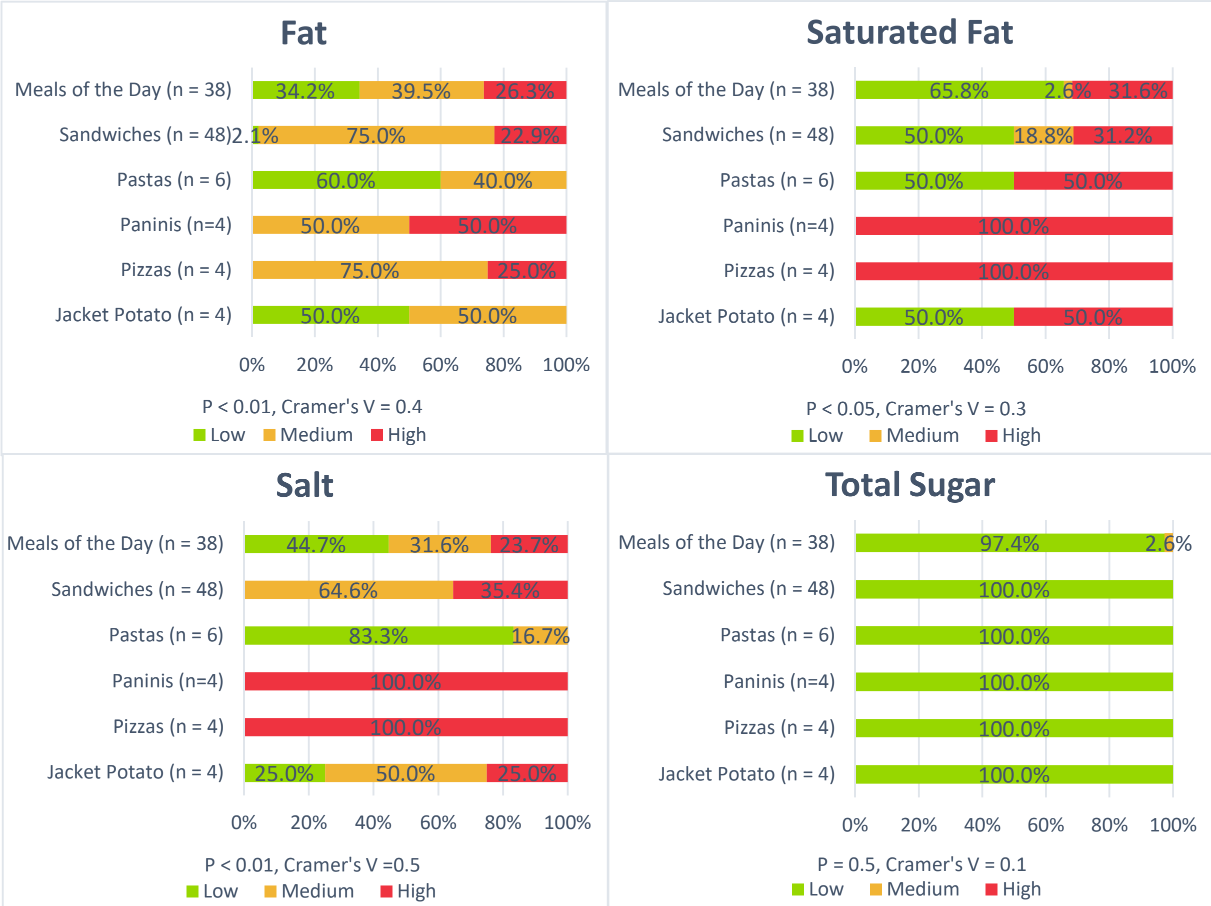

Figure 4.3. Percentages of School 1 main meal items classified as low, medium and high (according to front-of-pack nutrition labelling)[312] for levels of fat, saturated fat, total sugar and salt.

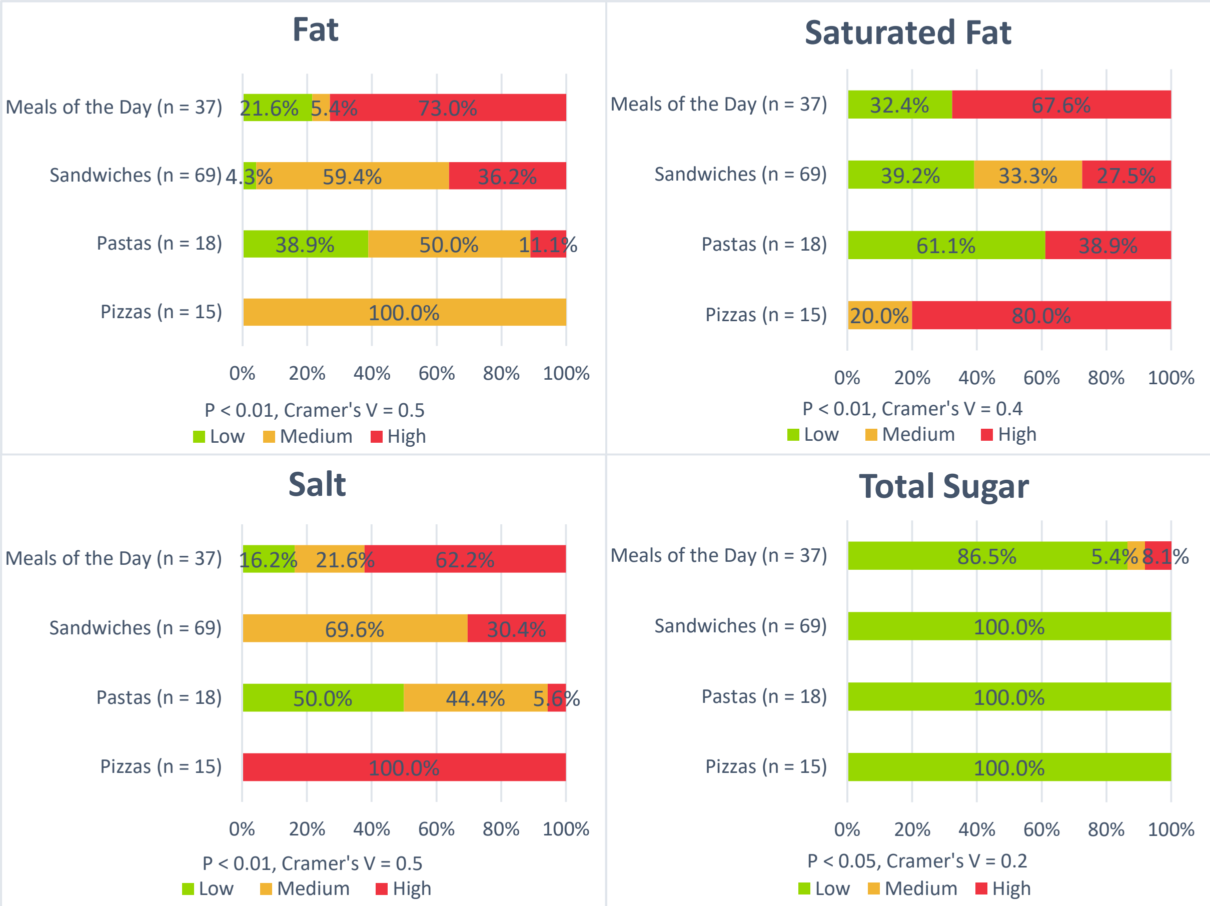

Figure 4.4. Percentages of School 2 main meal items classified as low, medium and high (according to front-of-pack nutrition labelling)[312] for levels of fat, saturated fat, total sugar and salt.

Figures 4.5 and 4.6 show the breakdown of drinks according to fop categories (low/med/high). Fisher's exact tests indicated significant associations between drinks sub-categories and total sugar in school 1 ($P < 0.01$, $\varphi c = 0.9$) and school 2 ($P < 0.01$, $\varphi c = 1.0$). Milk was medium in total sugar in both schools while all 3 unique flavoured milks were high in sugar, almost half of which is considered free sugar (3.8g added sugar/8.5g total sugar per 100ml). Meanwhile, 14 of the 15 unique juice-based drinks across both schools were profiled as high in total sugar, despite consisting of a mixture of fruit juice (40.3% on average) and water. This difference can be attributed to the different portion sizes found for juice-based drinks (330 ml on average) compared to pure juice drinks (150 ml). These findings align with the earlier nutritional composition findings by illustrating how the majority (16/22 in S1, 9/17 in S2) of drinks provided in schools are high in total sugar, much of which is free sugar.

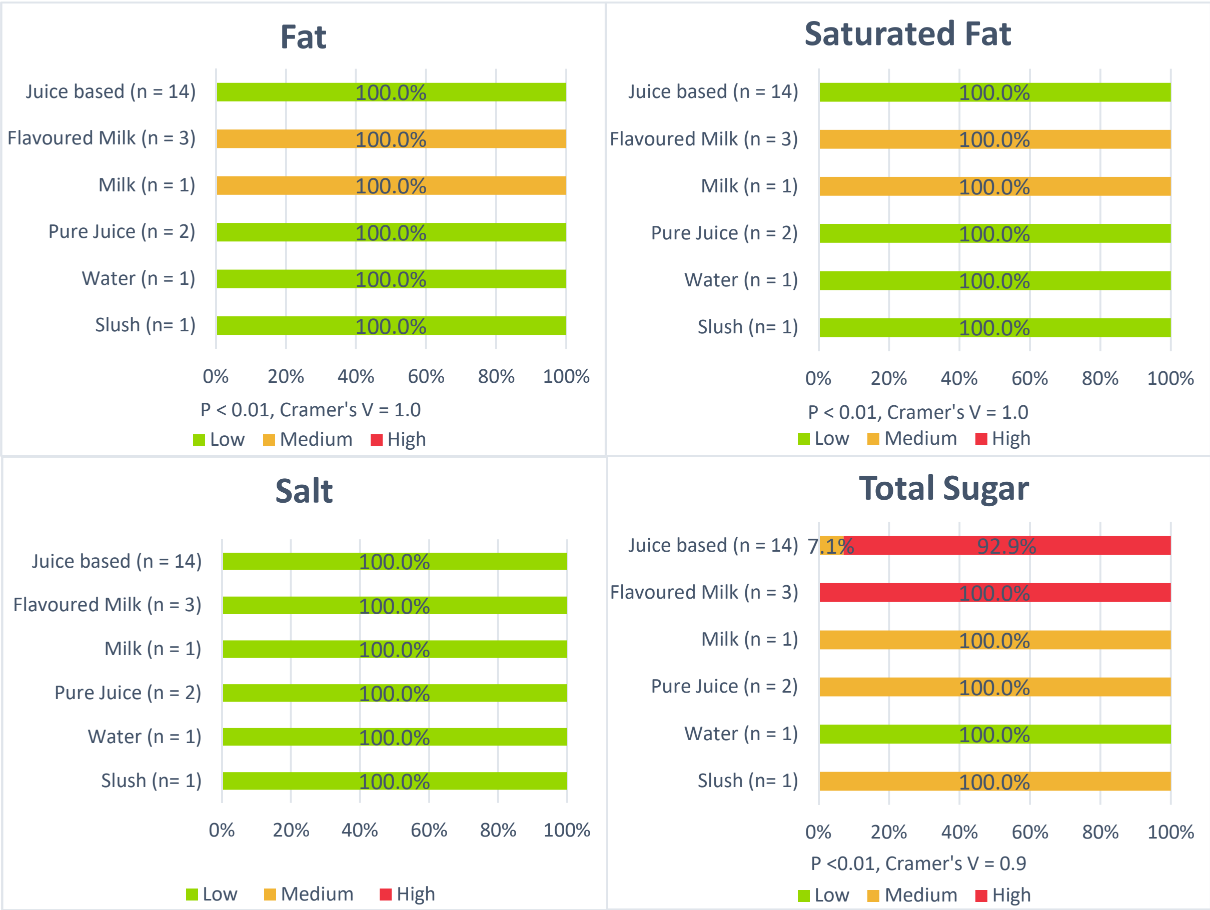

Figure 4.5. Percentages of School 1 drinks items classified as low, medium and high (according to front-of-pack nutrition labelling)[312] for levels of fat, saturated fat, total sugar and salt.

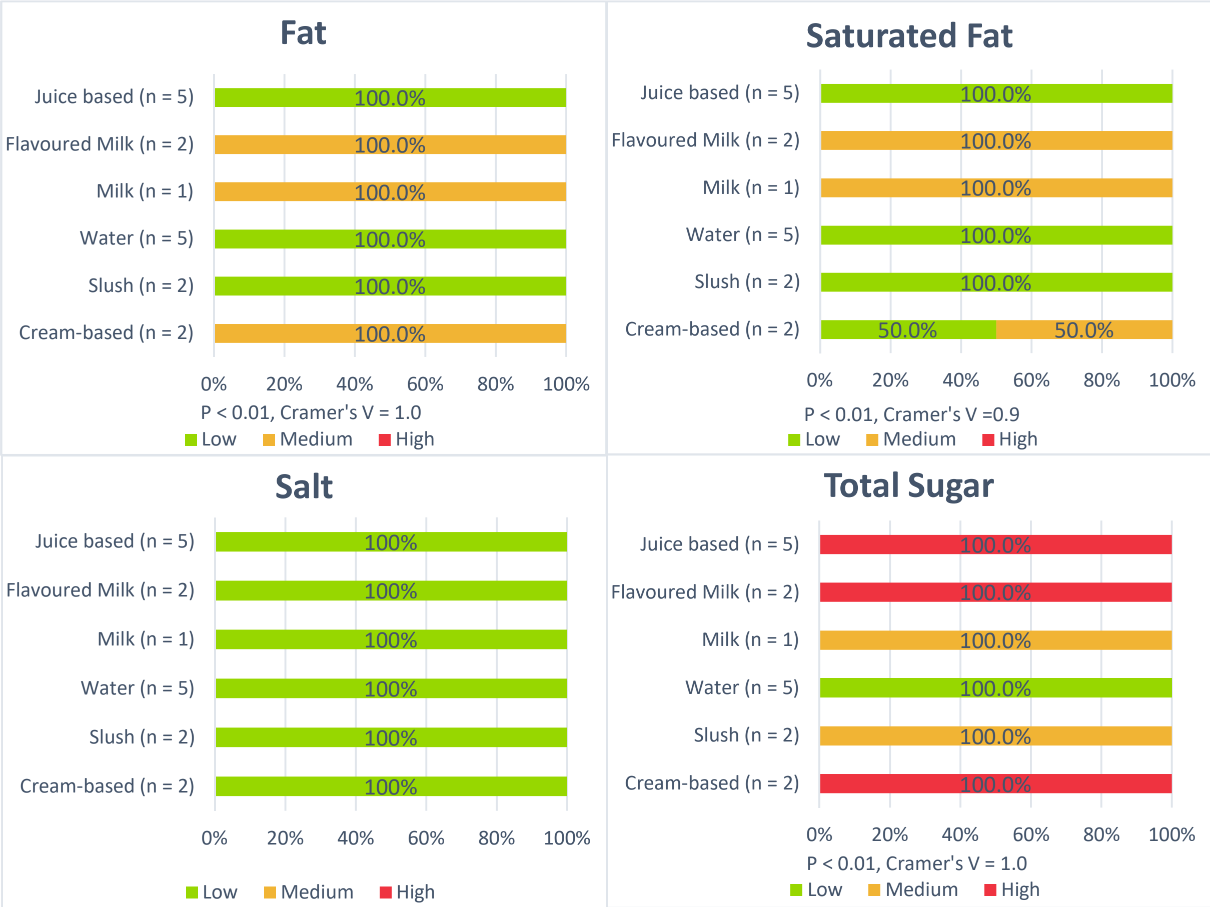

Figure 4.6. Percentages of School 2 drinks items classified as low, medium and high (according to front-of-pack nutrition labelling)[312] for levels of fat, saturated fat, total sugar and salt.

4.5.3 Comparison to Reference Values

Tables 4.5 and 4.6 outline the energy and nutrient values for 8 “typical” lunches in school 1 and school 2. Energy and nutrients which did not meet the minimum/maximum reference values are highlighted according to percentage deviation (amber = < 5% deviation, orange = ≥ 5% deviation, light red = ≥ 10% deviation, dark red = ≥ 20% deviation). All “typical” lunches failed to meet at least one of the NBS, with many lunches deviating by 20% or more for several values.

Six of the eight “typical” lunches in school 1 fell under maximum values for saturated fat, while five lunches fell under the maximum value for fat. Four lunches were below the maximum value for sodium, while all lunches met the minimum value for protein. All eight lunches exceeded the maximum value for free sugars by a difference of greater than or equal to 20%. Only three lunches met the minimum value for fibre, two lunches met the minimum value for calcium and two lunches met the minimum value for zinc. None of the “typical” lunches met the minimum value for iron, potassium, iodine or vitamin D. In school 2, five lunches exceeded the maximum values for saturated fat, five were above the maximum value for sodium, while all eight lunches exceeded the maximum value for free sugars. All eight “typical” lunches met the minimum value for protein but none met the minimum values for magnesium, iodine or vitamin D. Six lunches failed to meet minimum values for calcium, fibre, potassium, folate, vitamin A and vitamin C.

Table 4.5. Median nutrient values (and inter quartile ranges) per portion for school 1 "typical" lunches

			School 1				*School 2*			
	Max/Min	*Reference Value**	*Meal of the Day & Drink (n=14400)*	*Pizza & Drink (n=5760)*	*Pasta & Drink (n=19200)*	*Sandwich & Drink (n=125760)*	*Meal of the Day & Sweet Snack (n=3600)*	*Pizza & Sweet Snack (n=1440)*	*Pasta & Sweet Snack (n=4800)*	*Sandwich & Sweet Snack (n=31440)*
Energy (kcal)		**646** (± 32.3)	**609.6** (± 162.3)	**560.7** (± 45.3)	**400.0** (± 80.6)	**529.2** (± 86.6)	**745.6** (± 185.4)	**696.7** (± 100.3)	**536.0** (± 120.4)	**665.2** (± 124.5)
Energy (kJ)		**2700** **(± 135.0)**	**2568.6** (± 682.6)	**2359.8** (± 190.9)	**1687.1** (± 335.5)	**2227.2** (± 363.4)	**3128.7** (± 769.7)	**2919.9** (± 403.7)	**2247.2** (± 488.9)	**2787.3** (± 508.4)
Fat (g)	**Max**	**25.1**	**18.7** (± 9.5)	**18.8** (± 2.1)	**8.5** (± 6.1)	**17.5** (± 5.7)	**26.5** (± 11.4)	**26.5** (± 6.6)	**16.3** (± 8.8)	**25.3** (± 8.5)
Saturated Fat (g)	**Max**	**7.9**	**5.9** (± 4.5)	**8.6** (± 1.1)	**4.5** (± 3.8)	**4.7** (± 3.8)	**7.5** (± 4.7)	**10.2** (± 1.6)	**6.1** (± 4.0)	**6.3** (± 4.0)
Protein (g)	**Min**	**13.3**	**27.2** (± 8.8)	**22.9** (± 5.5)	**15.3** (± 5.4)	**24.3** (± 6.1)	**29.9** (± 8.5)	**25.5** (± 5.1)	**18.0** (± 4.9)	**27.0** (± 5.7)
Carbohydrate (g)	**Min**	**86.1**	**86.5** (± 26.1)	**78.2** (± 6.7)	**68.3** (± 7.2)	**71.4** (± 13.6)	**101.8** (± 27.9)	**93.5** (± 11.9)	**83.6** (± 12.3)	**86.7** (± 16.8)
Free Sugars (g)	**Max**	**8.6**	**17.2** (± 8.6)	**19.6** (± 8.1)	**15.9** (± 8.1)	**16.4** (± 8.1)	**20.4** (± 9.8)	**22.8** (± 9.4)	**19.1** (± 9.4)	**19.6** (± 9.4)
Fibre (g)	**Min**	**8.0**	**8.3** (± 2.8)	**4.7** (± 0.0)	**5.8** (± 0.9)	**5.0** (± 1.3)	**9.3** (± 3.0)	**5.7** (± 0.8)	**6.9** (± 1.2)	**6.0** (± 1.5)
Sodium (mg)	**Max**	**714**	**599.8** (± 251.8)	**914.4** (± 75.9)	**176.0** (± 133.2)	**686.2** (± 161.2)	**730.2** (± 261.6)	**1044.8** (± 103.8)	**306.4** (± 150.8)	**816.6** (± 176.0)
Calcium (mg)	**Min**	**350**	**240.0** (± 151.0)	**399.3** (± 98.8)	**231.2** (± 160.9)	**283.7** (± 187.4)	**262.9** (± 139.6)	**422.1** (± 80.3)	**254.1** (± 150.2)	**306.5** (± 178.3)
Iron (mg)	**Min**	**5.2**	**3.7** (± 1.3)	**2.2** (± 0.1)	**2.5** (± 0.7)	**2.5** (± 0.9)	**4.6** (± 1.3)	**3.1** (± 0.4)	**3.3** (± 0.8)	**3.3** (± 1.0)
Zinc (mg)	**Min**	**3.3**	**3.6** (± 1.8)	**2.7** (± 0.4)	**2.6** (± 0.9)	**2.2** (± 1.0)	**3.9** (± 1.8)	**3.0** (± 0.3)	**2.9** (± 0.8)	**2.5** (± 0.9)

Magnesium (mg)	**Min**	**105.0**	**92.8** (± 30.6)	**53.4** (± 10.8)	**74.0** (± 14.7)	**63.0** (± 24.0)	**105.0** (± 31.0)	**65.6** (± 11.9)	**86.2** (± 15.6)	**75.2** (± 24.5)
Potassium (mg)	**Min**	**1225**	**1125.1** (± 403.5)	**646.3** (± 134.1)	**462.8** (± 217.3)	**462.3** (± 166.8)	**1172.4** (± 406.1)	**693.6** (± 141.7)	**510.2** (± 222.0)	**509.6** (± 173.0)
Iodine (µg)	**Min**	**49.0**	**33.0** (± 34.2)	**25.4** (± 24.7)	**19.3** (± 25.3)	**26.7** (± 25.6)	**37.1** (± 36.1)	**29.6** (± 27.1)	**23.4** (± 27.7)	**30.9** (± 28.0)
Vitamin A (µg)	**Min**	**245.0**	**300.8** (± 321.2)	**215.6** (± 11.0)	**146.0** (± 104.0)	**71.8** (± 80.7)	**316.1** (± 324.7)	**231.0** (± 49.1)	**161.4** (± 114.5)	**87.1** (± 93.8)
Vitamin B6 (mg)	**Min**	**0.5**	**0.5** (± 0.2)	**0.3** (± 0.1)	**0.2** (± 0.1)	**0.4** (± 0.2)	**0.5** (± 0.2)	**0.3** (± 0.1)	**0.2** (± 0.1)	**0.4** (± 0.2)
Folate (µg)	**Min**	**70**	**92.3** (± 52.3)	**68.7** (± 8.9)	**36.4** (± 15.3)	**70.9** (± 38.8)	**93.7** (± 52.4)	**70.1** (± 9.2)	**37.8** (± 15.5)	**72.3** (± 38.9)
Vitamin B12 (µg)	**Min**	**0.5**	**1.5** (± 1.2)	**1.3** (± 0.7)	**0.8** (± 0.8)	**1.4** (± 1.0)	**1.2** (± 1.0)	**1.0** (± 0.2)	**0.5** (± 0.4)	**1.1** (± 0.8)
Vitamin C (mg)	**Min**	**14.0**	**36.6** (± 21.0)	**25.9** (± 14.7)	**15.0** (± 17.7)	**6.1** (± 15.3)	**31.6** (± 15.0)	**20.9** (± 0.6)	**10.0** (± 9.8)	**1.2** (± 4.4)
Vitamin D (µg)	**Min**	**3.5**	**0.8** (± 1.0)	**0.4** (± 0.8)	**0.4** (± 0.8)	**0.7** (± 0.9)	**0.7** (± 0.7)	**0.3** (± 0.4)	**0.2** (± 0.4)	**0.6** (± 0.6)

Deviation from reference value	< 5% deviation	≥ 5% deviation	≥ 10% deviation	≥ 20% deviation

*reference values are from nutrient-based standards (NBS) for school food[4], otherwise derived from respective dietary reference value[9]. Values for free sugars, fibre and vitamin D all revised in light of SACN recommendations[261,262].

Table 4.6. Median nutrient values (and inter quartile ranges) per portion for school 2 "typical" lunches

	Max/Min	*Reference Value**	*School 1* Meal of the Day & Drink (n=13005)	*School 1* Pizza & Drink (n=15300)	*School 1* Pasta & Drink (n=34425)	*School 1* Sandwich & Drink (n=117300)	*School 2* Meal of the Day & Sweet Snack (n=5355)	*School 2* Pizza & Sweet Snack (n=6300)	*School 2* Pasta & Sweet Snack (n=14175)	*School 2* Sandwich & Sweet Snack (n=48300)
Energy (kcal)		**646** (± 32.3)	**729.8** (± 143.5)	**546.9** (± 102.1)	**473.3** (± 119.2)	**497.8** (± 164.3)	**875.7** (± 158.0)	**711.6** (± 131.0)	**619.2** (± 136.2)	**643.7** (± 177.1)
Energy (kJ)		**2700** **(± 135.0)**	**3067.8** (± 598.0)	**2306.2** (± 430.7)	**1975.3** (± 479.9)	**2093.5** (± 686.2)	**3660.0** (± 651.4)	**2978.1** (± 542.4)	**2567.5** (± 544.7)	**2685.6** (± 733.2)
Fat (g)	Max	**25.1**	**28.7** (± 11.0)	**15.3** (± 3.1)	**12.7** (± 8.4)	**19.9** (± 12.6)	**38.8** (± 12.5)	**25.9** (± 6.9)	**22.8** (± 10.3)	**30.0** (± 13.9)
Saturated Fat (g)	Max	**7.9**	**9.6** (± 4.9)	**5.9** (± 1.4)	**4.1** (± 3.6)	**4.9** (± 4.1)	**13.9** (± 5.7)	**10.3** (± 3.2)	**8.4** (± 4.5)	**9.2** (± 4.9)
Protein (g)	Min	**13.3**	**31.4** (± 10.0)	**19.5** (± 4.3)	**16.9** (± 5.9)	**21.5** (± 6.1)	**32.1** (± 9.5)	**21.0** (± 3.5)	**17.5** (± 4.8)	**22.1** (± 5.1)
Carbohydrate (g)	Min	**86.1**	**90.6** (± 20.7)	**86.7** (± 18.0)	**74.3** (± 14.0)	**60.5** (± 21.9)	**105.0** (± 20.1)	**103.6** (± 18.2)	**88.7** (± 13.1)	**74.9** (± 21.3)
Free Sugars (g)	Max	**8.6**	**15.5** (± 12.5)	**13.1** (± 11.2)	**14.5** (± 11.7)	**12.6** (± 11.6)	**18.4** (± 9.2)	**17.7** (± 7.9)	**17.4** (± 8.1)	**15.4** (± 7.8)
Fibre (g)	Min	**8.0**	**10.2** (± 3.5)	**4.2** (± 0.4)	**5.3** (± 1.4)	**3.9** (± 1.3)	**11.0** (± 3.5)	**5.4** (± 0.9)	**6.2** (± 1.4)	**4.8** (± 1.3)
Sodium (mg)	Max	**714**	**1054.6** (± 556.6)	**879.0** (± 98.8)	**304.0** (± 207.7)	**708.7** (± 280.4)	**1197.1** (± 557.9)	**1032.6** (± 109.1)	**446.4** (± 210.9)	**851.2** (± 282.8)
Calcium (mg)	Min	**350**	**382.5** (± 217.7)	**313.7** (± 106.3)	**229.0** (± 180.9)	**280.7** (± 199.1)	**334.0** (± 173.8)	**301.5** (± 54.4)	**180.4** (± 124.7)	**232.2** (± 149.9)
Iron (mg)	Min	**5.2**	**4.9** (± 3.0)	**2.6** (± 0.4)	**1.9** (± 1.3)	**2.1** (± 0.7)	**5.6** (± 3.0)	**3.3** (± 0.5)	**2.6** (± 1.3)	**2.8** (± 0.8)

Zinc (mg)	Min	**3.3**	**3.7** (± 1.8)	**2.3** (± 0.5)	**1.8** (± 0.7)	**1.9** (± 0.8)	**3.9** (± 1.7)	**2.5** (± 0.4)	**2.0** (± 0.7)	**2.1** (± 0.8)
Magnesium (mg)	Min	**105.0**	**101.8** (± 26.8)	**43.1** (± 10.9)	**56.4** (± 17.0)	**50.3** (± 18.1)	**111.2** (± 26.9)	**51.7** (± 10.9)	**65.7** (± 17.2)	**59.6** (± 18.3)
Potassium (mg)	Min	**1225.0**	**1390.7** (± 480.6)	**397.4** (± 127.2)	**383.1** (± 282.3)	**436.6** (± 173.3)	**1408.6** (± 467.9)	**405.3** (± 55.9)	**401.0** (± 260.0)	**454.5** (± 134.3)
Iodine (µg)	Min	**49.0**	**34.2** (± 34.9)	**19.3** (± 23.2)	**23.1** (± 22.6)	**23.4** (± 23.2)	**26.4** (± 27.9)	**10.1** (± 7.3)	**15.2** (± 8.6)	**15.5** (± 10.0)
Vitamin A (µg)	Min	**245.0**	**543.8** (± 621.9)	**154.2** (± 58.3)	**109.2** (± 102.9)	**86.6** (± 92.6)	**559.3** (± 623.5)	**167.6** (± 70.9)	**124.6** (± 112.1)	**102.1** (± 102.8)
Vitamin B6 (mg)	Min	**0.5**	**0.7** (± 0.3)	**0.2** (± 0.1)	**0.3** (± 0.2)	**0.4** (± 0.2)	**0.8** (± 0.3)	**0.2** (± 0.0)	**0.3** (± 0.2)	**0.4** (± 0.2)
Folate (µg)	Min	**70**	**104.0** (± 56.0)	**26.9** (± 7.5)	**25.7** (± 13.5)	**55.7** (± 19.5)	**105.5** (± 55.7)	**27.8** (± 4.0)	**27.1** (± 12.0)	**57.1** (± 18.6)
Vitamin B12 (µg)	Min	**0.5**	**1.4** (± 1.1)	**1.0** (± 0.7)	**0.7** (± 0.7)	**1.0** (± 1.1)	**1.2** (± 0.9)	**0.8** (± 0.2)	**0.5** (± 0.4)	**0.8** (± 0.9)
Vitamin C (mg)	Min	**14**	**36.7** (± 34.2)	**2.5** (± 1.7)	**2.8** (± 3.2)	**2.8** (± 4.5)	**36.4** (± 34.2)	**2.1** (± 1.3)	**2.4** (± 3.0)	**2.4** (± 4.4)
Vitamin D (µg)	Min	**3.5**	**0.8** (± 1.1)	**0.4** (± 0.8)	**0.3** (± 0.7)	**0.6** (± 0.8)	**0.7** (± 1.0)	**0.3** (± 0.6)	**0.3** (± 0.6)	**0.5** (± 0.7)

Deviation from reference value	< 5% deviation	≥ 5% deviation	≥ 10% deviation	≥ 20% deviation

*reference values are from nutrient-based standards (NBS) for school food[4], otherwise derived from respective dietary reference value[9]. Values for free sugars, fibre and vitamin D all revised in light of SACN recommendations[261,262].

Table 4.7 outlines the results from the one sample Wilcoxon signed rank tests, comparing median nutrient values for (1) an average lunch and (2) all lunch combinations to reference values. The school 1 average lunch, based on an estimated 1716 lunches, failed to meet 14/20 reference values (energy, carbohydrates, free sugars, fibre, calcium, iron, zinc, magnesium, potassium, iodine, folate, vitamins A, B6 and D) (all significant at P < 0.01). A school 2 average lunch, based on an estimated 1685 lunches, also failed to meet 14/20 NBS (saturated fat, free sugars, fibre, sodium, calcium, iron, zinc, magnesium, potassium, iodine, folate, vitamins A, B6 and D) (all significant at P < 0.01). Median values for all lunch combinations were similar to the average lunches, with both schools failing to meet 15/20 reference values.

Table 4.7. Comparisons for "average" and all lunch combinations to NBS (values highlighted where NBS was not met)

			School 1		*School 2*	
	Max/Min	*Reference Value[*]*	*Estimated Average Lunch (n=1716)*	*Main Meal Combinations (n=288120)*	*Estimated Average Lunch (n=1685)*	*Main Meal Combinations (n=305698)*
Energy (kcal)		**646** (± 32.3)	**576.0[a]**	**530.1[a]**	**625.1[a]**	**537.6[a]**
Energy (kJ)		**2700** (± 135.0)	**2415.1[a]**	**2230.3[a]**	**2617.0[a]**	**2252.0[a]**
Fat (g)	Max	**25.1**	**19.0[a]**	**16.8[a]**	**22.4[a]**	**20.2[a]**
Saturated Fat (g)	Max	**7.9**	**6.4[a]**	**4.0[a]**	**8.1[a]**	**4.9[a]**
Protein (g)	Min	**13.3**	**20.3[a]**	**22.9[a]**	**19.8[a]**	**20.6[a]**
Carbohydrate (g)	Min	**86.1**	**84.0[a]**	**74.2[a]**	**88.4[a]**	**71.3[a]**
Free Sugars (g)	Max	**8.6**	**24.7[a]**	**16.5[a]**	**26.9[a]**	**9.7[a]**
Fibre (g)	Min	**8.0**	**5.8[a]**	**5.7[a]**	**5.9[a]**	**4.6[a]**
Sodium (mg)	Max	**714**	**555.2[a]**	**643.1[a]**	**688.8[a]**	**675.5[a]**
Calcium (mg)	Min	**350**	**287.8[a]**	**293.7[a]**	**268.5[a]**	**202.8[a]**
Iron (mg)	Min	**5.2**	**2.8[a]**	**2.7[a]**	**2.6[a]**	**2.2[a]**
Zinc (mg)	Min	**3.3**	**2.5[a]**	**2.3[a]**	**2.1[a]**	**1.9[a]**

Magnesium (mg)	Min	**105.0**	**72.8**[a]	**72.1**[a]	**59.9**[a]	**53.3**[a]
Potassium (mg)	Min	**1225**	**699.6**[a]	**525.7**[a]	**605.3**[a]	**443.9**[a]
Iodine (µg)	Min	**49.0**	**30.7**[a]	**15.1**[a]	**25.3**[a]	**13.8**[a]
Vitamin A (µg)	Min	**245**	**157.8**[a]	**93.1**[a]	**220.0**[a]	**71.7**[a]
Vitamin B6 (mg)	Min	**0.5**	**0.3**[a]	**0.4**[a]	**0.4**[a]	**0.3**[a]
Folate (µg)	Min	**70**	**59.9**[a]	**62.5**[a]	**47.8**[a]	**47.1**[a]
Vitamin B12 (µg)	Min	**0.5**	**1.1**[a]	**1.0**[a]	**0.9**[a]	**0.7**[a]
Vitamin C (mg)	Min	**14**	**18.2**[a]	**2.0**[a]	**13.7**[a]	**2.2**[a]
Vitamin D (µg)	Min	**3.5**	**0.7**[a]	**0.2**[a]	**0.7**[a]	**0.2**[a]

Deviation from reference value	< 5% deviation	≥ 5% deviation	≥ 10% deviation	≥ 20% deviation

[a] indicates statistical significance for Wilcoxon one sample signed ranks tests comparing average lunch to NBS and all possible lunch combinations to NBS, significance accepted at $p < 0.01$.
* reference values are from nutrient-based standards (NBS) for school food[4], otherwise derived from respective dietary reference value[9]. Values for free sugars, fibre and vitamin D all revised in light of SACN recommendations[261,262].

4.6 Discussion

This study aimed to collate information on UK secondary school food and describe school food provision. Findings revealed that schools provide a variety of food/drink options each day to students, including meals of the day, pizzas, sandwiches, pastas and various sweet/savoury snacks, drinks and fruit options. Findings also suggest that meals of the day provided the most nutritious options. In particular these meals of the day were the highest among main meal sub-categories for levels of carbohydrates, fibre, iron and vitamins A, B6, C and D in both schools. However, in school 2 particularly, meals of the day were also found to be higher than other main meal sub-categories for levels of energy, fat and saturated fat.

Significant differences were found among main meal and drinks sub-categories for energy and several nutrient values. Pizzas and paninis provided the highest levels of saturated fat (school 1 only) and sodium (both schools) compared to other main meal sub-categories, while FoP nutrient profiling found that almost all of these items were high in saturated fat and salt.

When considering drinks, juice-based drinks contained high amounts of free sugars in school 1 and school 2. Whilst these less preferable categories such as pizzas, paninis and juice-based drinks only make up part of what's provided, staff did emphasise the popularity of these items over more preferable items (e.g. meals of the day, fruit) (see Chapter 3). This echoes findings from previous quantitative[15] and qualitative[20,25,291] research and gives further evidence that students' school food choices bias towards less favourable items.

These findings also highlight the importance of considering the nutritional content of students' school food choices. For example, findings indicate that a student who chooses a juice-based or pure-juice drink as part of their lunch has already exceeded the maximum recommended value for free sugars by virtue of choosing that drink. Previous research reports that beverages may account for over a third of all school food/drink purchases, meanwhile students may consume between 12.9 and 16.7g of free sugars from school beverages alone per day[16]. In a similar vein, selection of a panini or pizza item would, on its own, give school 1 students more than the maximum recommended amounts of saturated fat and sodium for a school lunch. Considering the reported popularity of these items, these findings illustrate how students' food choices, by biasing toward specific items (e.g. juice-based drinks, pizzas, paninis) options, can greatly diminish the effectiveness of school food standards. Policymakers could benefit from an integration of students' food choice behaviours when considering how school food is prepared and provided. Such considerations could include identification and reformulation/replacement of critical food/food categories (e.g. juice-based drinks, pizzas, paninis). Other initiatives could incorporate nudge/choice architecture principles, by providing a wider variety of fruit and vegetable options (e.g. salad counter) and promoting healthy grab-and-go options (e.g. salad bowls, fruit slices, plant-based snacks), which others have also advocated for[29,185].

Indications from the observation periods (discussed in Chapter 3) were that provision in both schools largely complied with FBS. That said, findings from this chapter indicate that the nutritional composition of school food provision falls down with respect to reference values derived from DRVs[9]. All "typical" lunches in both schools failed to meet a number of reference values, with deviation of 20% or more observed for several values. Of the sixteen "typical" lunches across the two schools, seven exceeded the maximum value for saturated fat, nine exceeded the maximum value for sodium, while all sixteen exceeded the maximum value for free sugars. Five lunches met the minimum value for fibre, four met the minimum for calcium, four met the minimum for zinc, while just one met the minimum value for iron.

In both schools, an average lunch based on an example compliant menu cycle was significantly below minimum values for levels of calcium, iron, zinc, magnesium, potassium, iodine, folate or vitamins A and D. An average lunch in both schools also contained roughly triple the maximum value for free sugars. To make matters worse, the average lunch calculation used provision quantities from an example of a compliant menu cycle. An average lunch calculation based on canteen sales data may have proved even less favourable, particularly when previous research points to students' school food selections leaning toward energy dense, micronutrient poor options[15–17]. Thus, similar to previous evaluations of school food[213,228,231,237], findings from the current study indicate that compliance with FBS is unlikely to guarantee school food provision that would comply with the previous NBS.

Previous evidence suggests that even whilst operating under FBS and NBS, schools failed to meet standards for saturated fat, sodium, folate, calcium, iron or zinc[213], illustrating that compliance with NBS has always proved difficult for schools. It is worth reiterating that NBS are no longer in place; however, given their derivation from DRVs[9], the failure of both schools to meet NBS indicates that school food provision is not sufficiently contributing towards students' daily dietary requirements. It is important to acknowledge however, that only 2 schools were included in this study and follow up research with a much larger sample of schools is required to confirm these findings.

Whilst both schools were largely compliant with FBS, findings from the observation periods (Chapter 3) suggest that catering practices were not "standardised", with variation found in the preparation of common items between schools. Findings from the present chapter confirmed this as Mann-Whitney U tests found significant differences in various energy and nutrient values for common categories and sub-categories. Similar findings have been noted in previous research[175] and illustrate how two schools can both comply with FBS, yet provide foods which vary substantially in terms of nutritional content. As outlined in chapter 1, there is very little in the current Ofsted inspection framework regarding compliance with school food standards, or the nutritional quality of school food. The findings outlined in this chapter therefore highlight a need for more stringent monitoring of compliance with school food standards and a clear discussion regarding what "compliance" can and should mean in terms of nutritional composition.

Findings from this study show that school food provision falls down with respect to energy and amounts of numerous micronutrients. This is particularly relevant given that adolescents' dietary intake as reported in NDNS data falls below lower reference nutrient intakes for iron, calcium, zinc, magnesium, potassium, iodine, vitamin A and folate[3]. Moreover, free sugar was consistently high in both schools; an average lunch in both schools was roughly triple the maximum value of 8.6g for a school lunch. This too aligns with NDNS findings which show that despite modest reductions in recent years (16.1% to 14.2% of food energy between 2008/2009 and 2015/2016 in 11–18 year-olds), adolescent intake of free sugars is still just under triple the recommended maximum of 5% of food energy[3]. Whilst it is difficult to make direct comparisons between average school lunch provision and NDNS data (which look at daily dietary intake), findings from this study point to a synchrony between the nutritional content of school lunch provision and trends in adolescents' daily intake as reported in the NDNS. Given the potential schools have to offset unhealthy adolescent diets and instil healthier habits, these findings suggest a missed opportunity by school food policymakers.

4.7 Implications for Policy & Practice

Findings from this study, and others[213,231,232] suggest that adequate nutrient density (particularly iron, calcium and zinc) remains a challenge for school food providers. An inherent barrier to boosting micronutrient density is staying within parameters for energy and maximum nutrient values (i.e. fat, saturated fat, sodium, free sugars). Spence et al.[175] found that after the implementation of school food standards in 2009, school lunches fell below minimum targets for mean energy, iron, calcium and vitamin C. The researchers suggested that decreases in the nutrient density of school foods may be a consequence of decreased energy density that happened with the introduction of the standards and stressed the need for increased nutrient density while maintaining lower energy content.

One suitable first step towards achieving this balance between energy/nutrient density is to first lower the energy density. Evidence suggests that decreasing the energy density of foods can free up individuals to consume sufficient foods/drinks to meet macro/micronutrient requirements without consuming excess calories(50). Relevant methods of lowering the energy density of foods include increasing the use of high water and/or high fibre foods (e.g. soups, legumes, potatoes, rice, fruit and vegetables) and decreasing the use of high-fat foods[318] (e.g. red meat, cheese, mayonnaise, custard) during meal preparation and provision. High-fibre foods could be especially appropriate in the school context, given that fibre was consistently low across average and typical lunches in the present study. Moreover, initiatives promoting water as the drink of choice (e.g. provided free with a main meal) could be worth exploring. Promotion of water within schools is also warranted, given that in the present study water and milk were the only drinks items not profiled as high in total sugar. Whilst the applicability of this within the UK school environment remains untested (e.g. adolescents may not accept these types of foods or promotions), this is a promising route of enquiry and could afford policymakers and caterers some well-needed flexibility to reformulate foods/menus to bolster nutrient density.

Whilst FBS were initially praised for the simplicity and flexibility they allow cooks[228], findings from this and the previous chapter contribute to previous evidence[231] in suggesting that FBS do not guarantee healthy, nutritious school food provision (at least when compared to previous NBS). For example, current school food standards specifically highlight (via supplementary guidance materials)[229] methods for bolstering levels of iron, zinc and calcium in school food and restricting high sugar and energy dense options. However, findings from both this study and others[213,231,232] indicate that these same areas (e.g. free sugar, calcium, iron, zinc content) remain unresolved. As such, FBS may need to be revised to give stricter parameters and/or more detailed instructions regarding ways to increase the amount of these nutrients in school food. In addition, greater supports for catering staff may be needed to help them prepare foods which come closer to reaching more favourable energy/nutrient levels. This is particularly relevant when considering the discretionary food preparation practices exhibited by catering staff during the observation visits (as discussed in chapter 3).

4.8 Findings in the context of the PhD

The literature review in Chapter 1 outlined the potential of schools as health promoting settings, as schools present a perfect opportunity to examine adolescent dietary behaviour and contribute towards insights into adolescent obesity. As chapter 1 outlined, students spend a considerable amount of time in schools; adolescents also consume a substantial proportion of their daily energy from food within the school setting. As such, establishing a healthy school environment could have a positive effect on students' dietary behaviours at school[171,172] and contribute substantially to their overall diet.

Chapter 1 also illustrated how a lack of evaluations and formal monitoring of school food provision since 2015 left ambiguity surrounding the nutritional composition of school food, thus uncovering a gap in current UK school food research. The first study of the thesis addressed this research gap and tackled the first two aims of the thesis: (1) to gain valuable insight into how English secondary school food is prepared and provided; (2) to examine the nutritional composition of school food provision. Study 1 was discussed across two chapters: Chapter 3 and Chapter 4. Findings from this chapter provide quantitative evidence for some of the insights discussed in chapter 3, including the variation in nutritional content between schools for categories such as pizza items and dessert main meal items. This was largely due to different portion sizes and different side items (e.g. school 1 pizzas provided with a side salad, several school 2 dessert items provided with custard), which was noted during the observation visits. Thus, the findings from this chapter support those of chapter 3 in illustrating that despite displaying compliance with FBS, catering practices do not appear to be "standardised".

In return, insights from the observation periods (Chapter 3) help to contextualise some of the findings from the current chapter, for example, the high levels of sugar found in several drinks items and levels of saturated fat and sodium in pizza, panini items. Discussions during the observation periods depicted these and other grab-and-go items as much more popular than meals of the day. The finding that the more popular items also seem to be among the less favourable items in terms of nutritional content highlights a potential issue associated with grab-and-go type provision. The extent of this issue shall be reviewed in the next three chapters, which explore students' school food choices.

This chapter provides a detailed description of secondary school food provision and, along with the next chapter (Chapter 5), serves as a fulcrum for the thesis. The findings discussed in this chapter prelude those from Chapter 5, which discuss the nutritional composition of students' school food choices. Given that students' food choice behaviours are viewed as a key impediment to healthy adolescent diets, and that evidence from Chapter 3 and elsewhere[15,20,25,291] suggests their choices lean towards the less favourable end of what schools provide, one would anticipate that the nutritional composition of students' choices would be even less favourable than that of school food provision.

4.9 Strengths & Limitations

To the authors' knowledge, this is the first study to conduct nutritional composition analysis for a school's food provision over the entire menu cycle. This is also the first study in recent years to examine UK school food provision. The study also considers school food provision in relation to both FBS and NBS, as part of updated reference values. In evaluating categories/sub-categories and exploring all lunch combinations along with an average lunch, this study provides a detailed and nuanced description of school food provision. As such, a final strength of this study is its ability to highlight and discuss some key food categories and specific nutrients of note.

However, the study does have some limitations. The school food provision considered relates to two schools only and may not represent provision in other secondary schools. That said, neither school was atypical; both schools approximated national averages in terms of size and FSM%. Further, school 1 contracted a national catering company, while school 2 had just moved catering in house that year, having previously contracted the same national catering company. Another limitation is that the nutritional composition data is only based on a 3-week period. Whilst the menu cycle is repeated for half the school year, the composition data does not comprehensively reflect provision for the school year. Following on, seasonality of food provision (e.g. more slush, cream-based drinks provided in warmer months, presumably) should also be considered. Moreover, whilst the observant participant approach, along with the reflexive practices helped to mitigate against observer effects[254] during the food preparation and provision, this still poses a limitation of this research.

Another important limitation relates to the methods used for attaining nutritional composition values. Calculation methods of ascertaining nutritional composition values are less accurate than direct analysis in a laboratory setting, due to the use of estimated yield/retention factors, estimated edible proportions, reliance on food composition databases and the heightened chance of researcher error. The EU Commission lists a tolerance of ±20% in nutrient levels for the purposes of nutrition labelling[319], which further illustrates the inherent variability in nutritional composition calculations. That said, the methodology employed in this study endeavoured to be as rigorous and true to life as possible (e.g. gathering brand, back of pack information and weights for each individual ingredient, weighing foods before and after preparation, imposing a limit of 5% difference between nutritional composition data and macronutrient information as seen on the ingredient packaging, comparing nutritional composition data across 3 separate databases, noting any deviations from written recipes during preparation, following published guidance[297,320,321] on use of yield and retention factors for nutrients in composite foods etc.). Nonetheless, the nutritional composition findings in this study should be considered within the context of these limitations.

Finally, the nutritional composition findings focus solely on food provision. This is not necessarily a limitation as the study set out to solely examine provision. However, any inferences made from this chapter should acknowledge first that the nutritional composition results are not a reflection of students' food choices or consumption. For example, students may purchase something at break, and again at lunch, and in doing so supplement their caloric intake for the school day by approximately/an average of 211.3 kcal (school 1) to 282.4 kcal (school 2). Chapter 5 will look to address some of these limitations, by exploring the nutritional composition of students' school food choices.

4.10 Conclusion

The nutritional composition of school food provision falls short of reference values, based on previous NBS and DRVs apportioned for a school lunch; subsequent initiatives could include increasing levels of fibre and important micronutrients (e.g. calcium, iron, zinc, iodine) and reducing levels of free sugar, saturated fat and sodium in certain food/drinks categories (e.g. juice-based drinks, pizza items, panini items). Nutritional composition results indicate that compliance with FBS does not ensure that students receive healthy, nutritious school meals, which comply with reference values (based on previous NBS and DRVs apportioned for a school lunch). It is important that policymakers consider the unique contextual factors (e.g. catering practices, school FSM%) present within school kitchens, along with students' food choice behaviours when looking to enact school food changes.

Chapter 5. Standard Choices? Assessing the Nutritional Composition of Adolescent Food Choice within the School Environment

5.1 Introduction

A running theme in this thesis has been the relevance of adolescents' food choices in relation to school food. Whilst discussions around school food and school food policy often relate to provision, the ultimate ambition with these initiatives is to positively influence adolescent food choice and dietary behaviour. Findings from chapters 3 and 4 illustrated how planned provision under the current school food standards does not guarantee provision of healthy, nutritious food (when compared against previous NBS). This aligns with previous research[213,228,231,237] on school food provision, further evidencing the challenge of working in this area. Furthermore, chapters 3 and 4 made reference to the impact of adolescents' food choice behaviours on school food provision; for example, catering staff reported preparing foods to align with students' preferences, and lamented that students' choices bias towards grab and go and convenience items, including savoury snacks, sweet snacks and drinks (chapter 3). Once again, this aligns with previous quantitative[15] and qualitative[20,25,291] research and further emphasises the importance and relevance of students' food choices. Meanwhile, chapter 4 highlighted how many of these more popular items were amongst the least nutritionally favourable items, illustrating how adolescents' food choices can greatly diminish the effectiveness of the school food standards.

Following on from chapters 3 and 4, the present chapter focuses specifically on school food choices, and the nutritional composition thereof. Catering data was downloaded from both schools, which enabled the research team to explore adolescents' school food choices. Catering data could also be combined with nutritional composition data, enabling the research team to describe the nutritional composition of adolescents' choices. This chapter describes this work, i.e. linking cashless catering data to nutritional composition data, exploring adolescents' school food choices, and evaluating the nutritional composition of these choices. Similar to the previous chapter, findings are discussed in relation to both food-based standards (FBS)[5] and reference values (based on previous NBS[4] and DRVs[9] apportioned for a school lunch), whilst implications are considered for policy and practice, current research and the PhD thesis.

5.2 Aims

The aims of the study described in this chapter were (1) to examine the school food choices of English secondary students using automatically collected data and (2) evaluate the nutritional composition thereof.

5.3 Methods

5.3.1 Study Design

The study had a cross-sectional design and entailed the linking of cashless catering data with nutritional composition data for the same 3-week period (corresponding with the 3-week menu cycle). This would be completed for both schools to provide a definitive account of students' school food choices in both schools. By linking canteen purchasing data to nutritional composition data, the adolescents' school food choice behaviours could be explored and the nutritional composition evaluated. Building on insights from chapters 3 and 4, the researchers were particularly interested in what the most popular school food/drink items were, the nutritional composition of an average lunch when based on choice rather than provision, and how adolescents' choices across the school day correspond to energy and nutritional values. Figure 5.1 provides an outline of the study methodology.

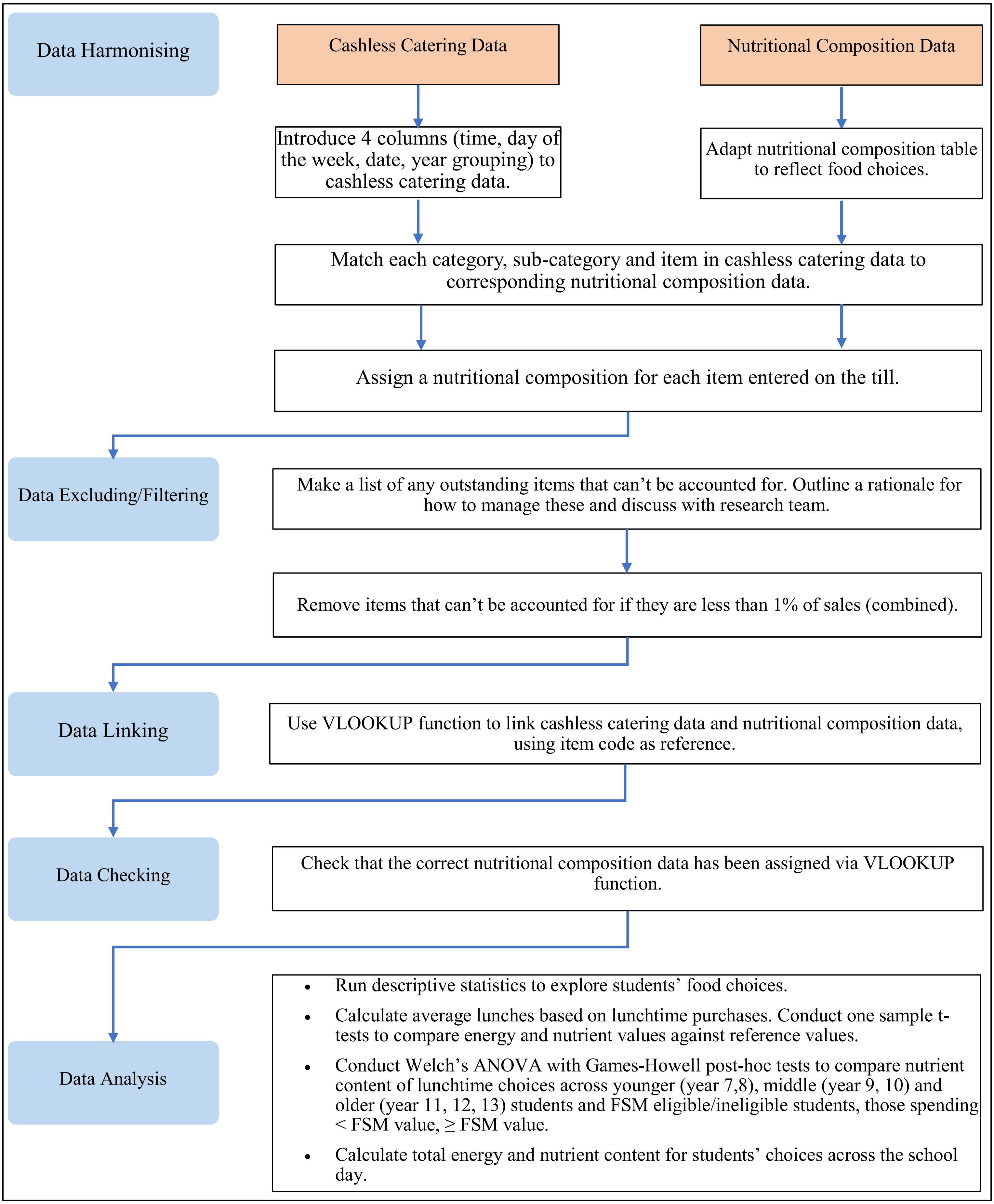

Figure 5.1. Flowchart of study methodology

5.3.2 Acquiring the Data

Data was downloaded from both schools for the period corresponding to the menu cycle and the three weeks preceding the observation visits. This time period was chosen in order to remove the impact of any potential observer effects[254] present during the observation periods. Data was downloaded through liaison with the school catering managers, along with the data management companies responsible for managing the catering system. The datasets included the food item codes, item descriptions, transaction numbers, prices, time and date of each transaction, and unique numerical identifiers for each student, along with their gender and year group. The researcher also requested that students' names or any other identifiable aspects be removed from the dataset, in order to preserve students' anonymity. The researcher was able to confirm consent from the school catering team to access the data and communicate this consent to the catering system administrators. The researcher instructed the system administrators on how the data should be formatted, the required time period (3 weeks directly preceding the observation periods), and which specific elements of data were needed (e.g. transaction number, time and date, price etc.). Once the school catering manager, school staff and catering system administrators were in accordance, the data was downloaded in cvs format and imported into Microsoft Excel spreadsheet. When downloaded, the catering data was presented such that each row was an individual item sold.

5.3.3 Data Harmonisation

Once the data had been collected, the next stage involved harmonising the cashless catering data and the nutritional composition data (i.e. establishing common variables across the two datasets, having common food descriptions and item codes across the two datasets, ensuring that for each entry on the catering data there was only 1 nutritional composition). This was done in order to facilitate clear and straightforward linkages at the data linking stage.

For the vast majority of food items, the way they were provided was the same as how they were chosen (e.g. ham baguette was the same when chosen as when it was provided). The need for distinction between choice and provision only became apparent when considering categories such as meals of the day and dessert main meal items. For example, multiple vegetable side options (e.g. sweetcorn, carrots, parsnips, red cabbage, mashed potato, roast potato, broccoli) were provided with roast gammon/lamb/pork/chicken. Students could choose all, some or none of the side options; therefore, it was important to incorporate this within the nutritional composition table. This resulted in two slightly different composition tables; one reflecting solely provision (where all food items and their possible sides were listed) and one reflecting students' food choice behaviours as observed during the observation visits. For these items which could differ based on students' choices (e.g. roast gammon/lamb/pork/chicken), the researcher took manual tallies as students were selecting their meals. Using these manual tallies, the researcher then calculated nutritional compositions for these items as weighted averages. These weighted averages took into account what students typically chose as their sides, to generate an aggregate nutritional composition for these items (school 1: 2 items, school 2: 30 items).

Next, the researcher introduced some new variables to the cashless catering datasets. The time and date variable was split up into two separate time and date variables. A day of the week variable was introduced; this enabled the researcher to assign specific main meals, depending on the day of the week (e.g. battered fish served every Friday, Chicken Korma only provided on Monday Week 1 in school 1). The item codes from the nutritional composition tables were also added to the cashless catering datasets. This established a common variable across the two datasets, which could then be used as the linking variable between the two datasets. A breakfast/break/lunch variable was added, to show the service in which the item was purchased. This was decided by consulting the timestamp for each item purchased. A break/lunch pair was also added, to indicate instances where a student purchased something at break and then again at lunch the same day.

Using a Microsoft Excel spreadsheet, the researcher went through each food item (for the three weeks) in the cashless catering data (n= 9078 foods, 3525 drinks in school 1; n= 15877 foods, 5851 drinks in school 2), identified its corresponding item (or items) in the nutritional composition table, and assigned the item code from the nutritional composition data to the item in the cashless catering data. Most items were a straightforward assignment, i.e. one nutritional composition directly corresponding to one item (e.g. waffle, pancake, ham baguette). However, some items were described on the till under an umbrella term (e.g. radnors, juice bursts); for these such items, the researcher used manual tallies to calculate an aggregate nutritional composition to assign (e.g. an aggregate radnor composition was developed, by calculating a weighted average based on manual tallies, and assigned to all radnors entered on the till). Meals of the day and dessert items were also described quite generally in the catering data, e.g. meals of the day appeared on the catering data as main meal meat/vegetarian. For these items the researcher used the date and day of the week variables and consulted the corresponding entry on the menu cycle to ascertain which specific meal of the day or dessert main meal item to assign. In summary, for each item, the rationale for the calculation of nutritional composition data was either:

1. A straight-forward assignment where both datasets listed the food item (e.g. ham baguette composition assigned to ham baguette).
2. Assignment by reference to menu cycle, which involved consulting time and date information (e.g. main meals).
3. Assignment based on developing an aggregate composition (e.g. viva flavoured milks) (school 1: 38 items, school 2: 68 items).

5.3.4 Data Filtering

The next stage involved filtering the data, i.e. going through the data and removing any items which were not appropriate (e.g. anomalies, unknown items, extreme cases etc.). While developing rationales for assigning nutritional composition data to all items sold, data were cleaned; this involved screening for any outstanding items/anomalies/inconsistencies. The decision was made to remove these items if they were less than 1% of sales (combined). These included items in the catering data having an unclear description, items being present on till data that were not present during the observation visits (e.g. "Love Joes wraps" were sold during the three weeks considered but these were not sold during the three weeks of observations, as the Love Joes counter was closed to accommodate students taking exams nearby) and items being sold on non-school days, due to the school hosting study sessions on weekends. Weekend sales (schools were hosting weekend study days at the time, before the examination periods) were removed, as these are not indicative of normal provision. Finally, a small number of extreme cases (e.g. one student purchasing 5 or more capri suns (a juice-based drink provided in both schools) were removed from the dataset. Less than 1% of cases were filtered out in either school.

5.3.5 Data Linking

At this point, the researcher had two clean datasets: the cashless catering data, and the nutritional composition table for school food as chosen. The next step was to link the two datasets to form one definitive dataset that encompassed adolescents' school food choices, documented on the cashless catering data, and the nutritional composition thereof. In excel, the VLOOKUP function was used to assign nutritional composition data to each entry on the cashless catering data, using the item code variable as a reference. The finalised dataset therefore comprised all items chosen by students during the three-week period, alongside the nutritional composition for each of the items.

5.3.6 Data Checking

Once the two datasets had been harmonised and linked, the researcher conducted a number of checks; these included, for example, checking that the time and date for main meals were consistent across the two datasets (i.e. so that the correct meal of the day had been assigned), that aggregate nutritional composition calculations were done correctly (i.e. that weights for weighted averages were correct and that all appropriate items were included in the calculation), that the nutritional composition data reflected foods as chosen and that the VLOOKUP function selected the appropriate data from the nutritional composition data, using the item codes as a reference. Ten percent of catering data entries were randomly selected (this amounted to 1260 entries in school 1 and 2173 entries in school 2) and traced back to the nutritional composition tables, to ensure that the data was correct. The researcher also computed frequencies for each category, sub-category (categories and sub-categories were carried forward from chapter 3, (see table 3.1) and ten percent of individual items in excel and then in SPSS, to ensure correct data handling and data importation to SPSS (i.e. check that the same frequencies were present in excel and SPSS for selected items, categories and sub-categories).

Reflexivity was practised throughout the process of linking the cashless catering and nutritional composition datasets. For example, the research team met regularly to discuss the weights used to calculate the aggregate nutritional compositions for certain items, and the rationales for assigning compositions to items described broadly on the catering data (e.g. dessert main meal items). In this way, all members of the research team were in accordance with how nutritional composition data would be assigned. The team also met during all stages of the harmonisation process, to ensure that the variable additions were logical and that item codes were assigned correctly. The team also discussed all steps of data filtering, making sure that there was sound rationale for omitting entries from the cashless catering data (e.g. items entered on the weekend for study sessions were removed; instances where more than 3 of the same item were purchased were removed). The researcher tabulated a checklist and also included a time and date for completion of first and second checks. The research team met frequently during this time, to discuss data linking steps and to further promote methodological rigour and transparency. The other two members of the research team also conducted independent data checks.

5.3.7 Data Analysis

When first collected, the cashless catering data was formatted so that each case (i.e. each row) was an item. Whilst this was beneficial for assigning nutritional composition data (i.e. one nutritional composition for one item), items were often purchased as part of a transaction. In order to facilitate more detailed analysis, it was important to restructure the data so as to have two working datasets; one dataset holding the nutritional composition for all items purchased, and a second dataset holding nutritional composition data for all transactions.

To facilitate this, data were imported from excel into SPSS, where long to wide, or cases to variables restructuring was conducted, using the transaction ID as an identifier variable. This organised each transaction into a single row (or case), with nutritional composition data provided for each item included in the transaction (e.g. if a transaction consisted of two items, there were two values present in the row for each energy and nutrient value considered, e.g. fat.1, fat.2 corresponding to the fat values for item 1 and item 2 respectively). In instances where a transaction consisted of multiple items, values were summed to attain energy and nutrient values for each transaction (i.e. fat.1 and fat.2 summed to ascertain total fat value for the transaction). Finally, the transactions were summed so that each student had a maximum of one entry per service, e.g. if a student made a transaction at 11:00 and another transaction at 11:02 during the breaktime service, these were added together so that the student could only have one “transaction event” during the service. This enabled an accurate assessment of what each student was purchasing within each service time.

Organising the data in this manner meant that analysis could be conducted at (1) the item level and (2) the transaction level. Descriptive statistics were conducted first to explore how item sales were distributed among different year groups, genders, days of the week and (sub)categories. Frequencies were conducted to identify the most popular items, by number of sales, in each school.

Two average lunches were evaluated, based on adolescents' food choices. The first "average lunch" was simply an average of all lunchtime transactions. Lunchtime transactions were isolated, an average taken for all lunchtime transactions over the three-week menu cycle, and the energy and nutrients within these items were then compared against reference values, which were based on previous NBS, along with 6 additional nutrient values. The second 'average lunch' considered was an average of all lunchtime transactions which included a main meal item. Main meals include sandwiches, meals of the day, pasta dishes etc. and represent the more "substantial" items available at lunchtime. Therefore, the researchers sought to explore how transactions including main meal items translated to energy and nutrient content. One sample t-tests were conducted, to evaluate each of the average lunches against the reference values.

The data was not normally distributed, however this was ignored due to the very large number of cases[315], along with the underlying nature of the data, i.e. cashless catering data is representative, real-life data as it encompasses the majority of the student population and includes choices over prolonged periods. This is in contrast to the analysis conducted on the food provision data (Chapter 4), whereby the data was not normally distributed and non-parametric tests were chosen. In the case of chapter 4, the decision to use non-parametric tests was taken by the research team after considering the nature of the data, e.g. main meal combinations represent permutations of possible main meal combinations, as such the data was hypothetical in nature. The research team also felt that comparing medians was more appropriate than comparing means when evaluating the nutritional composition of the food/drink (sub)categories. This was after considering that there would likely be wide variation both across and within (sub)categories in the types of foods/drinks in question, the numbers of food/drink items in each (sub)category and also in terms of the energy and nutrient content of different items. Finally, the small number of items in some (sub)categories (e.g. sweet snacks, drinks, paninis) meant that medians were more appropriate, as median calculations are less susceptible to influence from extreme values compared to means.

Welch's analysis of variance (ANOVA) was conducted to compare the energy and nutrient values of students' choices across gender, age and FSM sub-groups. Welch's ANOVA was chosen as the data failed to meet the assumption of homogeneity of variances and Welch's ANOVA is robust against this violation of the equality of variance assumption and unequal group size[322]. The data was also not normally distributed, however this was ignored due to the very large number of cases[315], along with the rationale that ANOVA is quite robust against non-normal distributions[323]. For the purposes of the ANOVA, age was divided into three groupings: younger (years 7-8), middle (years 9-10) and older (years 11-14) students. For FSM, students were divided into two groups: FSM eligible students and FSM ineligible students. A separate ANOVA was conducted to compare differences between those students spending below the FSM value of £2.34 and those students spending equal to or greater than the FSM value. Given that the data failed to meet the assumption of homogeneity of variances, pairwise comparisons were conducted using Games-Howell post hoc tests rather than more conventional post-hoc tests (e.g. Tukey's post hoc tests).

The final section of the analysis examined choices beyond lunchtime. Students' choices across the school day were summed and average energy and nutrient content of students' school day choices were compared to dietary reference values (DRVs)[9]. All statistical tests were conducted in SPSS. Statistical significance was accepted at $P < 0.05$.

5.4 Results

5.4.1 Breakdown of students using the canteen

Table 5.1 provides a summary of the students who used the canteen (i.e. made at least one purchase) during the three weeks considered. Almost two-thirds (65.1%) of students in school 1 purchased something in the canteen during the three weeks, while over three quarters (80.0%) of school 2 students purchased something at school. Of the students who used the canteen, the majority were female (S1: 50.7%; S2: 54.4%). Of those who purchased something during the three weeks, under a fifth (15.6%) in school 1 were eligible for free school meals (FSM%), meanwhile over a quarter (27.1%) in school 2 were eligible.

Table 5.1. Breakdown of students using the canteen

	School 1		School 2	
	N	**%**	**N**	**%**
Students on roll	1146		962	
Students using canteen	746	(65.1%)	770	(80.0%)
Sex				
Male	368	(49.3%)	351	(45.6%)
Female	378	(50.7%)	419	(54.4%)
FSM Eligibility of School		9.5%		20.1%
FSM students using the canteen	116	(15.6%)	209	(27.1%)
Non-FSM students using the canteen	630	(84.4%)	561	(72.9%)
Year Group				
Year 7	190	(25.5%)	189	(24.5%)
Year 8	165	(22.1%)	176	(22.9%)
Year 9	152	(20.4%)	133	(17.3%)
Year 10	121	(16.2%)	144	(18.7%)
Year 11	101	(13.5%)	106	(13.8%)
Year 12	12	(1.6%)	10	(1.3%)
Year 13	5	(0.7%)	11	(1.4%)

5.4.2 Breakdown of Item Sales

Table 5.2 provides a breakdown of item sales in each school. In school 1, 12605 items were sold during the three weeks, 21728 items were sold in school 2, despite it being a smaller school. A substantially higher percentage of school 2 students used the canteen compared to school 1. In both schools, just over half of the items were sold at lunch (school 1: 54.4%, school 2: 52.1%), while a large percentage were sold at break (school 1: 42.8%, school 2: 38.9%). This is despite break being a shorter service period (20 minutes) compared to lunch (30 minutes). In school 1, the majority of items were purchased by male students (54.2%) compared to female students (45.8%), whilst in school 2, a greater proportion of items were purchased by female students (53.8%) compared to male students (46.2%). More items were purchased by younger students, with year 7 and year 8 students accounting for over half of all items purchased in both schools (school 1: 56.4%, school 2: 53.7%).

Table 5.2. Breakdown of Item Sales in School 1 and School 2

	School 1		**School 2**	
	N	**%**	**N**	**%**
No. of items sold across the three weeks	12603		21728	
Day of the week				
Monday	2024	(16.1%)	4350	(20.0%)
Tuesday	3016	(23.9%)	4436	(20.4%)
Wednesdays	3434	(27.2%)	4351	(20.0%)
Thursdays	2620	(20.8%)	4378	(20.2%)
Fridays	1509	(12.0%)	4213	(19.4%)
Time of day				
Breakfast	356	(2.8%)	1961	(9.0%)
Break	5394	(42.8%)	8441	(38.9%)
Lunch	6853	(54.4%)	11326	(52.1%)
Gender				
Male	6825	(54.2%)	10037	(46.2%)
Female	5778	(45.8%)	11691	(53.8%)
Year Group				
Year 7	3888	(30.9%)	6842	(31.6%)
Year 8	3218	(25.5%)	4811	(22.1%)
Year 9	2703	(21.5%)	3504	(16.1%)
Year 10	1476	(11.7%)	4653	(21.4%)
Year 11	1228	(9.7%)	1691	(7.8%)
Year 12	69	(0.5%)	134	(0.6%)
Year 13	21	(0.2%)	92	(0.4%)

Table 5.3 lists the twenty most popular items sold in each school across the three-week menu cycle. In both schools, the most popular items were almost all snacks or drinks, with sweet snacks, savoury snacks and drinks accounting for the 10 most popular items in both schools. Sweet and savoury snacks accounted for 9 of the 20 most popular items in school 1 and 10 in school 2. Drinks, meanwhile, accounted for 5 of the top 20 items in school 1 and school 2. Main meals accounted for 4 of the top 20 items in school 1 and 5 of the top 20 items in school 2.

Table 5.3. List of the 20 most popular items in each school (by number of times selected across three-week menu cycle).

	School 1				School 2			
	Description	**N**	**Category**	**% of all items sold**	**Description**	**N**	**Category**	**% of all items sold**
1	Traybakes	1446	Sweet Snacks	11.5	Traybakes	2050	Sweet Snacks	9.4
2	Waffle	1432	Savoury Snacks	11.4	Cookies	1904	Sweet Snacks	8.8
3	Water	971	Drinks	7.7	Flavoured Water	1785	Drinks	8.2
4	Juice Burst	912	Drinks	7.2	Water (still)	1234	Drinks	5.7
5	Bacon Sandwich	836	Savoury Snacks	6.6	Juice Burst	1192	Drinks	5.5
6	Radnor	742	Drinks	5.9	Toast	1047	Savoury Snacks	4.8
7	Cookie	603	Sweet Snacks	4.8	Bagel	962	Savoury Snacks	4.4
8	Viva Flavoured Milk	493	Drinks	3.9	Waffles	937	Savoury Snacks	4.3
9	Bagel	492	Savoury Snacks	3.9	Bacon Sandwich	909	Savoury Snacks	4.2
10	Garlic cheese bagel	423	Savoury Snacks	3.4	Capri Sun Orange	907	Drinks	4.2
11	Raspberry Slush	342	Drinks	2.7	Donut	837	Sweet Snacks	3.9
12	Margherita Pizza with Salad	339	Main Meals	2.7	Sandwich £1.70	568	Main Meals	2.6
13	Meat Pizza with Salad	334	Savoury Snacks	2.6	Margherita Pizza (trad)	562	Main Meals	2.6
14	Pancake	330	Savoury Snacks	2.6	Baguette	500	Main Meals	2.3
15	Cheese Toast	256	Savoury Snacks	2.0	Tea Cake	415	Savoury Snacks	1.9
16	Pasta & cheese	219	Main Meals	1.7	Slurp	413	Drinks	1.9
17	Toast	193	Savoury Snacks	1.5	Meat Pizza Slice	406	Main Meals	1.9
18	Love Joes Wrap	177	Main Meals	1.4	Cheese Toast	333	Savoury Snacks	1.5
19	Fruit Pot	169	Fruit	1.3	Cold Pasta Pot	332	Main Meals	1.5
20	Beef Burger & Chips	159	Main Meals	1.3	Nachos	323	Savoury Snacks	1.5

Figure 5.2 illustrates the percentage of items from each category sold across the three-week period. Main meals (e.g. meals of the day, pizzas, pastas, sandwiches) accounted for 20.4% of sales in school 1 and 21.0% of sales in school 2. Savoury snacks (e.g. waffles, bacon sandwiches, bagels) accounted for the largest percentage of sales in school 1 (32.9%) and school 2 (26.1%). Meanwhile, sweet snacks (e.g. cookies, traybakes, donuts) and savoury snacks together accounted for approximately half (school 1: 50.2%, school 2: 49.9%) of all items purchased in both schools. Figure 5.3 illustrates the percentage of main meal items sold across the three weeks. Meals of the day, the most nutritionally favourable items, and the cornerstone of the school food standards, accounted for 16.9% of main meal items sold in school 1, and 21.9% of main meal items sold in school 2. This corresponds to 3.4% of all item sales in school 1 and 4.6% of all item sales in school 2. Pizzas (26.2%) were the most popular main meal sub-category in school 1, while sandwiches (37.1%) were the most popular main meal sub-category in school 2.

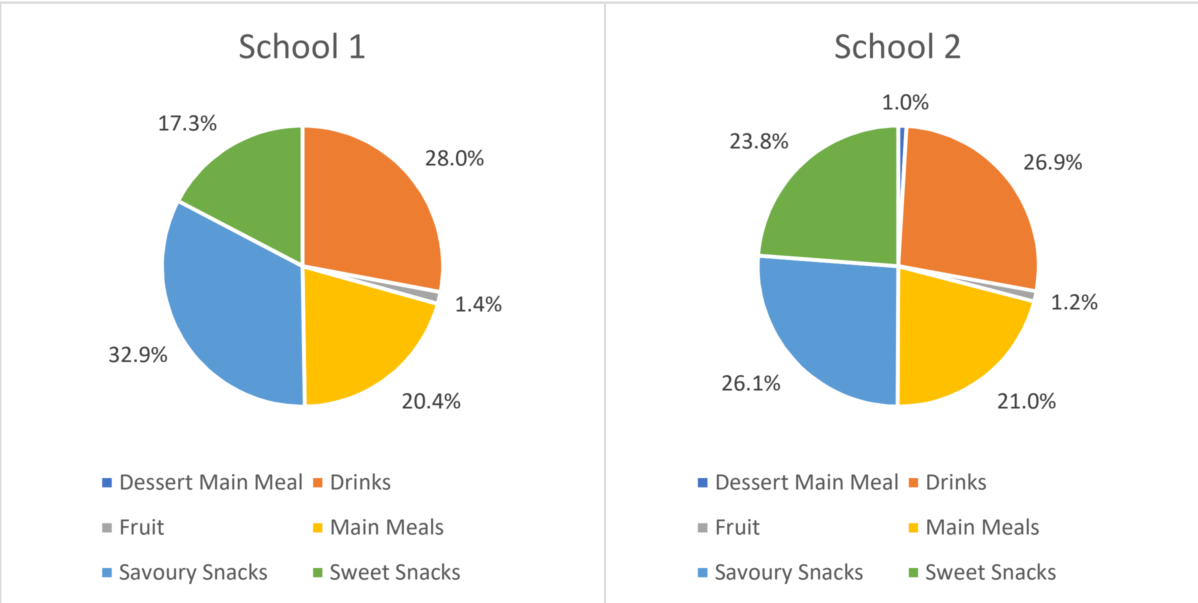

Figure 5.2. Percentages of item sales across main categories in school 1 and school 2.

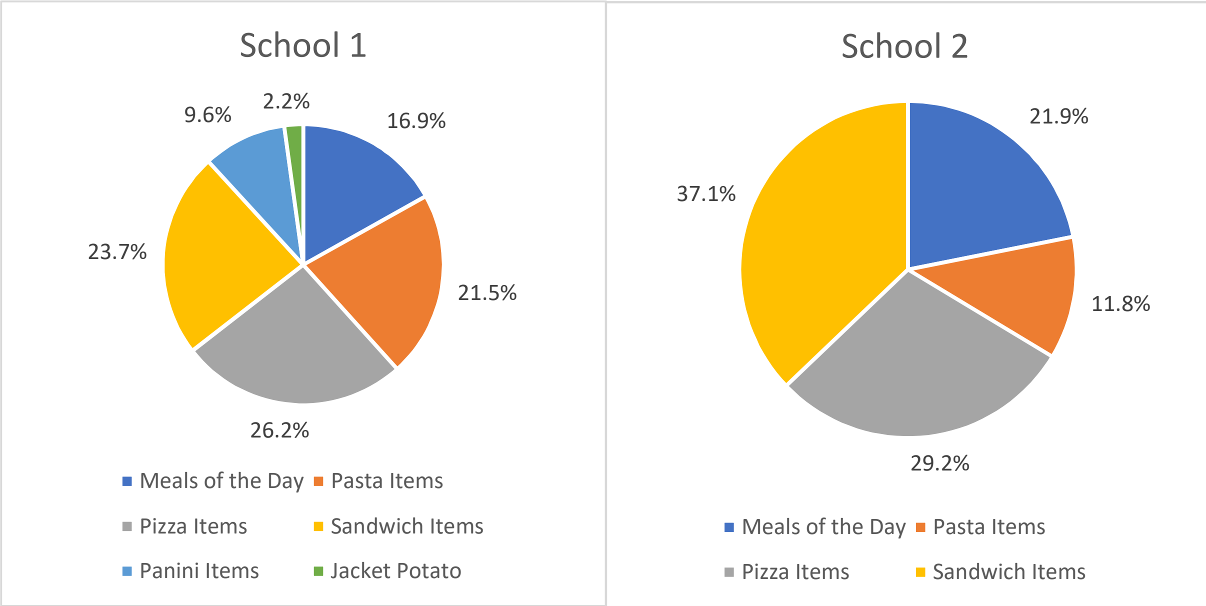

Figure 5.3. Percentages of item sales across main meal subcategories in school 1 and school 2.

5.4.3 Breakdown of Transactions

Table 5.4 provides a breakdown of transactions made in each school. A total of 8,124 transactions took place in school 1 over the three weeks, while 12,513 transactions took place in school 2. The majority of transactions took place during lunch (school 1: 51.1%, school 2: 49.5%), while the average spend per student was higher at lunchtime (school 1: £1.95, school 2: £1.81) than at break (school 1: £1.29, school 2: £1.48). However, interestingly, break was only slightly lower than lunch for both the number of transactions and the average spend per student. In both schools, large percentages of lunchtime transactions were preceded by a breaktime transaction that same day (school 1: 51.0%, school 2: 56.1%).

Table 5.4. Breakdown of transactions and expenditures per transaction for three-week period

	School 1	School 2
No. of transactions	8122	12513
Transactions by service time		
% of transactions - breakfast	3.4%	11.3%
% of transactions - break	45.5%	39.2%
% of transactions - lunch	51.1%	49.5%
% of lunchtime transactions preceded by a breaktime transaction	51.0%	56.1%
Transactions by student		
male students	52.7%	44.8%
female students	47.3%	55.2%
FSM eligible	17.7%	29.1%
non-FSM eligible	82.3%	70.9%
Breakfast		
Average spend per transaction:	£1.06	£0.58
FSM eligible	£1.06	£0.42
non-FSM eligible	£1.06	£0.61
Male students	£1.04	£0.67
Female students	£1.09	£0.50
Break		
Average spend per transaction:	£1.29	£1.48
FSM eligible	£1.38	£1.71
non-FSM eligible	£1.26	£1.37
Male students	£1.34	£1.63
Female students	£1.23	£1.34
Lunch		
Average spend per transaction	£1.95	£1.81
Male students	£2.01	£1.87
Female students	£1.89	£1.77
FSM eligible	£1.89	£1.86
Non-FSM eligible	£1.97	£1.79

5.4.4 Average Lunches as Chosen

Table 5.5 provides the energy and nutrient values for an average lunch (as chosen) in school 1 and school 2. Average lunch 1 was based on all lunchtime transactions across the three-week menu cycle which included a main meal item. Average lunches which included a main meal were found to be higher in energy and nutrient content than average lunches based on all transactions. That said, they were still low in iron, calcium, iodine, magnesium, potassium and vitamins A and D, while also being high in free sugars and sodium. Average lunch 2 was based on all lunchtime transactions across the three-week menu cycle. In both schools, these were found to be high in free sugars and relatively low for energy and several important macro/micro nutrients, including fibre, iodine, iron, calcium, zinc and vitamins A, C and D.

Findings suggest that a school 1 average lunch, based on 4156 transactions, failed to meet 16/20 reference values. A school 1 average lunch based on lunches which included a main meal (n=2314), failed to meet 14/20 reference values. A school 2 average lunch, based on 6193 transactions, failed to meet 16/20 reference values, while an average lunch based on lunches which included a main meal (n=3530), failed to meet 17/20 values. One sample t-tests found that average lunches (based on all transactions or transactions including a main meal) in both schools deviated significantly (P < 0.05) from reference values for energy and all nutrient values (except vitamin C in school 1). However, in cases where the reference values were met, this was not an issue. Average lunches in both schools failed to meet the maximum reference values for free sugars, along with minimum values for carbohydrates, calcium, iron, magnesium, potassium, iodine and vitamins A and D (all significant at P < 0.05).

Table 5.5. Energy and nutrient content of 'average lunches' in schools and **c**omparisons for average lunches, based on total lunchtime transactions and lunchtime transactions which include a main meal, to reference values (values highlighted in cases where value is not met).

	*Reference Values**		*School 1*		*School 2*	
	Max/Min	***Value***	***Average Lunch 1 (transactions including a main meal) (n=2314)***	***Average Lunch 2 (all lunchtime transactions) (n=4156)***	***Average Lunch 1 (transactions including a main meal) (n=3530)***	***Average Lunch 2 (all lunchtime transactions) (n=6193)***
Energy (kcal)		**646** (±32.3)	614.9[a] (±244.9)	453.2[a] (±275.7)	713.9[a] (±267.6)	565.7[a] (±304.2)
Energy (kJ)		**2700**	2579.0[a] (±1019.7)	1894.0[a] (±1154.5)	2978.9[a] (±1111.7)	2346.6[a] (±1268.4)
Fat (g)	Max	**25.1**	23.3[a] (±12.8)	17.2[a] (±12.6)	27.6[a] (±12.7)	22.4[a] (±13.4)
Saturated Fat (g)	Max	**7.9**	8.6[a] (±4.7)	5.8[a] (±4.8)	9.6[a] (±5.1)	8.1[a] (±5.1)
Protein (g)	Min	**13.3**	26.5[a] (±11.2)	16.3[a] (±14.3)	24.4[a] (±7.9)	16.2[a] (±11.6)
Carbohydrate (g)	Min	**86.1**	78.5[a] (±28.3)	60.3[a] (±32.5)	95.5[a] (±37.4)	76.5[a] (±41.0)

Free Sugars (g)[a]	Max	**8.6**	13.2[α] (±13.2)	16.9[α] (±13.7)	21.4[α] (±18.1)	23.0[α] (±17.7)
Fibre (g)[b]	Min	**8.0**	6.5[α] (±3.0)	4.2[α] (±3.5)	6.3[α] (±2.5)	4.5[α] (±3.1)
Sodium (mg)	Max	**714**	761.7[α] (±347.9)	497.0[α] (±401.5)	878.4[α] (±360.5)	622.6[α] (±431.4)
Calcium (mg)	Min	**350**	306.5[α] (±160.4)	194.1[α] (±179.8)	279.5[α] (±126.9)	200.2[α] (±153.1)
Iron (mg)	Min	**5.2**	3.3[α] (±1.5)	2.2[α] (±1.7)	3.4[α] (±1.5)	2.4[α] (±1.7)
Zinc (mg)	Min	**3.3**	3.6[α] (±2.4)	2.2[α] (±2.4)	2.6[α] (±1.1)	1.8[α] (±1.4)
Magnesium (mg)	Min	**105.0**	77.9[α] (±36.2)	51.5[α] (±41.0)	69.0[α] (±26.5)	50.9[α] (±32.5)
Potassium (mg)	Min	**1225.0**	652.5[α] (±431.4)	432.6[α] (±413.1)	673.0[α] (±421.8)	448.8[α] (±416.8)
Iodine (µg)	Min	**49.0**	17.0[α] (±14.9)	12.3[α] (±17.4)	18.8[α] (±19.2)	12.3[α] (±18.3)
Vitamin A (µg)	Min	**245**	143.0[α] (±109.9)	87.5[α] (±103.7)	201.3[α] (±198.7)	139.7[α] (±170.1)
Vitamin B6 (mg)	Min	**0.5**	0.4[α] (±0.2)	0.2[α] (±0.2)	0.4[α] (±0.3)	0.3[α] (±0.3)
Folate (µg)	Min	**70**	62.4[α] (±29.7)	38.2[α] (±35.3)	49.1[α] (±29.9)	32.1[α] (±30.4)
Vitamin B12 (µg)	Min	**0.5**	1.3[α] (±1.1)	0.8[α] (±1.0)	0.9[α] (±0.7)	0.6[α] (±0.7)
Vitamin C (mg)	Min	**14**	14.5 (±13.3)	8.4[α] (±12.3)	9.0[α] (±15.9)	5.5[α] (±12.9)
Vitamin D (µg)[c]	Min	**3.5**	0.6[α] (±0.8)	0.5[α] (±0.7)	0.7[α] (±0.7)	0.6[α] (±0.7)

[α] Indicates statistical significance for one sample t-tests, comparing average lunch to reference values, significance accepted at P < 0.05
* reference values are from nutrient-based standards (NBS) for school food[4], otherwise derived from respective dietary reference value[9]. Values for free sugars, fibre and vitamin D all revised in light of SACN recommendations[261,262].

5.4.5 Group Differences in Lunchtime Choices

Table 5.6 outlines the mean energy and nutrient intakes from school lunches as chosen (i.e. all lunchtime transactions) across gender (male, female) and student year groupings (year 7-8, year 9-10, year 11-14). Welch's ANOVA found significant mean differences between lunches chosen by male and female students in school 1 for all energy and nutrient values, except free sugars. Lunches chosen by male students were significantly (P < 0.05) higher than lunches chosen by female students for levels of energy, fat, saturated fat and sodium but also in fibre, protein, calcium, iron and zinc. In school 2, fewer significant differences were found between male and female students' choices; that said, lunches chosen by male students were still significantly ($P < 0.05$) higher than those chosen by female students in levels of energy, carbohydrates, protein, free sugars, sodium, iron and vitamins C and D.

Welch's ANOVA indicated significant mean differences between year groupings in school 1 for levels of energy, saturated fat, carbohydrates, free sugars, calcium, magnesium, iodine, folate and vitamins A and D. Games Howell post-hoc tests indicated significant ($P < 0.05$) differences between lunches chosen by younger (year 7-8) and older (year 11-14) students for several values (e.g. energy, saturated fat, carbohydrates, free sugars). In school 2, Welch's ANOVA found significant differences ($P < 0.05$) between year groupings for all energy and nutrient values, except saturated fat. Games Howell post-hoc tests indicated significant ($P < 0.05$) differences in lunches chosen by younger (year 7-8) and middle (year 9-10) students for all energy and nutrient values considered. Findings indicated that in general, younger students (year 7-8) chose lunches which were more energy and nutrient dense than middle (year 9-10) or older (year 11-14) students.

Whilst significant differences were found in both schools across year groupings and gender, the findings also found some broader commonalities in choices across sub-groups. All age and gender sub-groups chose lunches which had adequate levels of protein, fat, sodium and vitamins B6, B12. However, all age and gender sub-groups also chose lunches which were low in energy, high in free sugars and low in levels of carbohydrates, fibre, calcium, iron and zinc and iodine. It is worth noting that reference values, which are derived from DRVs[9], would differ for solely male or female students, as they would for different age groups, thus, direct comparison to reference values was not appropriate for these groups.

Table 5.6. Mean energy and nutrient content of school lunchtime transactions, across gender and student year groupings.

	School 1					*School 2*				
	Gender		***Year Grouping***			***Gender***		***Year Grouping***		
	Male ***(n=2141)***	***Female*** ***(n=2015)***	***Yr 7-8*** ***(n=2242)***	***Yr 9-10*** ***(n=1494)***	***Yr 11-13*** ***(n=420)***	***Male*** ***(n=2642)***	***Female*** ***(n=3551)***	***Yr 7-8*** ***(n=3297)***	***Yr 9-10*** ***(n=2305)***	***Yr 11-13*** ***(n=591)***
Energy$^{\alpha\beta}$ (kcal)	468.5 (±280.5)	437.0* (±269.7)	463.5‡ (±283.6)	444.8 (±271.2)	428.4‡ (±245.4)	578.3 (±320.5)	556.2* (±291.0)	582.5‡ (±315.0)	542.0‡ (±284.7)	564.1 (±309.4)
Energy$^{\alpha\beta}$ (kJ)	1959.0 (±1174.7)	1824.8* (±1128.8)	1937.5‡ (±1187.6)	1857.3 (±1135.0)	1792.1‡ (±1028.7)	2403.1 (±1335.9)	2304.7* (±1214.2)	2418.5‡ (±1314.7)	2244.5‡ (±1184.6)	2344.3 (±1295.2)
Fat$^{\beta}$ (g)	17.8 (±13.0)	16.6* (±12.2)	17.2 (±12.9)	17.5 (±12.6)	16.2 (±11.4)	22.5 (±14.0)	22.3 (±12.9)	23.0‡ (±14.0)	21.4‡ (±12.4)	22.4 (±13.5)
Saturated Fat$^{\alpha\beta}$ (g)	6.2 (±4.9)	5.4* (±4.7)	5.9‡ (±4.9)	5.8 (±4.7)	5.2‡ (±4.3)	8.1 (±5.3)	8.2 (±5.0)	8.3‡ (±5.4)	7.9‡ (±4.7)	8.2 (±5.2)
Protein$^{\beta}$ (g)	17.4 (±14.7)	15.0* (±13.8)	16.5 (±14.7)	15.9 (±14.0)	16.2 (±13.7)	16.6 (±11.7)	16.0* (±11.4)	16.8‡ (±11.8)	15.4‡ (±11.2)	16.4 (±11.7)
Carbohydrate$^{\alpha\beta}$ (g)	61.7 (±32.7)	58.8* (±32.2)	62.5$^{\ddagger+}$ (±33.8)	58.0^{+} (±31.4)	56.5‡ (±27.5)	79.1 (±43.8)	74.6* (±38.8)	78.7‡ (±42.3)	73.4‡ (±38.8)	76.5 (±41.9)
Free Sugars$^{\alpha\beta}$ (g)	17.1 (±14.3)	16.7 (±13.0)	18.4$^{\ddagger+}$ (±14.6)	15.4^{+} (±12.5)	14.8‡ (±11.9)	24.1 (±19.1)	22.2* (±16.5)	24.1$^{\ddagger+}$ (±18.3)	21.8‡ (±16.7)	21.4^{+} (±17.7)
Fibre$^{\beta}$ (g)	4.3 (±3.6)	4.0* (±3.4)	4.2 (±3.6)	4.1 (±3.4)	4.1 (±3.2)	4.4 (±3.0)	4.6 (±3.1)	4.7‡ (±3.1)	4.2$^{\ddagger+}$ (±2.9)	4.6^{+} (±3.1)
Sodium$^{\beta}$ (mg)	535.8 (±412.5)	455.9* (±385.4)	497.8 (±407.3)	492.7 (±397.1)	508.3 (±386.2)	641.5 (±441.8)	608.5* (±423.1)	636.5‡ (±440.7)	604.2‡ (±412.5)	617.3 (±449.2)
Calcium$^{\alpha\beta}$ (mg)	206.2 (±181.9)	181.2* (±176.6)	201.0‡ (±184.1)	186.0‡ (±177.1)	185.8 (±164.4)	202.0 (±156.5)	198.9 (±150.6)	211.2‡ (±159.4)	185.5‡ (±143.5)	195.8 (±148.9)
Iron$^{\beta}$ (mg)	2.3 (±1.7)	2.1* (±1.7)	2.2 (±1.8)	2.1 (±1.7)	2.1 (±1.6)	2.5 (±1.7)	2.4* (±1.6)	2.5‡ (±1.7)	2.3‡ (±1.6)	2.4 (±1.6)
Zinc$^{\beta}$ (mg)	2.4 (±2.5)	2.0* (±2.3)	2.3 (±2.5)	2.1 (±2.4)	2.0 (±2.3)	1.7 (±1.3)	1.8 (±1.4)	1.8‡ (±1.4)	1.6$^{\ddagger+}$ (±1.3)	1.9^{+} (±1.5)

Magnesium$^{\alpha\beta}$ (mg)	53.5 (±41.9)	49.3* (±39.9)	52.9 (±42.4)	49.9 (±39.6)	49.1 (±37.8)	50.0 (±32.1)	51.5 (±32.7)	52.6‡ (±33.4)	48.2$^{\ddagger+}$ (±30.6)	51.9^{+} (±33.4)
Potassium$^{\alpha\beta}$ (mg)	468.3 (±433.7)	394.6* (±386.4)	447.1 (±422.1)	415.8 (±406.0)	414.3 (±386.4)	442.1 (±401.0)	453.7 (±428.2)	464.7‡ (±429.7)	422.4‡ (±390.8)	462.3 (±437.1)
Iodine$^{\alpha\beta}$ (µg)	13.0 (±17.7)	11.5* (±17.0)	13.4$^{\ddagger+}$ (±19.1)	10.9^{+} (±15.4)	11.1‡ (±13.9)	12.4 (±18.9)	12.3 (±17.8)	13.3‡ (±19.2)	10.5$^{\ddagger+}$ (±16.3)	14.2^{+} (±19.6)
Vitamin A$^{\alpha\beta}$ (µg)	92.3 (±102.2)	82.4* (±105.1)	92.6$^{\ddagger+}$ (±110.5)	82.8^{+} (±95.2)	77.2‡ (±93.5)	136.9 (±167.9)	141.7 (±171.8)	147.5‡ (±184.4)	122.5$^{\ddagger+}$ (±138.5)	163.1^{+} (±192.0)
Vitamin B6$^{\beta}$ (mg)	0.3 (±0.2)	0.2* (±0.2)	0.2 (±0.2)	0.2 (±0.2)	0.3 (±0.2)	0.3 (±0.3)	0.3 (±0.3)	0.3‡ (±0.3)	0.3‡ (±0.2)	0.3 (±0.2)
Folate$^{\alpha\beta}$ (µg)	40.3 (±34.3)	35.9* (±36.3)	38.3 (±35.6)	36.9‡ (±34.1)	41.9‡ (±37.9)	31.5 (±29.4)	32.6 (±31.0)	33.5‡ (±31.8)	29.7$^{\ddagger+}$ (±27.3)	33.8^{+} (±33.0)
Vitamin B12$^{\beta}$ (µg)	0.9 (±1.1)	0.7* (±1.0)	0.8 (±1.1)	0.8 (±1.0)	0.8 (±1.0)	0.6 (±0.7)	0.6 (±0.7)	0.6$^{\ddagger+}$ (±0.7)	0.5$^{+ø}$ (±0.6)	0.7$^{\ddagger ø}$ (±0.8)
Vitamin C$^{\alpha\beta}$ (mg)	9.5 (±12.7)	7.3* (±11.6)	8.8 (±12.7)	8.0 (±11.7)	7.6 (±11.3)	4.8 (±11.9)	6.0* (±13.5)	6.1‡ (±13.9)	4.1$^{\ddagger+}$ (±10.6)	6.8^{+} (±14.5)
Vitamin D$^{\alpha\beta}$ (µg)	0.5 (±0.7)	0.4* (±0.7)	0.5‡ (±0.8)	0.5 (±0.7)	0.4‡ (±0.6)	0.6 (±0.7)	0.5* (±0.6)	0.6‡ (±0.7)	0.5‡ (±0.6)	0.6 (±0.7)

* indicates statistical significance for Welch's ANOVA comparing average lunches in each school across gender, significance accepted at $P < 0.05$.
$^{\alpha}$ indicates statistical significance for Welch's ANOVA comparing average lunches in School 1 across year groupings, significance accepted at $P < 0.05$.
$^{\beta}$ indicates statistical significance for Welch's ANOVA comparing average lunches in School 2 across year groups, significance accepted at $P < 0.05$.
$^{+\ddagger ø}$ indicates statistical significance for Games-Howell post hoc tests, comparing pairs of year groupings significance accepted at $P < 0.05$.

Table 5.7 outlines the energy and nutrient values for school lunches as chosen, across FSM eligibility status. In school 1, Welch's ANOVA indicated that lunches chosen by non-FSM eligible students were significantly ($P < 0.05$) higher in levels of energy, fat, saturated fat, carbohydrates and free sugars compared to FSM eligible students. Contrastingly, in school 2, non-FSM eligible students chose lunches which were significantly ($P < 0.05$) lower than FSM eligible students in levels of energy, fat, saturated fat, carbohydrates, free sugars, fibre, calcium, magnesium, potassium, iodine and all vitamins considered.

A separate ANOVA was conducted to compare lunches chosen by students spending below or equal to £2.34 at lunchtime, and those spending more than £2.34. In both schools, students who spent over £2.34 at lunch chose lunches which were significantly ($P < 0.05$) higher in all energy and nutrient values compared to students who spent £2.34 or less. Moreover, students spending over £2.34 chose lunches with more than twice as much energy (school 1 only), fat, saturated fat (school 1 only), protein, fibre, sodium, iron, calcium, zinc, magnesium, potassium, vitamin A, folate, vitamin C, vitamin D than those spending £2.34 or less.

Table 5.7. Mean energy and nutrient intakes from school lunchtime transactions, across FSM entitlement and whether students spent above, below or equal to FSM value

Reference Values[*]			*School 1*				*School 2*			
	Max/Min	***Value***	***Pupil is FSM eligible*** *(n=763)*	***Pupil is not FSM eligible*** *(n=3394)*	***Pupil spend is equal to or below the FSM value*** *(n=2797)*	***Pupil spend is above the FSM value*** *(n=1359)*	***Pupil is FSM eligible*** *(n=1821)*	***Pupil is not FSM eligible*** *(n=4372)*	***Pupil spend is equal to or below FSM value*** *(n=4248)*	***Pupil spend is above the FSM value*** *(n=1945)*
Energy (kcal)		**646** (± 32.3)	424.5 (±241.1)	459.6$^{\beta}$ (±282.6)	322.4 (±168.6)	722.3$^{\alpha}$ (±257.6)	602.2 (±329.4)	550.4$^{\beta}$ (±291.6)	431.6 (±215.2)	858.4$^{\alpha}$ (±261.5)
Energy (kJ)		**2700**	1776.9 (±1009.4)	1920.3$^{\beta}$ (±1183.2)	1345.6 (±706.7)	3023.0$^{\alpha}$ (±1074.3)	2499.7 (±1375.2)	2282.9$^{\beta}$ (±1215.6)	1784.9 (±890.6)	3573.6$^{\alpha}$ (±1093.5)
Fat (g)	Max	**25.1**	15.7 (±11.1)	17.5$^{\beta}$ (±12.9)	12.1 (±8.0)	27.6$^{\alpha}$ (±13.9)	23.8 (±14.6)	21.8$^{\beta}$ (±12.8)	17.1 (±9.7)	33.9$^{\alpha}$ (±13.0)
Saturated Fat (g)	Max	**7.9**	5.3 (±4.4)	5.9$^{\beta}$ (±4.9)	3.9 (±3.4)	9.7$^{\alpha}$ (±5.0)	8.6 (±5.7)	7.9$^{\beta}$ (±4.9)	6.3 (±3.9)	12.2$^{\alpha}$ (±5.3)
Protein (g)	Min	**13.3**	16.3 (±13.1)	16.2 (±14.6)	10.4 (±10.6)	28.3$^{\alpha}$ (±13.5)	16.9 (±12.1)	16.0$^{\beta}$ (±11.3)	11.0 (±8.5)	27.7$^{\alpha}$ (±8.7)
Carbohydrate (g)	Min	**86.1**	56.5 (±28.3)	61.1$^{\beta}$ (±33.3)	44.1 (±19.8)	93.6$^{\alpha}$ (±27.5)	81.7 (±44.1)	74.3$^{\beta}$ (±39.5)	59.5 (±30.1)	113.6$^{\alpha}$ (±37.1)
Free Sugars (g)	Max	**8.6**	14.5 (±13.5)	17.5$^{\beta}$ (±13.7)	14.6 (±12.3)	21.8$^{\alpha}$ (±15.1)	26.8 (±19.7)	21.4$^{\beta}$ (±16.6)	18.6 (±15.3)	32.5$^{\alpha}$ (±18.9)
Fibre (g)	Min	**6.9**	4.0 (±3.1)	4.2 (±3.6)	2.7 (±2.3)	7.2$^{\alpha}$ (±3.5)	4.7 (±3.2)	4.4$^{\beta}$ (±3.0)	3.3 (±2.3)	7.2$^{\alpha}$ (±2.8)
Sodium (mg)	Max	**714**	492.3 (±381.6)	498.1 (±405.9)	355.6 (±327.5)	788.1$^{\alpha}$ (±382.8)	630.4 (±445.9)	619.3 (±425.3)	462.2 (±344.8)	972.8$^{\alpha}$ (±392.8)
Calcium (mg)	Min	**350**	197.4 (±174.7)	193.4 (±180.9)	134.1 (±150.6)	317.6$^{\alpha}$ (±171.9)	213.3 (±161.9)	194.7$^{\beta}$ (±149.0)	147.3 (±125.5)	315.7$^{\alpha}$ (±144.3)

Iron (mg)	Min	**5.2**	2.1 (±1.5)	2.2 (±1.7)	1.5 (±1.1)	3.6[α] (±1.7)	2.4 (±1.7)	2.4 (±1.6)	1.7 (±1.2)	3.9[α] (±1.6)
Zinc (mg)	Min	**3.3**	2.1 (±2.1)	2.2 (±2.5)	1.3 (±1.5)	4.1[α] (±2.9)	1.8 (±1.4)	1.7 (±1.4)	1.2 (±1.0)	2.9[α] (±1.4)
Magnesium (mg)	Min	**114.4**	50.6 (±36.3)	51.7 (±41.9)	33.8 (±25.8)	87.8[α] (±42.4)	53.3 (±33.8)	49.9[β] (±31.8)	36.7 (±23.7)	81.9[α] (±27.1)
Potassium (mg)	Min	**1288**	420.5 (±358.9)	435.3 (±424.2)	271.8 (±227.8)	763.5[α] (±502.3)	466.7 (±429.6)	441.3[β] (±411.2)	275.9 (±261.4)	826.2[α] (±443.1)
Iodine (µg)	Min	**53.2**	14.8 (±21.3)	11.7[β] (±16.4)	9.3 (±16.5)	18.4[α] (±17.6)	15.1 (±21.9)	11.2[β] (±16.4)	7.1 (±12.2)	23.7[α] (±23.5)
Vitamin A (µg)	Min	**245**	89.9 (±118.1)	87.0 (±100.2)	55.9 (±78.4)	152.5[α] (±118.2)	150.8 (±194.3)	135.1[β] (±158.8)	90.4 (±92.1)	247.4[α] (±238.2)
Vitamin B6 (mg)	Min	**0.2**	0.2 (±0.2)	0.2 (±0.2)	0.2 (±0.2)	0.4[α] (±0.2)	0.3 (±0.3)	0.3[β] (±0.2)	0.2 (±0.2)	0.5[α] (±0.2)
Folate (µg)	Min	**70**	40.2 (±35.1)	37.7 (±35.4)	25.9 (±29.0)	63.5[α] (±33.7)	34.6 (±32.8)	31.1[β] (±29.2)	19.5 (±19.2)	59.7[α] (±31.9)
Vitamin B12 (µg)	Min	**0.5**	0.8 (±1.0)	0.8 (±1.1)	0.5 (±0.8)	1.4[α] (±1.2)	0.6 (±0.8)	0.5[β] (±0.6)	0.4 (±0.5)	1.0[α] (±0.9)
Vitamin C (mg)	Min	**14**	8.0 (±11.7)	8.5 (±12.4)	4.6 (±8.9)	16.3[α] (±14.2)	6.1 (±14.0)	5.2[β] (±12.4)	2.4 (±7.1)	12.1[α] (±18.7)
Vitamin D (µg)	Min	**4**	0.5 (±0.7)	0.5 (±0.7)	0.3 (±0.6)	0.8[α] (±0.9)	0.7 (±0.8)	0.5[β] (±0.6)	0.4 (±0.5)	0.9[α] (±0.9)

[α] indicates statistical significance for Welch's ANOVA comparing average lunches across students spending below or equal to the FSM allocation value (£2.34) at lunch, and those spending more, significance accepted at $P < 0.05$.
[β] indicates statistical significance for Welch's ANOVA comparing average lunches across FSM eligible and non-FSM eligible students, significance accepted at $P < 0.05$.
* reference values are from nutrient-based standards (NBS) for school food[4], otherwise derived from respective dietary reference value[9]. Values for free sugars, fibre and vitamin D all revised in light of SACN recommendations[261,262].

5.4.6 Choices Across the School Day

Given the popularity of purchases at break (school 1: 45.5% of total transactions, school 2: 39.2% of total transactions), and that NBS[4] is derived from dietary reference values (DRVs)[9], a final piece of analysis was to expand the scope beyond simply lunchtime transactions and explore how students' choices throughout the school day corresponded to DRVs. Energy and nutrients were summed for each day a student purchased something at school (i.e. all items selected at breakfast, break, lunch). This gave daily totals for each student for each day they made a purchase. Averages and standard deviations were then calculated for this list of daily totals.

Table 5.8 provides the mean energy and nutrient content for students' school day choices and illustrates what percentages of DRVs are fulfilled at school. In both schools, school day choices accounted for large percentages of DRVs for protein (school 1: 41.9%, school 2: 49.1%), along with vitamin B12 (school 1: 66.7%, school 2: 60.0%). However, students' school day choices also corresponded to very high percentages of DRVs for free sugars (school 1: 76.3%, school 2: 84.0%) and saturated fat (school 1: 31.2%, school 2: 39.9%), meanwhile, students' choices corresponded to very low percentages of DRVs for fibre (school 1: 15.1%, school 2: 20.4%), and a number of micronutrients, including iron (school 1: 16.2%, school 2: 18.9%), iodine (school 1: 16.2%, school 2: 13.9%), magnesium (school 1: 16.9%, school 2: 20.1%) and potassium (school 1: 12.8%, school 2: 14.8%). Inter-school variation was also evident, with differences observed for a number of values, including saturated fat (school 1: 31.2%, school 2: 39.9%), sodium (school 1: 24.9%, school 2: 36.0%), and calcium (school 1: 18.6%, school 2: 27.9%).

Table 5.8. Mean energy and nutrient content for whole school day transactions, as a percentage of DRVs[9]

Dietary Reference Values			*School 1*		*School 2*	
	Max/Min	***Value***	***Daily Average all students***	***% DRV***	***Daily Average all students***	***% DRV***
Energy (kcal)		**2152.5**	558.0 (±341.6)	25.9%	702.2 (±387.2)	32.6%
Energy (kJ)		**9000.0**	2337.0 (±1430.9)	26.0%	2928.4 (±1616.9)	32.5%
Fat (g)	Max	**83.7**	20.7 (±14.3)	24.7%	27.5 (±16.6)	32.9%
Saturated Fat (g)	Max	**26.3**	8.2 (±6.5)	31.2%	10.5 (±6.9)	39.9%
Protein (g)	Min	**44.2**	18.5 (±15.2)	41.9%	21.7 (±13.9)	49.1%
Carbohydrate (g)	Min	**287.0**	76.3 (±44.8)	26.6%	94.8 (±53.6)	33.0%
Free Sugars (g)	Max	**28.7**	21.9 (±19.2)	76.3%	24.1 (±22.1)	84.0%
Fibre (g)	Min	**26.5**	4.0 (±3.6)	15.1%	5.4 (±3.5)	20.4%
Sodium (mg)	Max	**2353.0**	586.6 (±488.0)	24.9%	847.9 (±538.8)	36.0%
Calcium (mg)	Min	**1000.0**	185.6 (±191.0)	18.6%	278.5 (±204.4)	27.9%
Iron (mg)	Min	**14.8**	2.4 (±1.9)	16.2%	2.8 (±1.8)	18.9%
Zinc (mg)	Min	**9.5**	2.2 (±2.3)	23.2%	2.3 (±1.7)	24.2%
Magnesium (mg)	Min	**300.0**	50.7 (±42.6)	16.9%	60.2 (±38.4)	20.1%
Potassium (mg)	Min	**3500.0**	447.5 (±416.1)	12.8%	517.8 (±429.6)	14.8%
Iodine (µg)	Min	**140.0**	22.7 (±26.5)	16.2%	19.5 (±23.1)	13.9%
Vitamin A (µg)	Min	**700.0**	123.5 (±119.6)	17.6%	166.9 (±174.4)	23.8%
Vitamin B6 (mg)	Min	**1.5**	0.3 (±0.2)	20.0%	0.3 (±0.3)	20.0%
Folate (µg)	Min	**200.0**	36.8 (±35.3)	18.4%	41.2 (±33.1)	20.6%
Vitamin B12 (µg)	Min	**1.5**	1.0 (±1.1)	66.7%	0.9 (±0.9)	60.0%
Vitamin C (mg)	Min	**40.0**	6.5 (±11.2)	16.3%	5.4 (±12.5)	13.5%
Vitamin D (µg)	Min	**10.0**	0.8 (±0.9)	8.0%	0.7 (±0.8)	7.0%

5.5 Discussion

This study aimed to analyse cashless catering data to investigate adolescents' school food choices and explore the nutritional composition thereof. In general, findings indicated a strong bias towards convenience items, namely sweet snacks, savoury snacks and drinks items, which dominated the most popular items sold in both schools. Mid-morning break emerged as a very popular service time and was only marginally below lunch in terms of number of transactions. Average lunches across the general student population and among specific sub-groups were found to be high in free sugars and low in fibre, calcium, iron and zinc. The mean nutritional composition of lunches chosen by these sub-groups failed to meet several reference values, indicating that the choices of all student groups could be improved upon.

A key finding from this study was students' preference for grab and go options. Sweet and savoury snacks together accounted for approximately half of all items sold across the school day in both schools. Moreover, the ten most popular items in each school were all either snacks (sweet or savoury) or drinks items. Previous research[14,15,20,25,231,291] has reported a similar bias toward grab and go items; for example, Pearce et al.[231] found that 41% of students who chose a school lunch had cakes and biscuits as part of it. Qualitative research by McSweeney et al.[14] reported that students frequently chose convenient items such as pizzas, paninis and pastas, even if they knew healthier items were available. Ensaff, Russell and Barker[15] examined students' food choices and found that drinks and snacks together accounted for 39.7 - 40.9% of item sales. Interestingly, the present findings indicated an even greater bias as together, snacks and drinks accounted for 78.2% of item sales in school 1 and 76.8% in school 2. However, these differences may be due to contextual factors uncaptured in the study (e.g. students in the current study may be more influenced by prices and value for money than students in other studies; schools in the present study may have been more lenient regarding enforcing/implementing rules surrounding provision of snacks). Further research, with a larger sample of schools, is needed to elucidate how adolescents' school food choices are distributed across categories more generally.

A consequence of this bias towards convenience is that very few students chose meals of the day as part of their lunch, which are typically the most favourable options provided in schools (as chapter 4 illustrated). In the present study, meals of the day comprised just 3.4 - 4.6% of item sales in school 1 and school 2 respectively. This aligns with previous research, for example, Ensaff, Russell and Barker[15] found that the equivalent “dishes of the day” made up 8.3 - 8.7% of students’ main food choices, meanwhile, pizzas (27.3 - 31.2%) and sandwiches (40.4 - 48.3%) were much more popular. That said, other work has reported more favourable selections; for example, Nicholas et al.[213] explored school food provision and choices between 2004 and 2011, and found that the number of students choosing main dishes had fallen by 9.3% in this time; however, circa 55.6% of students still chose a main dish. Meanwhile, research by Stevens et al.[232] found that 38.1% of students having a school lunch chose main dishes as part of their lunch.

These percentages are substantially higher than those reported in the present study; however, it is important to clarify that these measures are not directly comparable as percentages of students choosing an item is a different measure from percentage of items sold. Moreover, the main dish category was broader (e.g. pasta items categorised under main dishes in the Stevens et al.[232] study were given separate sub-category in the present study) than “meals of the day” reported in this study or “ dishes of the day” reported elsewhere[15]. Thus, considered together, these findings suggest that adolescents are not availing of the more favourable options provided in schools. This also illustrates how adolescents’ food choices can negate the intentions of school food policymakers and providers.

In both schools, students’ choices were found to be high in free sugar and low in energy and several important macro/micronutrients, including fibre, calcium, iron and zinc. Further, the average lunch as chosen failed to meet most (14/20 in school 1, 15/20 in school 2) of the energy and nutrient reference values. This aligns with previous research; for example, Nicholas et al.[213] found that an average lunch as taken (i.e. as chosen) was high in NMES (non-milk extrinsic sugars) but low in levels of fibre, iron, calcium and zinc, vitamin A and folate. Pearce, Wood & Nelson[231] found intakes from school lunches (measured by weighed food record) failed to meet NBS for free sugar, saturated fat, sodium, vitamin A, folate, calcium, iron and zinc; Stevens et al.[232] conducted weighed food records over 5 consecutive days in eighty English secondary schools, and reported that school lunches as chosen failed to meet NBS for energy, carbohydrates, fibre, vitamin A, folate, calcium, iron, zinc; finally, Norris et al.[324] collected food diaries over 5 days and found that average school lunches as chosen failed to meet SNSSL (Scottish Nutrient School Standards for Lunches) for fat, saturated fat, non-milk extrinsic sugars, NSP, vitamin A, folate, calcium and iron. The results of this present study therefore align with previous work and suggest that adolescents' lunchtime choices are consistently high in free sugars and low in fibre and key micronutrients, notably calcium, iron and zinc.

This study also found some group differences in school food choices, namely between gender, year and FSM groupings. For example, younger students and FSM eligible students engaged/used the canteen more so than their respective counterparts. Similar findings have been reported elsewhere; for example, Ensaff, Russell and Barker[15] found that FSM students used the catering facilities significantly more ($P < 0.001$) than non-FSM students. Male students and younger students generally chose lunches which were higher in energy and several nutrient content than female students or middle/older students respectively. This also aligns with qualitative research by Deslippe et al.[325] which found that different body-ideals between students of different genders (being strong and fit for males, being thin for girls) was associated with different dietary behaviours (food restriction for girls, increased consumption for boys). Whilst significant differences were found in both schools across year groupings, gender and FSM eligibility, broader commonalities were also found between sub-groups; for example, all age and gender sub-groups chose lunches which had adequate levels of protein, fat, sodium and vitamin B12. However, all sub-groups also chose lunches which were high in free sugars, while almost all groups chose lunches which were low in energy, carbohydrates, fibre, calcium, iron and zinc (the exception being choices made by students spending more than £2.34), providing additional evidence that these are nutrients of note across the student population; as such, increased density of these nutrients in school foods (and school food choices) could bring about a large positive impact on dietary health of the adolescent population as a whole.

The current study also explored adolescents' choices more broadly, looking at choices throughout the school day. Students' choices for the whole school day, on average, accounted for over three quarters of their daily recommended amount for free sugars. Moreover, findings suggest that students' school choices throughout the school day are low in energy, iron, calcium, zinc, fibre, magnesium, potassium, iodine, folate and vitamins A, C or D. This aligns with recent NDNS findings[3], which show that adolescents' daily intakes fall below RNIs for these same nutrients (free sugars, fibre, iron, calcium, zinc). This alignment between NDNS findings and school day choices suggests that rather than being more favourable, the nutritional quality of adolescents' school food choices is consistent with their diet in general.

It is worth noting at this point that choice is not the same thing as consumption and therefore it is difficult to comment accurately or absolutely on students' nutritional intake at school. For example, a student may only consume half of what they choose, or they may supplement what they purchase in school food with food from elsewhere. Nonetheless, the present findings suggest that adolescents' school food choices could be greatly improved upon.

The findings from the study also highlighted some interesting comparisons and contrasts between the two schools. For example, despite being a smaller school (1146 pupils on roll in school 1, compared to 962 pupils in school 2), a higher percentage of students utilised the canteen in school 2 (80.0%) than school 1 (65.1%), which translated to far more item sales in school 2 (21728) than school 1 (12603). This may be due (at least in part) to the schools' locations; school 1 was in a built up urban environment, whereas school 2 was on the outskirts of the city and had fewer nearby outlets. In terms of food choices however, patterns were largely similar across the two schools. The two schools were equivocal for percentages of items sold that were main meals, drinks, dessert main meal and fruit. The most notable difference were for savoury snacks (school 1: 32.9%, school 2: 26.1%) and sweet snacks (school 1: 17.3%, school 2: 23.8%). Among main meal sub-categories, the main inter-school differences were found for pasta (school 1: 21.5%, school 2: 11.8%) and sandwich items (school 1: 23.7%, school 2: 37.1%). This suggests that despite differences in uptake, students' choices in both schools were broadly similar, suggesting that adolescents' school food choices follow broadly similar patterns, irrespective of school attended.

Indications from chapter 4 were that provision in school 1 was more favourable than school 2. Following on from this, there was evidence in the current study suggesting that school 1 choices were more favourable in terms of nutritional content than school 2 choices. For example, average lunches as chosen in school 1 were lower in energy, fat, saturated fat, sodium and free sugars than in school 2. Moreover, choices across the whole school day were more preferable for levels of sodium, fat and saturated fat in school 1 compared to school 2. Given that choices were broadly similar across the two schools in terms of percentage of item sales across categories/sub-categories, the observed differences may be influenced by the nutritional content of what's provided. However, it is difficult to say with certainty the extent to which these differences can be attributed to students making more preferable choices, or students availing of more preferable provision.

5.6 Strengths & Limitations

This study had a number of strengths. For instance, the nutritional composition data was developed based on three weeks of immersive observations. This enabled the researcher to easily assign nutritional composition data to each item sold during the three weeks. Furthermore, the researcher's experiences in the schools, along with the reflexive practices taken (e.g. note-taking, taking manual tallies of sales for specific categories such as drinks) helped the researcher to interpret the cashless catering data and assign nutritional composition data correctly (e.g. developing weighted averages based on manual tallies to assign a nutritional composition to items described under an umbrella term in the catering data). Whilst it would've been possible to assign nutritional composition data to cashless catering data without doing the observations and such triangulation, the researcher's experience certainly provided an additional level of rigour to the linking process (e.g. knowing which items were described under an umbrella term on the cashless catering data). As such, researchers carrying out similar work in the future, who may not have time or resources to carry out such immersive observations, could consider either (1) carrying out a short but structured period of observations, centring efforts on the types of data/insights collected in this work (see section 3.4.1), or (2) consulting catering managers to provide guidance on interpreting entries on the cashless catering system.

The present chapter evaluated school food choices over a full three-week menu cycle. This enabled analysis of school food choices across days of the week and direct comparison to NBS, which was evaluated over a three-week period. In line with this, the linking of nutritional composition data with cashless catering data gave an in-depth measure of adolescents' school food choices. For example, the inclusion of large catering datasets enabled the analysis of sub-group differences whilst maintaining large sample sizes within each group. Another strength of the study was the comparison of energy and nutrient content of school lunches as chosen across age cohorts (young, middle, older adolescents), gender (male/female), FSM eligibility status and amount spent at lunch. These comparisons helped to pinpoint potentially vulnerable groups and explore group differences in school food choices and the nutritional implications thereof. Finally, the study extended beyond lunchtime and examined how choices throughout the school day contribute towards adolescents' recommended daily intakes.

The study also had some limitations. Only 2 schools were included in the study and as such, it is difficult to make wider claims regarding school food choices generally. That said, neither school was atypical in terms of size or FSM%. Meanwhile, the large datasets gathered in each school does allow for some generalisations (e.g. the popularity of snacks and drinks observed in both schools may occur in many other schools also). Three weeks of data for the whole school population provided a substantial dataset of food choices, however the analysis conducted relates only to three weeks and for example would not incorporate changes due to seasonality and/or changes to the menu. The nutritional composition data assigned to just three weeks also meant it was not possible to explore students' food choice behaviours over a longer time period. Following on from this, the three weeks selected for each school was the three weeks directly preceding the three weeks of observations. Whilst this alleviated any potential observer effects[254] during the observation periods, and perhaps gave a more authentic example of school food sales and student choices, the selection of this time period meant that the researcher was unable to account for some of the items sold, which were omitted from the final dataset. However this was a very small percentage of the items sold (e.g. < 1.0% in each school).

Another limitation relates to whether transactions made by students were only intended for that student. In school 2 particularly, some students purchased several items at one time (observed in the data) and may have been purchasing items for other students or purchasing several items to consume throughout the day. Whilst extreme cases (e.g. one student purchasing 5 or more capri suns) were removed from the dataset, it is possible that valid cases were incorrectly removed, or that illegitimate cases (e.g. where a student purchased food for them and someone else) were incorrectly included. That said, it is important to stress that these ambiguous cases were a small minority of instances (< 1.0% in both schools).

The study assessed student food choice and thus cannot draw any conclusions regarding students' school food intake or consumption. For example, it is unclear whether students consumed all or some of the items they purchased (e.g. students may have only consumed half of the items they purchased; students may have shared or swapped items with other students). It is also unclear when students consumed the items purchased (e.g. students may have purchased items at lunch to consume after school or purchased items at break to consume at lunch). Moreover, some students may purchase something at school to supplement food brought in from elsewhere (e.g. from home or from a nearby outlet).

Similarly to Chapter 4, an important limitation of this study relates to the methods used for attaining nutritional composition values (this was explained in detail in the previous chapter, see section 4.9). Moreover, the nutritional composition tables had additional calculations, in order to calculate weighted averages for items displayed broadly on the till data (e.g. radnors, main meals) or items that had multiple options (e.g. students could select multiple vegetable side options with roast chicken). Whilst manual tallies were taken to inform these calculations, the tallies were only taken over 2 lunchtime services, as the researcher was unable to capture this for longer. Therefore, these additional calculations may not be the most accurate reflection of students' choices more generally and as is the case with chapter 4, findings from this chapter should be considered within the context of these limitations.

5.7 Implications for Practice & Policy

A key finding from this study was the popularity of mid-morning break. Traditionally, school food standards have focused primarily on lunchtime (e.g. current standards do consider foods outside of lunch, but lunch remains the central focus; e.g. previous NBS related solely to school lunches), whilst much of previous research has evaluated school lunches only[212,231,232,237,243,324,326]. However, this study found that large percentages of transactions occurred at break (school 1: 45.5% of total transactions, school 2: 39.2% of total transactions). Furthermore, students often purchased something at break and again at lunch the same day (51.0% and 56.1% of lunchtime transactions were preceded by a breaktime transaction in school 1 and 2 respectively), while findings from chapter 4 indicate that breaktime purchases (i.e. savoury snacks category) correspond to selection of items with 211.3 – 282.4kcal, 8.8 – 10.8g of fat, and 279.4 – 442.7mg of sodium. This aligns with previous research by Nicholas et al.[213] which found that students purchasing something at mid-morning break had a substantial snack, equivalent to 15% of their daily energy requirement. These findings also illustrate the relevance of services throughout the school day (particularly mid-morning break) and suggest that greater consideration should be given to all school food services in future evaluations of school food and/or school food policy. Further research is needed to examine the popularity of mid-morning break in a larger sample of schools, and explore how this popularity impacts choices at lunchtime, and students' daily intakes from school food.

The proliferation of grab and go/convenience items (e.g. sweet snacks, savoury snacks, drinks) among students' choices illustrates a limitation of school food standards, which focus on food provision and whose effectiveness is dependent on students choosing a variety of options across the range of what's available. Meals of the day form the cornerstone of school food standards, therefore the finding that meals of the day accounted for just 3.4 - 4.6% of item sales over the three weeks is emblematic of how students' choices can subvert the efforts of school food providers and policymakers. Furthermore, the high levels of free sugars observed in this study may in part be due to this bias toward grab-and-go and convenience items. As was illustrated in the previous chapter, drinks and sweet snacks, on their own, contributed the recommended maximum amount of free sugar for a school lunch. Similarly, previous research has reported that students may consume between 12.9 and 16.7g of free sugars from school beverages alone per day[16]. Together with findings from chapters 3 and 4, findings from this chapter illustrate the relevance and importance of these (sub)categories (sweet snacks, juice-based drinks). As such, efforts to reduce the free sugar content of both school food provision and choices should target these (sub)categories.

The previous chapter outlined some ways in which school food provision could be ameliorated; improvements to the nutritional composition of school food provision could positively impact school food choices, by bolstering the nutritional quality of what's provided (e.g. decrease free sugar content, increase fibre, calcium, iron, zinc), limiting the number of specific options (e.g. juice-based drinks, cookies, pizzas, paninis were highlighted as items/sub-categories of note in chapter 4, after comparing their nutritional composition in to reference values derived from NBS and DRVs) available, or by providing more sweet alternatives (e.g. wider array of fruit options, provision of berries which are sweet but also high in fibre, provision of less energy dense items such as soups). That said, altering provision is an indirect method of influencing choice, and as previous research has illustrated, provision can easily be undermined or circumvented by students' food choice behaviours (e.g. students may choose to not have a school lunch[214], students may purchase items from nearby outlets[245,327,328], students may select less favourable grab and go items like cookies, pizzas etc.[14–16,231], students may select multiple "regulated" items[14]).

Efforts are therefore needed to try and influence students' food choices directly; nudges[183] (i.e. adjustments to the framing of choices) may prove effective in this regard, by designing the food choice architecture specifically to promote more favourable school food choices[329].

Such initiatives could include shorter queues for healthier items[29], strategically positioning healthier items, and adding attractive labelling and descriptive names to their packaging[184,185,253,330]. Echoing previous researchers[20,107,331–334], consultation with students as "experts by experience" is imperative in this regard, both for knowledge generation purposes and for bolstering the fidelity and effectiveness of any initiatives looking to positively influence adolescent school food choices.

5.8 Implications for PhD Project

Chapter 1 outlined the key motivations for the project, to explore what foods are prepared and provided in schools, what is chosen by students and what these mean in terms of nutritional composition. Discussion of current research in chapter 1 also indicated that students' food choice behaviours may undermine and/or circumvent the intentions of school food providers and policymakers. Chapter 3 helped to provide insights into how these issues play out in the real world, as catering staff reported a preference among students for grab-and-go items over more nutritious meals of the day. Chapter 4 illustrated that these more popular items (i.e. grab-and-go items such as waffles, cookies, pizzas, juice-based drinks) were among the least favourable items in terms of nutritional content, highlighting a potential issue associated with grab-and-go type provision. The present chapter validates this, as grab-and-go items dominated the most popular items among students and accounted for large percentages of total sales.

Together with the previous chapter, this chapter serves as the fulcrum of the thesis. Findings from chapter 4 indicated that even if schools were satisfying the current FBS, food provision could still fail to meet energy and nutrient reference values, suggesting that the nutritional composition of school food provision warrants attention. The present study goes a step further and illustrates how students' choices deviate even further from the ideal in terms of nutritional composition. As the energy and nutrient reference values used in this thesis are based on previous NBS[4] and are derived from DRVs[9], they serve as a useful barometer for the nutritional quality of school food. Therefore, the findings from chapters 4 and 5 illustrate that both school food provision and students' choices are falling short of recommended levels.

Findings from this chapter give further evidence of how students' choices are not evenly distributed across the range of what schools provide, but instead bias toward grab-and-go items. This illustrates how important food choice is and how students' choices can undermine the effectiveness of school food standards. This stresses the need to better incorporate students' food choice behaviour and preferences into school food policy. Chapter 1 outlined how various school-based interventions have been designed in an attempt to positively influence students' choices. However, there remains a lack of clarity regarding how best to achieve these, what healthy options (e.g. fruits, yoghurts) students would be amenable to, how best to frame/display/offer foods, and what the main factors are in students' school food choices. The proceeding two chapters, chapters 6 and 7 will employ qualitative approaches to try and provide some insight into the findings from chapters 3-5 and look to shed some light on how and why students make their food choices at school.

5.9 Conclusion

Adolescents' school food choices, which are dominated by snacks and drinks, are providing them with inadequate amounts of energy and micronutrients, and excessive amounts of free sugar. School food policymakers should give greater attention to school food as chosen and look to integrate adolescents' food choice behaviours into school food initiatives. Consultation and co-design approaches may prove crucial in this regard.

Chapter 6. “I think it'd be better if the students had a choice to be healthy or not.” Exploring the School Food Environment and Students’ Views as Key Stakeholders

6.1 Introduction

As outlined in chapter 1, adolescents’ school food choices and intake constitute a substantial amount of their daily intake; thus, promoting healthy food choices and dietary behaviours within the school environment can have a meaningful positive impact on adolescents’ diet in general, and subsequently on their overall health and wellbeing. As mentioned in chapter 1, whole-school, top-down approaches to tackle school food provision and student eating habits have been widely advocated for[105]. However, their implementation can sometimes overlook the importance of lower-level factors relating to student food choice. Such lower-level factors include the physical and social contextual factors at play within the school environment, including students’ taste preferences, catering practices, school food uptake protection, school food availability and parental views[18,290].

In response to this, there has been a body of research conducted on students’ lunchtime experience and students’ food choices within the UK school environment[13,22–24,185,243,245,332]. These studies have highlighted a number of important barriers and facilitators of school food choices, including the cost of school food, the length of queues, social aspects of school food and the presence of nearby outlets. A number of theoretical frameworks (e.g. SEM[31], FCPM[32]) have conceptualised the key influences of food choices and described how these influences may coalesce to drive adolescents’ food choices.

Despite this, evidence from chapter 5 of this thesis, and previous work[14,15,20,25,231,291] suggests that adolescents’ choices continue to bias towards less healthy, convenient options. There remains a need for further understanding of how and why adolescents’ make their school food choices, along with how healthier food choices may be effectively encouraged. Furthermore, previous research[20,107,331–334] has advocated for greater inclusion of the student perspective in school food discussions and policy-making, in order to align public health priorities with student needs.

The study described in this chapter employed qualitative methods (focus groups) to explore how and why students make their food choices in school and to get students' perspective on their lunchtime experience in the school canteen. Of particular interest was students' depiction of their school lunchtime experience, including when lunch begins, the process of purchasing foods and where students have their lunch.

6.2 Aims

The present study aimed to explore how secondary school students make their food choices within the school environment and explore students' lunchtime experience, from their perspective.

6.3 Methods

6.3.1 Strength of Focus Group Methodology

Focus group discussions were selected as they offer a naturalistic environment in which students can speak candidly. When compared to other qualitative data collection methods, such as interviews, focus groups have an advantage in that they may facilitate greater anonymity and help participants to discuss topics freely[263]. This can help generate a richer, more detailed type of data[264]. Finally, as there are multiple people present, focus groups enable the simultaneous incorporation of multiple voices and perspectives. In this way, topics can be discussed from different perspectives and the group can come to consensus/agreement/disagreement naturally by themselves. As such, focus groups may enable the researcher to delve deeper into the subject in question, uncover points of consensus or discord amongst the participants and gain a more nuanced perspective.

6.3.2 Study Design

Five focus group discussions were conducted with Year 8 students (n=25) aged 12-13 years in a secondary school in Northern England. Year 8 students were selected as these students had recently transitioned from primary to secondary school, but yet were not in the first year of adjustment (like year 7 students) and could speak knowledgeably about secondary school food (further details on recruitment are given in section 3.3). Recruitment of this year group was also amenable to the school, as this avoided recruiting students who were in important examination years. Each focus group consisted of students from mixed genders, ethnicities and academic abilities. Participant heterogeneity was chosen as it was felt that this would best capture the perspective of the general student population.

6.3.3 Schedule Development

A deductive approach was taken for the schedule development and data analysis. This was deemed more appropriate for the study as there is already a body of research on students' lunchtime experience and students' food choices within the UK school environment[13,22–24,185,243,245,332], along with some theoretical frameworks (e.g. SEM[31], FCPM[32]) describing the influences of food choices.

Focus group schedule development was informed primarily by the socio-ecological model (SEM)[31], along with the conceptual framework for adolescent eating behaviour[54] and the food choice process model (FCPM)[32]. The SEM[31] proposes behaviour change can be influenced at 5 levels: Policy, Community, Institutional, Interpersonal and Individual and proposes food choices may be influenced across multiple levels. For example, schools may look to encourage healthy student choices by implementing school-wide policies/initiatives for food provision (institutional level) but should also consider the pervasiveness of social norms (interpersonal level) in determining students' food choices. Story et al.[54] propose a similar conceptual model of food choice. Their model builds on ecological and socio-cognitive models and describes food choices across 4 levels of influence: individual influences, social environmental influences, physical environmental influences and societal influences. This model has been adopted for previous qualitative inquiries, to look at food choices in Irish adolescents[205] and identify barriers to healthy eating among Irish teenagers[206].

The FCPM[32] was also considered as, like the two aforementioned models, it describes the various factors and processes involved in food choices. However, the FCPM posits the individual as an active decision-maker within the food choice process and illustrates how the decision-maker must balance multiple influences across different levels. An added advantage of the FCPM is that it incorporates a life-course approach and acknowledges how food choice influences may grow or lessen in effect as the individual develops.

Based on the study aims, question topics included school food provision, students' food choices and overall dining experience within the school environment. Question topics were also chosen so as to map onto the five levels of the SEM (e.g. questions of students' experience of lunch in the canteen mapped onto the organisational level of the SEM, while questions asking if students bring food in from home, or go to nearby outlets mapped more so onto the community level of the SEM) and to touch on some of the principles of the FCPM, particularly the role of the student as an active decision-maker. Questions were written as open-ended, in an effort to avoid asking leading questions, discourage yes/no responses and encourage participants to reflect before responding and discuss the question rather than simply answer it. The researcher also tried to mitigate against social desirability biases[255], whereby participants volunteer responses that they think are more socially acceptable, rather than ones which reflect their reality. Such efforts included insisting that there were no right or wrong answers, asking indirect questions (e.g. what does the "average" student choose?) and assuring students their responses would be anonymous in any future publication or report.

Three tasks were developed to serve as ice breakers, engage the students and get them thinking and talking about school food. The tasks asked students to (1) recall as much as they could about what is provided in the school canteen, (2) name what they had for lunch the previous day, along with 3 words to describe it and (3) make and discuss their suggestion for a new school food/drink item. Students were also asked to complete a short demographics questionnaire at the end of the focus group. The schedule was reviewed by an expert panel of researchers in public health and nutrition, postgraduate students, and six parents of secondary school students. Refinements were made to the wording and selection of questions, order of the schedule and number of questions included (see Appendix 4 for the finalised focus group schedule).

6.3.4 Procedure

In person focus group interviews were conducted at school during the school day. A plain, quiet room was selected as the discussion site, to limit distractions from both outside and inside the room. The researcher took a number of measures to facilitate free-flowing conversation. For example, the researcher welcomed students as they entered the room and asked each student to take a seat wherever they wished. The researcher then gave all students an information sheet outlining what the study entailed and what the collected data would be used for. Students also received a consent form with their information sheet. Before the FG commenced, the researcher outlined what was in the information sheet and consent form and asked the students if they had any questions. At this point, the researcher gave a brief description of the study and outlined what the discussion would generally be focusing on (i.e. what students choose to eat and drink at school). During the discussions, the researcher sat amongst the students in a square formation and offered questions. The researcher acted as a facilitator, posing questions but letting students lead the discussion thereafter. In this way, the conversations more closely resembled a genuine conversation amongst students. At the end of each discussion, participants were asked to complete a short demographics questionnaire, which included questions on age, gender and participants' perception of their own diet (see Appendix 4). Discussions were audio-recorded, transcripts were typed up verbatim and anonymised prior to analysis. The researcher took reflection notes during and after each discussion, to aid later analysis. Five FGs were carried out, lasting approximately 45 minutes on average. This was sufficient to reach data saturation[335,336], whereby similar responses appear again and again and no new insights are gathered.

6.3.5 Analysis

The analysis followed the six major phases of thematic analysis as outlined by Braun & Clarke[265]. These six phases are as follows: (1) familiarisation with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, (6) producing the report. Whilst taking a deductive approach, coding maintained a degree of flexibility, so that narratives and context could be taken into account, and themes could be identified from the data. In taking this approach, the study could investigate important lower-level factors (e.g. school food availability, school food rules), consider these in relation to existing theories (especially the SEM[31] and FCPM[32]) and explore subtleties and intricacies of students' lunchtime experience.

During the familiarisation phase, transcripts were read and re-read, with initial reflections written down throughout. The researcher reflected on any notes taken during the collection stage and in a deductive analysis, started to consider how initial thoughts correspond to the theoretical framework. Once the researcher had thoroughly read the transcripts and was familiar with the data, they proceeded to the next stage, which involved carrying out the initial coding. Coding involved organising the data into meaningful groups[337]. NVivo 12 software (QSR, Melbourne, Australia), which was used to manage and analyse the data, labels these groupings as nodes. Codes represent a feature of the data that appears interesting to the researcher and can be considered the most basic element of the analysed data. At this stage, the researcher looked at the data more broadly and included any observations that they found interesting. The researcher coded as much of the data as possible, while data extracts were coded into multiple nodes. At the end of the second stage, the researcher had coded all of the data and had a list of nodes.

The third phase involved deductively searching for themes. During this phase, the researcher once again went through the data thoroughly, but began to identify repeated patterns of data and similar nodes which would form themes. The researcher began to consider the relationships between codes, between nodes and between potential themes. Nodes were grouped to form themes, or sub-themes, while other nodes were left by themselves. Whilst the researcher approached the coding flexibly, themes were also considered with respect to previous research and conceptual models of food choice, particularly the SEM[31]. At this stage, the researcher had a clearer concept of how some themes were constructed or the significance of some themes more than for other themes. However, these more ambiguous themes could be refined at the next stage. At this point, the researcher also had some nodes which didn't clearly fit into any of the current themes. These nodes were kept, as these could make more sense at a later stage in the analysis. At the end of this third stage, the researcher now had a set of initial themes, sub-themes and all the relevant data extracts to support these.

The fourth stage involved reviewing and refining the themes. During this stage, the researcher reviewed each initial theme, and its constituent data extracts. The researcher reviewed if there was a consistent and coherent pattern to the data extracts in the theme. If extracts did not align with the coherent "message" of the theme, then they were either removed or inserted into another node in another theme, where they fitted better. Alternatively, the theme was relabelled or redefined so as to incorporate these incongruous data extracts. Each theme was reviewed thoroughly, and themes/sub-themes were collapsed, separated or relabelled as appropriate. In line with deductive reasoning, themes were also considered and constructed with respect to existing theoretical models of food choice and previous research. This helped the researcher to refine the themes and also to identify novel aspects of the themes. Towards the end of this stage, the researcher also re-read through the transcripts in their entirety, to ascertain if the set of themes captured the overall sentiments or messages of the data and to double-check that any interesting data extracts had not been missed in the coding stages. At the end of this stage, the researcher had analysed all of the data and had a set of unique, refined and data-rich themes which fitted the data and captured the key concepts and messages of the participants' responses.

The fifth stage of the analysis involved refining and naming the themes. This was done by going through each theme and ascertaining it's essence. The researcher identified what was interesting or important for each theme, what story each theme told, how the themes related to each other and fitted into the overall story of the data. A similar process was carried out for any sub-themes within each theme, by identifying how each sub-theme contributed to the story of the theme, and how these sub-themes related to each other. At the end of this stage, the researcher had a finalised list of themes and subthemes. They could define what each theme represented and be able to describe each theme in a couple of sentences, along with its relationship to the overall narrative of the findings. The sixth and final stage was producing the report. The writing up of thematic analysis findings should look to outline, in a concise, detailed and coherent manner, the story that the data tells, both within and across the key themes identified in the analysis. Key themes were laid out in a logical order, and pertinent quotations were included to adequately support the assertions put forward by the researcher. In line with deductive reasoning, key themes were also considered with respect to previous research and theoretical frameworks.

Reflexivity was also practised throughout the analysis process. The researcher took notes during and after each focus group and wrote memos and reflection notes during the analysis. Throughout the analysis process, the research team also met to discuss the analysis and the place of the findings in relation to pre-existing research and models of food choice. Given that deductive analysis involves active consideration of pre-existing research, it was important that the researcher adopt reflexive practices and not try to forcefully fit the results into the framework of previous research. Iterations of the analysis were conducted until the research team were satisfied that the themes were (1) representative of the data, (2) unique, with minimal overlap of data across themes and (3) sufficiently rich in data.

6.4 Findings

6.4.1 Focus Group Participants

The focus group participants consisted of slightly more females than males (11 males, 14 females). Most participants were White British (20 White British, 2 Mixed, 2 Black or Black British, 1 Asian or Asian British). Most participants were from 2 children households (n=16), while a large portion (n=7) were from single-parent households. Index of multiple deprivation (IMD) data was generated, using participants' postcodes volunteered as part of the demographics questionnaire. Participants were quite evenly distributed in terms of IMD deciles, 9 of 23 participants (not all students provided postcodes) lived in areas in the first three deciles, representing the three most deprived areas, 9 participants lived in areas in deciles 4 to 7 inclusive, representing the middle levels of deprivation, while 5 participants lived in areas in the last three deciles, representing the three least deprived areas (see Table 6.1).

Table 6.1. Demographic characteristics of students taking part in the focus group interviews (n=25)

		n
Gender	Male	11
	Female	14
Ethnicity	White British	20
	Black or Black British	2
	Mixed	2
	Asian or Asian British	1
Household	1 adult, 2 children	6
	1 adult, 3 children	1
	2 adults, 1 child	1
	2 adults, 2 children	9
	2 adults, 3 children	1
	3 adults, 2 children	1
	3 adults, 4 children	1
	3 adults, 5 children	1
	4 adults, 5+ children	1
	5+ adults, 4 children	1
How Would you Describe your diet?	Very Healthy	0
	Healthy	10
	Neither Healthy nor Unhealthy	11
	Unhealthy	4
	Very Unhealthy	0
IMD Decile*	1	4
	2	3
	3	2
	4	1
	5	3
	6	2
	7	3
	8	2
	9	0
	10	3

* Index of Multiple Deprivation, Decile 1 is the 10% most deprived areas in the country, based on home postcode. 2 participants not included due to non-response.

6.4.2 Themes

Five key themes were identified from the focus group discussions: (1) queues and knock-on effects, (2) cost, (3) school food choice factors, (4) school food practices, and (5) students' suggestions. The following sections outline each of the five themes and provide relevant quotations from the discussions to support each theme. Table 6.2 outlines the five key themes and their associated sub-themes.

Table 6.2. Key themes and sub-themes from focus group discussions

Themes	Sub-themes
Queues & Knock-on Effects	• Queues • Food Availability • Knock-on Effects
Cost	• Cumulative Cost • Parents as Monitors • Cheaper Prices Elsewhere
School Food Choice Factors	• Sensory Aspects • Variety and Excitement • Habits
School Food Practices	• Menu Changes • School Built Environment • School Rules & Policies (and student disconnect)
Students' suggestions	• Menu/School Food Suggestions • School Organisational Suggestions

Queues & Knock-on Effects

Queues were identified as a critical factor and for students who had a school lunch, their lunchtime experience was depicted as busy, urgent and time pressured and it was apparent that this was mainly due to the long queues. Students described the queues as "very chaotic" and "extremely busy", with some students reporting spending up to 20 minutes in queues during lunch, which itself only lasts 30 minutes.

> *You spend most of your time trying to get the food. And not enough time trying to eat it. And then you have to go to lesson.* Student 18

> *It's just everyone for yourself in the end. Everyone for yourself. It's a war.* Student 16

> *That's how full it gets, like that fast…if you go a minute early, you'll be at the front of the queue but if you go any later, you'll be a mile back.* Student 20

For some students, queues constituted too great a barrier to choosing school food; for example, in one of the discussions, three participants reported not eating anything during the school day, due to the time it takes to queue up. A similar sentiment was reported by another student:

I think my mum complains about me cos I [often] don't get any food cos the line is too long. And I really don't want to be in that line for the rest of lunch so that's why I don't get a lot of food there. Student 1

Closely linked to queue length was food availability. Students relayed a sense of urgency in terms of joining the queue early so that more food options would still be available.

If you're lucky [and] you get out of class a little bit earlier, then you've more chance of getting some food. Student 15
…even a minute early is good. Student 17

Some students reported how their school food choices could only be made at or close to the point of service, when students could see what was still available.

I decide when I'm at the queue and when I'm at the front. Because, if I'm in the queue and there's only about 5 things that I want to have left, normally people will get it. And that's why I go out the front of the queue to see what else, what's left there. Student 1

Some students mentioned how, even if they like school food or have particular school food/drink items they like, queue length and subsequent item (un)availability present significant barriers to having school food.

I think most of the foods quite nice. It's just the time you have to spend to get it. And when you get there, there's none of it left. Student 10

Yeah, all the popular food and the food that you like is gone. So, you have to get something else that you don't like or not get anything at all. So, it's just a waste of time staying in that line. Student 11

Students also mentioned not having enough time to finish their food and getting in trouble for having food leftover in class.

And then you get told off for having food. And it's like you just got it. So you can't really finish it. Student 16
Yeah, and then they try and make you throw it away. Student 20

Long queues were also linked to students' desire to spend time with their friends, with some students feeling forced to choose between the two.

> *Because the queues are too long. And by the time you've finished the queues you've got 5 minutes of your social time like and [there's] no point. Might as well just spend your whole lunch with your friends.* Student 11

Long queues, the time required to get school lunch and subsequent food (unavailability) also informed some students' preference for alternative options, such as getting food at break, getting lunch at nearby outlets or bringing food in from home. For example, student 11 noted that *"the lines are shorter"* at breaktime, while student 15 reported that *"it's a lot busier at lunch"*.

> *The food doesn't go down as fast as well [at breaktime]. So, if you are a little bit late then you might get what you want but at lunch there's no choice.* Student 20

> *...a lot of people just get food at break, eat at break and then don't eat at lunch.* Student 23

Long queues and food (un)availability were also key reasons for students choosing a packed lunch over a school lunch.

> *I brought stuff from home cos at school you have to queue up and it costs more money. So I just bring stuff from home.* Student 3

> *...I probably prefer packed lunches to school dinners. Cos you can choose what you want really. And then there's not loads of people getting stuff from your fridge.* Student 7

Finally, some students mentioned purchasing foods/drinks at nearby outlets including McDonalds, Tesco and Sainsburys, to bring into school for lunch. This was viewed as easier and more convenient than purchasing school food.

> *I sometimes just go to Sainsburys in the morning and get a £3 meal deal. It's faster, cheaper than school.* Student 9

> *It's just easier. It's literally down the road. Takes 5 minutes to get there, 5 minutes to get back. So, you can spend 25 minutes in there.* Student 11

Cost

The cost of school food was also salient to students' school food choices and students frequently made reference to cost throughout the discussions. Some students mentioned that whilst the prices may seem appropriate per purchase, the cumulative cost of daily purchases makes school food too expensive.

> *I want to be school dinners but it's too much money for the whole week. So, I'm just eating them certain days…*Student 10

> *I [have] a bagel or bacon sandwich. But it's all too much. I think it's £1.50 for a bacon sandwich. It doesn't sound [like] a lot but, say for people who don't have a lot of money...* Student 7

> *...I'd probably get a waffle at break, a drink and then at lunch a drink and a pizza. And that's five pounds. It's like, who has the money for that? Like, I know it's not a lot but five pound a day.* Student 11
> *...that's like 25 pound a week.* Student 13
> *Exactly! And a hundred pound a month. That's a lot.* Student 11

Some students also mentioned how their parents also noticed the cost of school food.

> *They did say that sometimes I spend too much money on the food because [of] how expensive it is. And you don't even get much and how expensive it is.* Student 14

> *My mum shouted at me for spending 10 pound in the first week.* Student 20

Cost was also cited as a key comparator used by students to evaluate school lunch and alternative options, particularly lunches at nearby outlets.

> *Even McDonald's is cheaper than the school. Like, the normal burgers you get at McDonalds are 90p. They're probably like £3 here.* Student 10

> *It's probably cheaper. And it tastes better. So I think [if] it's cheaper and tastes better then obviously you're going to go for that one aren't you.* Student 11

> *Get a meal deal from coop cos it's cheaper.* Student 24

Interestingly, some students expressed the belief that the food in school was similar to the food purchased in nearby outlets in terms of nutritional quality and healthiness; therefore, the lower food prices found at nearby outlets appeared even more appealing compared to school food, which students often described as expensive.

I know it's (McDonald's) unhealthy but it's just, it's nicer. Student 12
It's unhealthy here. Student 11
It's the same as the school. Student 13
Exactly. Student 11

School Food Choice Factors

Aside from cost and queues/convenience, students' school food choices were also influenced by a host of other factors, most notably sensory aspects of food, a desire for variety and food choice habits. Whilst the previous factors of cost and queues/convenience were more prominent in students' discussions and hence are themes in their own right, these other factors remain relevant to students' food choices and were also cited as such by students themselves. During the discussions, how the food looked and tasted was often mentioned, for example, student 3 mentioned how "the salad doesn't look great", student 11 described it as being "all moist and wet and not nice", while student 20 claimed it "doesn't taste that fresh." Student 20 also reported that the cheese tasted "plasticy" but also mentioned how visual aspects (e.g. the size of the portions) of foods may encourage purchases.

...sometimes people will come to the table with a brownie, and we'll be like, "Ah brownies look thick today" and then [we] go and get a brownie. Student 20

Some students expressed a desire for more variety, as they referred to there being the same options available in school without much variety; student 3 mentioned how "there's not much other options" in the school canteen, while student 5 spoke of getting "sick of the same thing every day". Student 6 echoed these sentiments and claimed school food provision was repetitive.

Because in school they don't really change the food. They always have the same food, more or less, every day. Student 6

Meanwhile, some students were clear that they "always have" certain foods and their school food choices were habitual.

I always have a sandwich every day. Student 4

I always have cookies. Student 14

It's what they like or what their friends get or just what they're used to having. Student 18
Yeah habit. Student 16

Social influences were also identified as a salient factor involved in students' school food choices. When discussing the social influences of school food choices, students exhibited an adoption of some perceived food norms. Perceived norms relate to what students believe or perceive to be the normative behaviour/belief (i.e. what most students think or do)[33,338]. Perceived norms were reported for various aspects of school food, including consumption of salads, selection of certain meal types (e.g. "plate meals") and health concerns.

…it's like a side plate of salad and everyone just puts it in the bin and just eats the pizza instead of the salad. Student 5
…when they do pasta, everyone has pasta. Student 2

No one eats anything of the healthy variation. Student 19
I don't see anybody with a plate with salad on it. Student 19
But sometimes you can get plate meals. Student 22
Yeah, but hardly anyone gets them. Student 24

School Food Practices

Throughout the focus group discussions, students displayed an engagement with their school environment, being aware of what was provided each day, what changes had been made to the menu recently and what the rules were as it pertained to school food provision (e.g. mandatory salad with pizzas) and school food consumption (e.g. students can't eat hot food at carpeted canteen areas). Students kept abreast of school menu changes and developments, for example, students mentioned changes to chicken wraps provided in schools. In general, students assumed that health considerations were the motive underpinning school food changes.

...they've tried to change all the bread to brown bread cos it's healthier. Student 2

…we used to have pizza every day and now it's like 3 times a week. Student 16
They tried to make it healthier. Student 20

These changes were met with confusion and/or disapproval by students. For example, student 22, when referring to the addition of salad to wraps, described how the school/kitchen staff "will kind of scam you off".

> *They used to do chicken wraps that were really nice, but I don't know why they've stopped…they make the chicken different. So, it isn't as nice, but people still bought it. But then they just stopped them all completely. I don't know why cos everyone used to get them. Everyone used to like them. And they just stopped it.* Student 12

Students also shared views on the school's built environment. For example, students discussed how the school was ill-equipped to accommodate the large numbers of students joining the queues.

> *They try their best to make the queues different but it's really hard to change it cos there's so many students in a certain year and so many students in another year.* Student 19

> *It's [whole school] quite small for a school. Yeah, it's really small. It's like there's not enough space to go anywhere.* Student 7

> *The whole school is crammed when it's raining . . . cos no one goes outside. So there's nowhere to sit.* Student 8

Students also highlighted how the structure and decoration of the canteen space may impede healthier choices.

> *…you won't know all that's there because you can't really see because there's a massive pillar.* Student 23

> *So say if it's a packed pot with sauce in it, you're not allowed to take that into open learning (a carpeted area with computers, desks etc.). . . cos it will cause a mess or something if you drop it.* Student 22
> *Carpet.* Student 23

The large benches in the school canteen also activated social influences of school food, with some students viewing the large benches as a detractor from having a school lunch due to the social implications.

...cos its benches. If you're in there with a little group, you don't really want to sit with them as well. Student 10

Yeah, cos there's these big benches. We used to have just normal seats. But say if there's about 3 out of here and you just want to sit down, then you've got to sit on a massive bench. Like, do you know what I mean? Student 6

Some students illustrated how the school-built environment limited their ability to incorporate healthier choices into a pleasurable overall lunch experience:

Lunch should be a time where everyone's eating their food in peace. But it’s more manic than lessons or that little gap in between lessons where you have to go to your next one. Lunch is even more manic than that. It's like everyone's everywhere. You can't even just sit down and have a conversation without someone or something happening, [people] talking really loud or no room to sit somewhere. Student 12

The final aspect of school food practices discussed by students related to a disconnect between their needs and a number of school rules and policies surrounding school food provision and consumption. One of the more prominent rules/policies mentioned in the discussions was the mandatory addition of a salad with certain main meal items (e.g. pizzas). Students recognised the motives for putting salad on plates (e.g. making meals healthier) but some felt they were not given a choice in the matter. For these students, the mandatory provision of salad prompted resistance.

...you'll say, "I don't want salad." Cos, we just throw it away. And [they say] "I have to give it to you." Student 12

But I think it's that they don't know you're allergic to (i.e. greatly dislike) that salad. And if they're telling you, you have to eat it. Student 11

Many students reported putting the salad in the bin immediately. The resultant food waste was also mentioned as an issue by students.

You'll be like, "I'll just put it in the bin, it’s just a waste" and they're like "I still have to give you salad." Student 20

Yeah, and they tell us they've tried to cut down on waste. And then they just put salad on all the plates. Student 18

...and we don't want it. Student 20

Other rules/policies highlighted by students related to the restriction of certain foods.

You can't buy 2 burgers. Student 11
You can only buy 1 burger or 2 wraps. Student 13

This limitation was met with resistance by some students, who viewed it as an impingement on their customer rights.

They say, "No, it's unhealthy". And?! So what? If I want to be unhealthy, I want to be unhealthy. What are they going to do to stop me?! Student 11

Finally, some students spoke about not being allowed to have drinks (except water) in class. Some students felt this was unfair, and that drinks which were made available in the canteen should be allowed in class. As Student 11 noted, students buy juice "to drink it, not to stare at it."

You're not allowed juice. You're only allowed water. You don't have to ask for water. You can have water out on [your] desk but if it's something else than water then you can't have it. But they still sell it in the canteen. Student 12

If you buy it at break and you drink a bit at break, you have to wait, like, those 2 lessons until lunch to drink it again. That's a bit unfair cos...what if you're thirsty? You bought the drink for a reason. Student 12

Students' Suggestions

During the discussions, adolescents made a number of suggestions with regards to school food. This was largely due to them being asked to suggest a new school/meal drink, although some suggestions extended beyond food provision and emerged more organically during the discussions. Students' suggestions typically fell into one of two categories: (1) school organisational suggestions and (2) school menu suggestions. For example, student 11 identified “either the queues or the big expense” as the most important areas of change. In line with this, one suggestion was to stagger lunchtimes, as illustrated below:

> *Well I think they should have different lunch times…It's quicker and you have more stuff, more time with your friends. But the school don't do that because, I don't know why.* Student 11

> *People would like if it (the queue) was like staggered. So like say year 7s go, then year 8s go.* Student 23

For many students, greater time flexibility was a priority. One student suggested placing fingerprint scanners on vending machines (which would be linked to their account in the same way that cashless catering machines operate), enabling students only wanting a drink to queue separately from those queueing for food.

> *Or there could be vending machines. Cos on PE days everyone's quite thirsty. There could be vending machines with the same things as at the counter….There should be vending machines with your fingerprint on them. Like, takes it off your parent pay account as well.* Student 5

Students also made a number of suggestions regarding the menu. One such suggestion focused on adjusting the prices of certain items to encourage healthier eating. Interestingly, some of these students reported incorrect prices whilst doing so (e.g. students listed fruit as costing 80p; however actual prices were 27p for whole fruit and 94p for fruit pots).

> *...fruit should be free because of how they're selling the salad free with things. They should sell the fruit as well because fruit is nicer than vegetables*…Student 11

> *It's like 80p. I know that's not a lot, but people might not want to pay 80p to get fruit, when they could get it for free*…Student 11

Students also suggested some new food options. Many of these included grab-and-go options, such as energy drinks, toasted sandwiches and pot noodles. Healthier school food suggestions included enabling students to tailor their food options.

> *...to choose what gets put on the salad. So you can get stuff that you do like, rather than what you don't like.* Student 4

...spinach and like cucumber and cheese and maybe some pepper. Student 4

Yeah, it'd be a lot better. Student 5
Yeah, more people would eat the salad. Student 2
It's what you want to eat. Student 3

6.5 Discussion

This study aimed to explore adolescents' experience of school food throughout the school day. In general, adolescents described their school lunchtime experience as time-pressured and hectic; meanwhile, adolescents frequently compared their school food and school food experience to alternative options (e.g. packed lunches, food from nearby outlets), and largely reported that school food and the school food environment may not be conducive to their needs.

Adolescents' lunchtime experience was characterised by long queues, food (un)availability and high food costs. These three factors (queue length, food availability and cost) have also been highlighted in previous research[23,24,339], suggesting that these are pertinent aspects of students' lunchtime experience more generally. Most prominent of these aspects were the queues, which had a cascading effect on students' school food choices and dining experience. Findings suggest that queues can influence (a) whether students opt for a school lunch or an alternative option (e.g. bring in a packed lunch), (b) whether students bother getting lunch at all, (c) what foods are available when students come to choose, (d) students' available time left to socialise and (e) students' overall lunch experience.

In general, students described the dining space as ill-equipped to accommodate the large number of students and depicted the school dining experience as manic and time pressured. Students described how long queues and its knock-on effects (e.g. food (un)availability, available seating, noise, time available to eat lunch, time available to socialise), along with certain school food rules/policies (e.g. not being permitted to eat hot food in areas with carpet) can impinge on their ability to have an enjoyable lunchtime experience. This echoes findings from previous research[14,18–22] in illustrating the importance of an enjoyable dining experience (i.e. shorter queues, having a place to sit, having time to spend with friends) in encouraging school lunch take up. Moreover, a previous multi-level modelling study by Townsend[249] found that increased time at lunch was associated with higher odds of students eating fruit for lunch (2.20; 95 % CI 1.18, 4.11), eating fruit and vegetables on a daily basis

(2.15; 95 % CI 1.33, 3.47), and decreased odds of eating unhealthy foods per day (0.44; 95 % CI 0.24, 0.80). The present findings further highlight the importance of time in influencing adolescents' school food choices.

Cost was also prominent in adolescents' descriptions of their lunchtime experience. Students reported that school food was expensive, particularly when considering the cumulative cost of getting school food every day. Bringing in packed lunches or purchasing foods from nearby outlets were identified as more cost-effective than purchasing a school lunch. This aligns with figures from the School Food Plan[227], which indicate that packed lunches can be made by parents for a much cheaper price than paying for school lunches (less then 50p for a packed lunch compared to £2.00 for a school lunch). Moreover, an ethnographic study of London secondary school students' lunchtime choices found they could purchase meal deals (meal with a soft drink) from nearby food outlets for between £0.99 and £1.50[327]. In contrast, observation of canteen data (chapter 5) indicated that in school 1, this same deal (main meal with a soft drink) would cost £2.40. School 2 was more competitive in this regard, as their main meal deal (also priced at £2.40) included a main meal, drink and dessert.

Previous research indicates that packed lunches have an inferior nutrient profile compared to school lunches[231,232]. Meanwhile, purchasing lunch from nearby outlets is associated with poorer food choices[26] and decreased diet quality[17] compared to packed lunches and school lunches. Despite this however, students and parents may feel that school lunch is too costly, and there were indications of this in the current study, as adolescents mentioned how their parents expressed concern over the amount of money they spend on school food. These findings suggest that cost remains a barrier to increasing school food uptake, and that providing healthy but competitive food continues to be a challenge for school food providers.

Throughout the discussions, adolescents compared getting lunch at school to alternative options (e.g. getting food at mid-morning break, bringing in a packed lunch or purchasing food from nearby outlets). In doing so, students could better contextualise their school lunch experience and highlight positive and negative aspects thereof. Many students reported a preference for alternative options, viewing them as more tailored to their needs (e.g. packed lunch, fast food, food at home), cheaper (e.g. packed lunch, food from nearby shops) or more convenient (e.g. packed lunch, food from nearby shop, getting food at break). The comparisons made by students illustrate how schools must compete for their custom[14,25,245,328,340,341].

During the discussions, adolescents exhibited the adoption of some perceived norms (e.g. everyone throws salad in the bin, no one eats healthy). Previous research suggests adolescents may be more susceptible to peer influences compared to other age cohorts[342]. Moreover, survey studies with 264 English[242] and 4679 American[211] adolescents found that adolescents may misperceive descriptive norms (what an individual thinks the normative behaviour is) and injunctive norms (how an individual perceives other members of the social group think about the normative behaviour)[33] (e.g. overestimating peers' snack and sugar-sweetened beverage intake, underestimating peers' fruit and vegetable consumption and misperceiving peers' attitudes toward these dietary behaviours). These misperceptions are also associated with adolescents' own dietary behaviours[242]. Social norms may therefore present a valuable opportunity for researchers to try and influence school food choice, and the ubiquity attached to normative behaviours by some students in the present study supports this. That said, further research is needed to better understand how norms-based messaging may influence adolescents' school food choices. Whilst evidence suggests descriptive norms can positively influence those who are performing below the descriptive norm[30], little is known about how norm messaging may influence individuals performing above the descriptive norm; some research suggests a boomerang effect, whereby those performing above the descriptive norm regress to meet the behavioural norm once made aware of it[343,344].

In line with deductive practices, coding was theoretically driven, with themes considered in relation to the SEM[31] and FCPM[32]. The findings from this study can be considered in relation to the SEM, which suggests that influences of food choice operate at different levels (Policy, Community, Institutional, Interpersonal and Individual) and that these influences are interactive. For example, adolescents described how large benches (institutional level) affect school food choices as the social implications of sitting in a small group on a large bench (interpersonal level) deterred students from having school main meals. Other students described how the busy and urgent nature of getting school lunches (long queues, uncertainty regarding food availability) (institutional level) prompted some students to consider alternative lunch options, such as nearby outlets (community level), where they could relax with friends (interpersonal level) and/or spend less money (intrapersonal level). Another example was the mandatory provision of salads with certain meals (organisational level), which facilitated the normative behaviour of throwing away the salad (interpersonal level); meanwhile, the resultant food waste influenced some students' perspective on the school's health messaging efforts (intrapersonal level). The adoption of deductive analysis, and consideration of the findings in relation to the SEM thus highlights the complexity of school food choices and emphasises the need for increased student consultation in order to facilitate positive dietary habits.

Findings may also be considered with respect to the FCPM. For example, a key benefit of the FCPM is its consideration of a life-course approach and the present findings helped to illustrate adolescents as autonomous consumers, with a growing sense of what they want as consumers. For example, adolescents reported purchasing lunches from nearby outlets as it better met their needs for lower prices, time to socialise and convenience; this would not be an option for younger primary school students. Linked to this are the key influences outlined in the FCPM, namely ideals, personal factors (e.g. some students were allergic to the salad), resources (e.g. time taken up by queueing, cost of school food, (un)availability of certain school food options) and food context (e.g. no hot food allowed in carpeted canteen areas, lack of space to sit in canteen), all of which were relevant in adolescents' discussions. Finally, adolescents also exhibited value negotiations as part of their personal system, for example, values of cost and convenience were key factors in determining where students chose to get their school lunch, and if choosing within the canteen, what they chose (i.e. buying convenience items rather than main meals). Many of these values and influences were expressed in students' suggestions, which centred around reducing queue length, making healthier food cheaper and letting students personalise their food. Together, these points illustrate how student consultation, in tandem with consideration of relevant conceptual models of food choice, can help to pinpoint key areas of change/influence for school staff and school food policymakers.

6.6 Implications for Policy & Practice

The findings from the present study suggest that schools compete with nearby outlets or packed lunches from home in terms of cost and convenience. With respect to cost, reductions and/or offers may make a difference and entice students to have a school lunch. The School Food Plan[227] cites economies of scale, whereby school food provision can become increasingly profitable and healthy. The plan also reports that schools need to reach an average school lunch uptake of 50% nationally (or 100 meals per day) in order to achieve financial viability. However, indications are that school food uptake is closer to 39.8%[214] or 41.1%[17]. Moreover, little is known about what price points are amenable to students, at what price school food uptake could increase sufficiently to achieve viability, or if such a balance between price and uptake even exists. Further research is needed in this area, to ascertain what is realistically achievable in terms of developing these economies of scale.

Secondary school caterers in England operate under considerable financial pressure. For example, the School Food Plan highlighted that school food provision has operated at a financial loss (without government subsidies) for decades[227]; a 2012 survey by the Children's Food Trust reported that school meals were charged at an average of £2.03, while production and labour costs stood at £2.41[214]. Similar observations have been made internationally; for example, a review of school food policy implementation identified financial parameters as a key barrier to successful implementation as healthy school food provision was associated with increased costs and decreased canteen profits and revenue[209]. Clarity is needed regarding what is most appropriate for UK secondary schools to charge for school food, from both a provision sustainability standpoint and a student satisfaction standpoint.

As students suggested, the introduction of staggered lunchtimes, separate vending machines for drinks, and separate queues for different foods (main meals or snacks) could help to lessen the amount of time students have to queue in order to get a school lunch. Whilst nutritional outcomes are of obvious importance, it is also important for policymakers and schools to consider the temporal and structural aspects of school dining in order to maximise uptake[345]. Moreover, students may opt for the healthier meals of the day if they have the shortest queue. For example, a study by Hanks et al.[29] found that introducing a convenience line for only healthy foods increased sales of healthy foods in US high school cafeterias by 18%. Additional changes to improve the dining environment could include providing extra seating, smaller multiple benches and removing carpet from dining spaces (or allowing students to have hot food in carpeted areas). These were all mentioned by students in the present study and thus may prove salient to their overall lunchtime experience.

Adolescents are experienced consumers and are accustomed to commercial food service providers (which provide convenience options which cater to their needs). In turn, adolescents may view school food in this light also and carry these expectations through to school food. To some extent, school food provision does resemble high street outlets, offering various options, including energy-dense, grab-and-go items that are high in levels of free sugars, sodium and saturated fat (e.g. as seen in chapters 3, 4 and 5). A criticism of such provision is that it perpetuates the notion that less healthy items may be consumed frequently rather than occasionally[14]. Meanwhile, previous qualitative[14] and quantitative research[15,213] has found that schools may encourage unhealthy dietary behaviours via in-school promotion (e.g. prominent placement of less healthy foods, in-school cake sales)[14], ample availability and provision of less healthy grab-and-go items (e.g. high-sugar beverages, chips, sweet snacks)[14,15] and limited provision and promotion of healthier options such as fruit and vegetables[213]. This was reflected in the present study, as some students perceived school food to be equally as unhealthy as McDonald's. As such, provision of more "sophisticated" healthy foods (e.g. salad bars, plant-based snacks etc.) may be a worthy area of focus for school food providers.

Whilst previous research[17,26,231,232] has found evidence for the healthiness of school food in comparison to alternatives, students in the present study viewed school food and alternatives (e.g. McDonald's) to be equally as unhealthy. In this way, students' perceptions may be more impactful than objective assessments in terms of influencing behaviour. Additional efforts are needed to communicate the nutritional quality of school food to students more effectively and to promote school foods as a healthier option than either lunches from nearby outlets or lunches brought from home.

Finally, consistent consultation with students is imperative, concerning issues such as school food rules and policies, menu formulation and temporal, physical aspects of the school lunch experience. In order to bolster the relevance and effectiveness of any future intervention and policy efforts, it is essential that students are consulted and viewed as co-creators of the school food environment[332], as efforts based solely on adults' presuppositions or theoretical knowledge hold limited potential in effecting dietary change within this unique cohort. Indeed, findings from the present study indicated a disconnect between students' views and the school's in terms of school catering practices. For example, students in the present study reported confusion and disapproval regarding some menu changes and school rules and policies (e.g. mandatory salad with pizzas, alteration of chicken wraps). Students also highlighted incongruities within the school food messaging efforts (e.g. mandatory salad versus food waste, drinks sold at canteen but not allowed outside of service times). This may point to a need for further efforts to inform students and publicise school catering changes, as school-student disconnect, and student messaging incongruities could potentially detract these students from having a school lunch. This echoes previous qualitative research on diet and PA behaviours in secondary school settings which highlighted a lack of consultation with students[20,107,331–334].

The value of student consultation was evident in the present study; students displayed potential as coproducers and provided a number of suggestions which they believed could encourage school meal uptake (e.g. staggering lunchtimes and having more vending machines to reduce queueing times, enabling students to personalise their food, lowering prices of healthier items). Findings from this study thus contribute to the evidence base in three ways: (1) illustrating how students react to and perceive the lack of consultation regarding school food rules and menu changes, (2) showcasing students' ability as school food thought-leaders and (3) highlighting points of particular student concern (e.g. queues, cost).

6.7 Strengths & Limitations

The focus group approach and naturalistic environment enabled candid conversations among students. The schedule (including the ice-breaker activities) succeeded in letting students relax, start thinking about school food, and have an honest discussion about school food. Subsequently, discussions focused on specific aspects of adolescents' lunchtime experience, thus gaining a deeper level of insight and highlighting their potential as thought-leaders in this regard. Finally, the inclusion of mixed groups provided a wide array of perspectives and experiences.

However, this study does have some limitations and the findings should be considered in light of these. One limitation was that students were recruited directly by school staff. This leaves potential that the students in the discussions may differ from the typical student; for example, the students who agreed to participate may have a greater personal interest in or knowledge of nutrition compared to the average student. Being in the same year group in the same school, the students all knew each other, which may also have influenced the responses. Although efforts were made to mitigate against social desirability bias[255], it still poses a limitation. While the school was not atypical (e.g. number of pupils on roll approximated national averages) it had a lower FSM% compared to national averages, which is also worth noting. Finally, the schedule focused on students' individual lunchtime experience and how they themselves make food choices. Whilst norms were evident during the discussions, the potential influence of peers and/or family was not explicitly investigated and inclusion of peer and family influences in the schedule may have provided a wider context to students' school food choices.

6.8 Implications for PhD Project

This chapter addressed the final aim of the thesis, to explore how and why students make their food choices within the school environment. The findings indicated that students make their school food choices under considerable time pressure, due in large part to the time needed to queue for school food, and also the chance that desired items may not be available if students queue up at a later point during the lunchbreak. School food choices are also made with financial considerations, due to the reportedly high cost of school food. Findings also indicated that students consider school food choices, and their appeal, in relation to alternatives such as getting food from a nearby outlet or bringing food in from home. Therefore, this study helps to achieve the final aim of the thesis, by highlighting key factors underpinning how and why students make their school food choices.

This chapter also provides a valuable contribution to this thesis, by giving context and insight to some of the findings from the previous chapters. For example, in chapter 3 catering staff members alluded to students' preference for sweet and savoury snacks. This reported bias was later confirmed in chapter 5 as drinks and snacks dominated students' school food choices. Moreover, many of these popular items were found to be high in free sugars and low in micronutrient density in chapter 4. This chapter provides insight to these findings, as adolescents described how the time-pressured and manic nature of their lunchtime environment, together with factors of cost, availability and social norms can encourage selection of these convenience items.

In exploring adolescents' lunchtime experience, from their perspective, this chapter ventures to the opposite side of the counter (i.e. to the students' side/perspective), thus providing greater balance to the project. In capturing the students' perspectives, and gathering their suggestions for school food changes, this chapter also helps to provide context to some of the implications mentioned in previous chapters. For example, reformulation of popular items or replacement of unhealthy items with healthier items on its own is unlikely to encourage healthier school food choices or increase school food uptake. Instead, there is a need for policymakers to also consider temporal and contextual factors, as this chapter illustrated. For example, persistently long queues or expensive school food items will remain deterrents for students choosing school food, regardless of what changes are made to the foods themselves. The suggestions for school food provided by students in this chapter also help to bolster a running argument in this thesis: that researchers, school staff, and school food policymakers should engage students as co-designers and co-producers of any efforts to bolster school food uptake, or any initiatives to facilitate heathier school food choices.

6.9 Conclusion

When making school food choices, students must consider various factors, and compare the weight of these factors in relation to choosing a school lunch or a school lunch alternative. Queues, convenience and cost are particularly salient factors to students' food choices and policymakers should emphasise these factors as such when looking to bolster school food uptake. Students should be consulted as coproducers regarding the design and implementation of any school food initiatives, as this holds the most promise in terms of pinpointing priority areas of concern and aligning public health concerns with adolescent norms, needs and beliefs.

Chapter 7. “I control what I eat and I'm sensible with what I eat, apart from school” – A Qualitative Study of Adolescents’ Food Choices and the School Environment

7.1 Introduction

This chapter discusses the findings from the second focus group study and the fourth and final study in the PhD thesis. Chapter 3 gave the first indication that students’ choices bias toward less healthy convenience options, Chapter 5 confirmed this and illustrated how students’ choices could be greatly improved upon, both in terms of which foods/drinks they choose and the nutritional composition of these choices. Similar to chapter 6, the present chapter explores how students make their school food choices. The school environment remained the primary focus, as it still provides the greatest opportunity for future dietary intervention, as highlighted in Chapter 1. That said, students’ food choices during the school day can be influenced by factors both within (e.g. queue length, food availability[23,24]) and beyond the school gate (e.g. parental views[52,206,346], presence of nearby food outlets[17,25,26] etc.). Furthermore, a large percentage (circa 60%)[17,214,217] of students do not have a school lunch, but instead acquire lunch from nearby outlets or bring lunch in from home. As such, it was important to enable students to discuss their food choices both within and beyond the school environment to explore how different environments may promote different food choices and dietary behaviours. Therefore, in addition to discussing school-specific influences (e.g. queues, food availability, time allocated for lunch), the present study also asked students about other potential factors contributing towards school food choices, namely the influence of family and friends. This marked a point of distinction from chapter 6 but also facilitated further insight generation by expanding the context of school food choices.

7.2 Aims

The aim of this study was to understand, from the students’ perspective, how they make their food choices throughout the school day and how they engage with their environments during the food choice process.

7.3 Methods

7.3.1 Study Design

Seven semi-structured focus group interviews were conducted with adolescents (Year 9, 13-14 years) (n=28) in a secondary school in Northern England. Focus group discussions were selected as they offer a more naturalistic environment in which students can speak candidly. Year 9 students were chosen as they represent a transitional period between early and mid-adolescence. This year group was also amenable to school management, as it avoided disrupting/distracting students in important examination year groups. Each focus group included students of mixed genders, ethnicities and academic abilities. Mixed groups were chosen in an effort to better capture the views of the wider student population (more details on recruitment are available in section 3.3).

7.3.2 Schedule Development

Development of the focus group schedule occurred at the same time as the schedule used in chapter 6. Whilst there was commonality across the two schedules, distinctions were made in terms of scope and focus. Development of both FG schedules was informed by the socio-ecological model (SEM)[31] and the food choice process model (FCPM)[32]. In terms of the SEM, the schedule developed for this study broadly resembled the schedule used in chapter 6, with questions relating to the institutional, interpersonal and individual levels of influence (e.g. covering topics such as school food provision, school lunchtime experience, school food rules and, personal food choices, pertinent food choice factors). However, by extending beyond the school gate, the present schedule also explored influences at the community level of influence.

In terms of the FCPM, the present schedule (and the chapter 6 schedule) touched on each of the three core components of the FCPM, i.e. influences, life course and experiences and personal food system. This was done by exploring how students manage their various food choice influences (e.g. social aspects of food, queues and food availability), whilst concurrently curating their own personal food system. A point of distinction between the chapter 6 schedule and the present schedule was the exploration of the potential influence of family and the home environment. As such, the schedule for this study extended its scope and (compared to the chapter 6 schedule) gave greater consideration to the third major component of the FCPM, adolescents' life-course events and experiences.

The schedule included a series of questions, tasks and prompts, all relating to school food choices. Question topics included school food provision, students' food choices at school and at home, how students make their food choices and the potential influence of friends and family on food choices. The question topics broadly resembled those from chapter 6 with common topics including school food provision, students' school food choices, along with how they make these choices. However, rather than being solely focused on the school environment, the present FG schedule also included questions on food at home and the potential influence of friends and family on students' school food choices. As such, this schedule intended to look beyond the immediate physical school environment and discuss more latent, social aspects (peer/parental influence) of school food choices. The schedule also endeavoured to extend the scope of discussion beyond the school gate to look at the potential influence of outside environments, in this case, the home environment.

Questions were written as open-ended, in an effort to avoid asking leading questions, discourage yes/no responses and encourage participants to discuss the question rather than simply answer it. The researcher also tried to mitigate against social desirability biases[255], whereby participants volunteer responses that they think are more socially acceptable, rather than ones which reflect their reality[255]. Such efforts included assuring students their responses would be anonymous in any future publication or report, asking indirect questions (e.g. what does the "average" student choose?) and insisting that there were no right or wrong answers. Two tasks were developed to serve as ice breakers, get students thinking about school food and promote discussion. These were to (1) recall as many food and drink items that were provided in the school canteen as possible and (2) name what they had for lunch the previous day, along with 3 words to describe it. The schedule was reviewed by an expert panel of external researchers/practitioners in public health nutrition and school food provision to gain expert feedback on the scope of the questions, along with the question wording and order. Feedback was also requested from six parents of secondary school students, to ensure that the questions made sense and also to see if there were any topics which parents felt were important to ask that were not being addressed.

A pilot focus group was also conducted with four older adolescents (18-19 years); ideally this pilot would've been conducted with adolescents still in secondary school, however the research team were unable to recruit adolescents at the time of schedule development. The purpose of the pilot focus group was to see how the schedule worked in a real-life setting, including how questions flowed, how participants perceived and comprehended the questions, how long the responses were, how long the focus group was etc. This helped to improve the structure of the schedule and helped the researcher to foresee potential challenges in carrying out the discussions (e.g. inserting time points for each question). Improvements and refinements were made to the question order and wording thereafter, to aid question comprehension and flow and support the quality of the data collected (please see Appendix 5 for FG schedule).

7.3.3 Procedure

In person focus group interviews were conducted at school during the school day. A plain, quiet room was selected as the discussion site, to limit distractions from both outside and inside the room. The researcher welcomed students as they entered the room and asked each student to take a seat wherever they wished. Prior to each FG, the researcher gave all students an information sheet outlining what the study entailed and what the collected data would be used for. Students also received a consent form with their information sheet. Before the FG commenced, the researcher outlined what was in the information sheet and consent form and asked the students if they had any questions. At this point, the researcher gave a brief outline of the discussion to follow and what the discussion would generally be focusing on (i.e. what students choose to eat and drink at school). During the discussions, the researcher sat amongst the students in a square formation and offered questions. The researcher acted as a facilitator, posing questions but letting students lead the discussion thereafter. In this way, the conversations more closely resembled a genuine conversation amongst students. At the end of each discussion, participants were asked to complete a short demographics questionnaire, which included questions on age, gender and participants' perception of their own diet. Discussions were audio-recorded, transcripts were typed up verbatim and anonymised prior to analysis. Seven FGs were carried out, lasting approximately 45 minutes on average. This was sufficient to reach data saturation[335], whereby similar responses appear again and again and no new insights are gathered.

7.3.4 Analysis

Transcripts were analysed using an inductive thematic approach. As the researcher read, and re-read the transcripts, common responses or sentiments were grouped into nodes. Through each subsequent iteration of the analysis, new nodes were created, existing nodes altered and grouped into themes. Themes were reviewed, reconstructed and refined until a small number of unique, data rich themes remained. Throughout this process, the research team met to discuss the themes and consider how they represented the data and related to one another. Reflexive practices were undertaken throughout the data collection and analysis processes; the researcher took reflection notes during and after each focus group discussion, wrote memos and reflection notes during the analysis and brought reflection notes to each research group meeting. Four iterations of the analysis were conducted in total, after which the research team was satisfied that the themes were (1) representative of the data, (2) unique (themes are distinct from each other, with minimal sharing of nodes between themes and (3) sufficiently rich in data. NVivo12 software was used to facilitate data management.

7.4 Findings

7.4.1 Questionnaire Responses

Table 7.1 provides a breakdown of the questionnaire responses. Participants were almost equally split by gender (13 males, 15 females). The vast majority of participants were White British (26 White British; 2 Mixed/Multiple ethnic groups - White and Black African). A majority of participants were from 2 children households (n=17), while a large portion (n=12) of participants came from single-parent households. Index of multiple deprivation (IMD) data was generated, using participants' postcodes, which were volunteered as part of the demographics questionnaire. Almost half of the participants who gave their postcode (10/22) lived in areas in either the 7^{th} or 8^{th} decile, representing the two least deprived areas in the country. Half as many participants (n=5) came from areas in the 1^{st} or 2^{nd} decile, representing the two most deprived areas.

Table 7.1. Demographic characteristics of adolescents taking part in the focus group discussions

		N
Gender	Male	13
	Female	15
Ethnicity	Mixed (White and Black African)	2
	White British	26
Household	1 adult, 1 child	1
	1 adult, 2 children	5
	1 adult, 3 children	3
	1 adult, 4 children	3
	2 adults, 2 children	6
	2 adults, 3 children	1
	3 adults, 1 child	1
	3 adults, 2 children	4
	3 adults, 5 children	2
	4 adults, 2 children	2
How would you describe your diet?	Very Unhealthy	2
	Unhealthy	3
	Neither healthy nor unhealthy	11
	Healthy	12
	Very Healthy	0
IMD Decile*	1	3
	2	4
	3	2
	4	1
	5	0
	6	2
	7	4
	8	6

* Index of Multiple Deprivation, Decile 1 is the 10% most deprived areas in the country, based on home postcode. 6 participants not included due to non-response.

7.4.2 Themes

Six themes were identified from the data: (1) parents' and adolescents' roles in the home food environment, (2) burgeoning food autonomy, (3) school food choice factors, (4) social aspects of school food (5) home versus school and (6) food knowledge & beliefs. Students identified two distinct environments during the focus group discussions: the home and school environments. Students juxtaposed the two, in terms of food provision, food choices, rules and customs surrounding food choice. This juxtaposition provided an indirect but important influence on adolescents' school food choices. Figure 7.1 outlines students' distinction between the school and home environments, along with how the six themes are posited between the two environments. The figure also illustrates how both the home and school environments directly and indirectly influence school food choices.

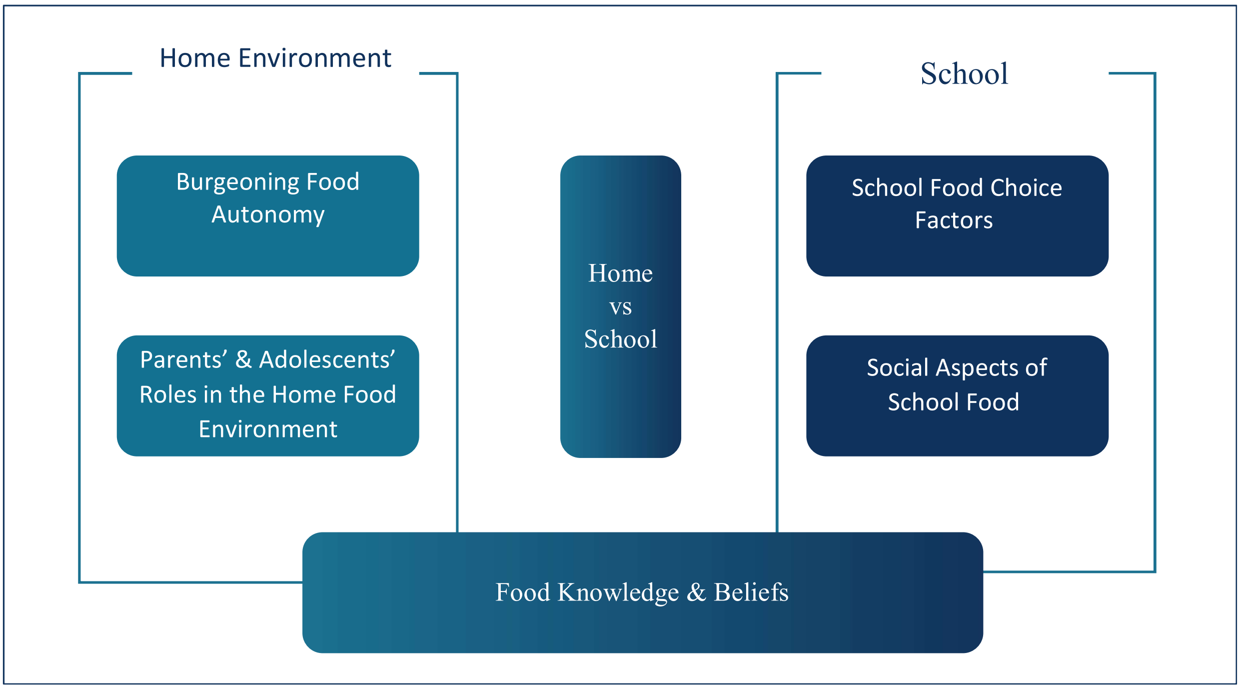

Figure 7.1. Adolescents' food choice at school: the six key themes and how these relate to the school and home environments, as distinguished by adolescents

Parents' & Students' Roles in the Home Food Environment

Students depicted the food choice process at home as structured and clearly defined. They reported that parents were primarily responsible for purchasing and preparing foods, and crucially, providing food options for adolescents to choose from. In this way, parents assumed the role of nutritional gatekeepers.

> *...you can decide [what to eat from] what's in the house. But when they're shopping it's not your choice. But whatever's in the house, it's kind of your choice [what to eat]*…Student 16

Students outlined how parents define the culture of the home food environment and students' food choices therewithin. Students described how parents establish the home food culture both implicitly, by modelling health behaviours to their children; and explicitly, by setting the rules, routines and customs surrounding food at home.

Mum will always go out at the weekend and she'll pick loads of fresh ingredients from the shop and then she'll make either a curry or a Bolognese…She'll always go to the shop and make a fresh meal every day and it'll be different every day…Student 6

…a rule my parents have, not necessarily for me, but for my sister, is that if she doesn't eat enough of her meal, she won't have anything after it. You know, like a dessert. Student 23

Students also acknowledged their influence at home, recognising that whilst parents hold ultimate control over food purchasing and provision, they still must provide foods which their children will eat.

…they know what we want, don't they. So, if Student 8 really liked pasta all the time, her mum would know to get some of it so Student 8 can have it one night…Student 7

…your parents know what you like, so they just make it for you. Student 22

Moreover, students reported exerting pester power (i.e. repeatedly requesting/suggesting an item) to persuade parents to purchase desirable food items, thus broadening their home food choice parameters.

…usually after a certain amount of time of me asking for the same thing, they usually just start buying it…Student 9

Burgeoning Food Autonomy

In general, adolescents admitted that they are still largely dependent on their parents/guardians. However, they also reported experiencing some instances of food autonomy. This burgeoning food autonomy was predominantly described within the home environment. Adolescents recalled times when it was clear that they had enacted instances of food autonomy, for example by taking on select cooking tasks, managing some aspects of their diet and taking greater ownership of their food choices.

…we take on the role while my parents work, me and my big brother, we both do the cooking. I cook more of the difficult food, whereas he dishes it out, makes sure that it's healthy. Makes sure that we have a balanced tea…Student 13

*I think cooking is a good essential for like, if your parents are gonna be home late, you could cook for them…*Student 6

Another instance of burgeoning autonomy involved students managing their diet at home and feeling more responsible for their food choices.

I probably make my own lunch and I try to put stuff in it that'd be healthy. Student 11

I won't go downstairs and take everything that I want. If I want to have something, I'll limit myself to how much I can have. I won't just eat it all at once. Student 9

Some students described diet management more generally, extending their sense of autonomy beyond the home environment.

We (Student 12 and siblings) limited our fizzy drinks as well. We build like a tin of coke cans or pepsi and it has to last for a few months. If not, we don't get anymore. Student 12

I feel like a lot of people when they're our age, not necessarily year 7s and 8s but when they get to our age, they would love a salad bar [in school] because they try and be healthy and go on diets. Well not diets but like, just try and eat healthier. Student 23

School Food Choice Factors

While the home environment was depicted as a structured, clearly defined food environment, students described the school food environment as being much more complex and dynamic in comparison. Students discussed how food choices within the school environment can be influenced by both general (time, cost, taste) and school-specific (e.g. time, availability of options) factors. Queue length, and the time spent in queues was highlighted as being particularly important. Students mentioned choosing convenient, grab-and-go foods in order to have more time to socialise with their friends, go outside and relax. For instance, one student mentioned how they simply opt for the shortest queue.

There's always big queues and I can't deal with queues so it's a bit like "oh there's no queue there, I'll get something from there". Student 7

Some students reported that the time dedicated to queuing can lead them to compromise other aspects of their lunch, with some opting to not purchase anything at lunch due to the length of the queues.

You might skip lunch cos you can't be bothered waiting in the queue. Student 16

Cos we only get half an hour for lunch and if the queue's massive, you're either not going to eat anything or go into the savage [long] queue. Student 23

Cost was also highlighted as a pertinent factor, with adolescents referring to "ridiculous prices" and "overpriced" cookies (a popular school food item) for example, or opting for packed lunches as they were "cheaper". Interestingly, some students discussed how cost was a factor in their decision to not choose "the main meal" (typically a nutrient dense option):

The main meal is like £2.16, but then a wrap is like 1 pound something. Student 28
A piece of pizza's a quid. And the brownies and stuff are [under a] quid. Student 26
. . . *In comparison to the main meals, there's a massive difference.* Student 26

Students highlighted several other food choice factors, including sensory aspects (e.g. taste, texture, appearance), cost and habits. Some students reported a preference for *"filling food"* and mentioned that fruit needed to *"look as appealing"* in order for students to choose it over less healthy options. For other students, however, food choice was *"all about taste"*. Other notable factors included the variety of items provided by schools, along with the relative visibility of healthier items, most notably fruit. Interestingly however, other students simply attributed their choices to habit:

There's not a day that goes by that I don't eat a cookie at school, to be honest. Student 9

We know what it tastes like so we're not going to hate it all the time. We're not going to want to try something new when we've already got something that we like. Student 13

Social Components of School Food

One of the most important school-specific factors, and a key marker of distinction between the home and school environments, was the social components of school food, which students referred to frequently during the discussions.

> *…you might change your actual eating pattern because you want to fit in with others, instead of being on your lonesome. Unless you want to be outcasted or put with, sort of, the people who don't contribute or fit into anything.* Student 13

Many students reported an inextricable link between school food choices and their social implications. Social norms and adhering to social convention were viewed as greatly important. In light of this, some students reported foregoing their own food preferences in order to toe the socially accepted line:

> *I see where my mates are queueing up. See if I want a main meal but all my mates are getting like a wrap or something, I'll go get a wrap.* Student 21

Wider social aspects, even those unrelated to the foods themselves, had an indirect influence on students' food choices. For example, one student illustrated how the social risk incurred from queueing alone can have a knock-on effect on food choices.

> *You kind of eat the same stuff because girls specifically, they don't like to stand in the queue by themself. So, you wait until someone else wants to get food and then you go in the queue together and normally get the same thing…Because you go to the same place and why not. We like the same stuff. Same taste buds.* Student 7

Some students went a step further, describing how the wider social milieu around food can take precedence over the food itself.

> *The food's irrelevant. At the end of the day, it's more about where you sit, what you're doing. How many of you is there.* Student 23

Home Versus School

Throughout the discussions, students differentiated between the home and school environments, identifying several differences between the two. Students generally expressed a preference for food provision at home compared to in school, perceiving food at home as being fresher, more flavourful and more diligently prepared. Students also reported a greater variety of foods provided at home, along with having more time to have their meal. Ultimately, students acknowledged differences in how they ate at home versus at school:

I eat differently at home than I do at school. Student 4

I eat a lot of healthy stuff at home, more so than I do at school. Student 18

Several students claimed to "prefer the food at home", deeming the food to be "healthier at home". Other students juxtaposed food choices in the two respective environments, reportedly maintaining healthy choices at home and reserving less healthy food choices for the school environment:

I do get stuff at school, that's usually a pizza. But then I'll get a wrap occasionally but at home, I'm always having healthy stuff like chicken and salad and stuff like that. But it's different in school, yeah. Student 6

One student attributed this difference in food choice behaviour to the lower level of supervision at school compared to at home.

...cos in school you're choosing what you want. Whereas at home you're influenced more by your parents. So, at school, that's why people normally do just get brownies and stuff. Because their parents aren't saying to them "right you're having this." You know you're choosing, which is why people just get the bad food. Student 25

Food Knowledge & Beliefs

Throughout the focus groups, students displayed a good level of food/nutrition knowledge, in terms of the nutritional content of certain foods, what constitutes a healthy diet, and food preparation/cooking. Students made reference to the Eatwell guide, sugar taxes and were able to broadly describe and define a healthy diet. However, food and nutrition knowledge was not viewed as important at present, but instead was described as being important for later in life, for the purposes of gaining independence and maintaining personal health.

*Well if I don't change my diet, I'm going to end up with bad illnesses when I get older…*Student 15

*…when you move out [from home], you have to know what is healthy, what you should live on, what you should buy…*Student 13

Despite showcasing a good level of food knowledge, students also exhibited some unhelpful dietary rationalisations and beliefs. For example, students mentioned their need to meet daily energy requirements and the perceived necessity of high-energy foods/drinks. The most commonly mentioned foods in this context included high sugar foods and energy drinks, which students viewed as practical, immediate sources of energy and an easy way to fuel themselves through the school day.

…after three exhausting periods [lessons] you just want to get your energy back up so you have something at lunchtime. Student 4

*Or an energy drink if you want energy...so sugary drink maybe…*Student 12

…cos it's got a lot of sugar in it so it boosts you with energy. Student 10

Another dietary rationalisation mentioned by students was the concept of "balance". Two definitions of "balance" were present during the discussions; the first corresponded to a balanced diet, similar to that outlined in the Eatwell guide, i.e. *"just going around all different sections of food"* and ensuring your meal had *"some meat, vegetables, some carbohydrates"*. The second referred to balancing a perceived healthy food item with an unhealthy one, in effect cancelling it out.

I've got a nougat bar which is unhealthy and I sort of balance it out with chicken and lettuce wrap. Then I've got flavoured orange drink, which is kind of unhealthy cos it's [got] sugar - so, I get a fruit shot to balance that out as well. Student 14

Some students extended this beyond the school gate, reportedly offsetting poor food choices in school with perceived healthier choices at home.

I'll eat normal food at home. I'll have healthier things. But at school I'm not really bothered. Student 9

I control what I eat and I'm sensible with what I eat, apart from school. Student 9

7.5 Discussion

This study looked to explore how adolescents make their food choices throughout the school day and how they engage with their environments whilst making food choices. When discussing their food decisions, adolescents highlighted various school-specific factors (e.g. queue length, food availability) and broader adolescent-specific factors (e.g. social norms, burgeoning autonomy) as key influences of their food choices. This concurs with previous research pertaining to school food choice which highlighted the cost of school food, length of queues, and availability of healthy options as salient factors[23,24]. Likewise, factors relating to adolescence more generally have also been reported elsewhere, including burgeoning food choice autonomy[92], peer influences[30] and the role of parents and parenting style[52,206,346]. Findings from this study thus give additional support to previous work in highlighting these factors as important and relevant to students' food choices.

The findings, particularly those relating to school food choice factors (e.g. queue length, food costs) and social aspects, can be considered with respect to the SEM, which draws attention to key opportunities and challenges to influence student food choice. For example, long queues (institutional level) hold large dissuasive power as they may force students to choose between having a school meal or spending time with friends (interpersonal level). As such, even health-conscious students (individual level) may feel forced to succumb to the normative social behaviour (interpersonal level) and purchase less healthy grab-and-go items, get lunch elsewhere or skip lunch entirely. Likewise, adolescents' struggles to integrate conflicting influences corresponds with the value negotiations described in the FCPM, highlighting the value and relevance of incorporating FCPM principles. For example, in the case of school food choices, students' health/nutrition values may conflict with values of cost, inconvenience attached with queueing or managing relationships with friends, all of which appeared to take precedence in the present study. Dietary intervention efforts may hold greater promise in facilitating adoption of health/nutrition values if they can first enable students to satisfy their more dominant values.

A key finding from the present study was adolescents' juxtaposition between the school and home environments, in terms of food provision, food choices, food choice rules and customs. This illustrates how school food choices are not solely planted within the school environment, but instead may be (in)directly influenced by multiple environments. Whilst some previous studies have considered multiple environments (e.g. school environment and nearby food outlets[17,26,340], home and school environments[179,205]) in exploring school food choice the present study furthers our understanding by suggesting an interplay between environments. The findings suggest environments may influence adolescents' food choices directly within their proximal environment (e.g. home environment influencing at home choices) but also indirectly across their distal environments (e.g. home environment enabling less healthy choices in school as students believe the two balance out). This illustrates how adolescents must integrate a myriad of direct (e.g. peer influences, social norms, availability of school food items, queue length) and indirect (e.g. parental food modelling, parental style) food choice influences as they move between environments.

A study conducted with American adolescents (aged 11-14 years) reported similar findings, attributing less favourable behaviours (e.g. skipping school lunch, consumption of energy-dense options) to a cultural mismatch between the school and home environments[347]. Cultural mismatch was described as sensory-emotional (e.g. food taste, quality, freshness) and socio-political (rules, available choices), with students contrasting home and school environments across these domains. The present study develops on this, by describing how students grapple with various influences across different environments as they look to reconcile this mismatch. This finding also supports previous claims[340,347] that there is a need for researchers and policy-makers to depart from environmental siloes and consider students' food choices across multiple environmental contexts.

Students relayed the use of some dietary rationalisations throughout the discussions. For example, students rationalised poor food choices in school by claiming to choose healthy options at home. Interestingly, students cited the perceived healthiness and freshness of food at home as a primary reason for preferring them over school foods, leaving incongruity between students' expressed food preferences and real-life school food choices. Similar findings have been reported in previous qualitative research, whereby students reported making healthier food choices at home as opposed to outside the home[25]. Moreover, cross-sectional research from the Republic of Ireland indicates that adolescents consume greater quantities of energy, free sugars, fat and saturated fat from foods acquired at school compared to at home[326]. Adolescents also had greater intakes of calcium, iron and dietary fibre from foods and drinks consumed at home compared to foods/drinks at school, with significant differences found for free sugars, fat and dietary fibre[326]. However, it is important to point out that school lunches are less of a staple in the Republic of Ireland (e.g. there are no mandatory standards in place for school food) compared to the UK, which may have had an impact on the nutritional composition of school lunches and thus, direct comparisons may not be appropriate.

Findings from a correspondence analysis using NDNS data[296], suggest that adolescents are much more likely to consume high-sugar, high-fat foods/drinks when eating at locations away from the home (e.g. 279% increase in likelihood of consuming sweetened soft drinks, 256% increase for chocolate and 282% increase for chips). Findings also indicated similar predictions for eating occasions outside of school or work (e.g. 202% increase in likelihood of soft drinks consumption, 188% increase for chocolate and 342% increase for chips). An analysis of UK adolescents' consumption patterns, using NDNS data, for example, found that adolescents (aged 11-18 years) consume more fruit and vegetables, less red and processed meat and fewer sugar sweetened beverages from packed lunches compared to meals sourced at school. However, these differences were not statistically significant[26]. These findings suggest that in general food/drink choices are more favourable at home compared to at school, thus providing support for adolescents' "healthier at home" perception.

Students' perception of home food as healthier may prove unhelpful if students are viewing the school environment as an opportunity to choose less healthy options and then offset this with perceived healthier choices at home. This rationalisation may also hinder students from availing of healthy food provision in schools. Furthermore, this "healthier at home" rationalisation places unrealistic expectations on home meals to provide large proportions of adolescents' daily recommended intakes for healthier foods (e.g. fruits and vegetables), especially if students are only enacting healthier behaviours in the home food environment. For example, analysis of children's (1.5 – 18 years) (n = 6548) vegetable consumption, using counts and portion sizes from NDNS food diaries[348], found that 77% of vegetables were consumed at home. However, results also indicated that only enough weight for one vegetable portion was eaten during an eating occasion, and this portion was likely to be the only portion of vegetables consumed per day. This exposes an issue with the "healthier at home" rationalisation and stresses the need for adolescents to consider their food choices throughout the day.

Some students extended the “balance” rationalisation to their overall diet, believing they could balance unhealthy food choices with healthy ones, in effect cancelling them out. This relates to previous work, which found adolescents described foods simply as either “good” or “bad”[206,349]. Moreover, a recent review of qualitative studies found a related concept, with adolescents viewing unhealthy food consumption as “fun”, but also reporting exercising dietary restraint and avoiding overeating[350]. Such binary conceptualisations of food may ill-serve adolescents as they posit foods not as complementary, but rather in opposition. As Stevenson et al.[206] point out, these binary conceptualisations of food hinder students from learning to incorporate “bad” or “fun” foods into a balanced and healthy overall diet.

Students illustrated a good level of food knowledge throughout the discussions, identifying key macronutrients (e.g. saturated fat, salt, sugar) and citing relevant information sources (e.g. Eatwell guide). Despite this knowledge, however, many students still expressed a preference for and selection of energy-dense, nutrient-poor options. Similarly, the sentiment that food knowledge and/or cooking skills were important for later in life rather than during adolescence indicates that the benefits of applying this food knowledge may not yet be fully appreciated by these adolescents. These findings contribute to an existing body of research in illustrating how food knowledge alone holds limited predictive power over students’ food choices[71,107,205,206,351] and signals a need for multi-component, innovative approaches to instil healthy dietary behaviours in adolescents.

7.6 Implications for Policy & Practice

The findings from this study reveal challenges and opportunities for researchers, schools and policymakers to positively influence students’ school food choices and associated behaviours (e.g. school lunch uptake). School food policymakers should consider students’ “home as healthier” perception, such as promoting more healthy options in schools (e.g. wider variety of fruit options, salad bar, free samples of healthy foods), and emphasising the freshness and quality of the foods prepared in schools. Additional efforts are also needed to help students implement helpful information (e.g. Eatwell plate) into their own dietary behaviours, discard binary definitions of food and consider food choices as part of an overall diet rather than as simply “good” or “bad”, “healthy” or “unhealthy”, “fun” or “not fun”.

Similar to findings from chapter 6, queues presented a persistent barrier to students choosing school food and/or choosing healthier school food options in the present study. Efforts to reduce queue length may prove worthwhile, by providing students with more time to purchase and consume their lunch and socialise with friends. Following on from students' suggestions in chapter 6, efforts to reduce queue length could include introducing staggered lunches, increasing presence of vending machines, having more options available in vending machines and providing different food categories at different counters. Additional efforts could include increasing the time for school lunch and enabling students to pre-order lunches, as is already practiced in primary schools. Greater time allocation for lunch may also hold a positive effect on school lunch take-up and take-up of healthier foods as it alleviates the value negotiations students in the current study reported grappling with (e.g. skipping lunch in order to spend time with friends). However, introducing such changes may not be viable in all schools as this would involve considerable financial investment to increase vending machines, number of purchase points/counters. Furthermore, staggering lunches or elongating lunches would consequently increase the length of the school day; this is something which may not be amenable to students either. Longer or staggered lunchtimes would also mean increased demands on school staff to supervise students during service times, and potentially mean longer working hours for catering staff.

Reducing queue length was highlighted as important in the School Food Plan[227] in terms of facilitating healthier choices. Within the plan, a Scottish evaluation, called "The Big Eat In"[352], was cited as an example of how queue length can be reduced in a real-world setting. "The Big Eat In" involved keeping all year 7 students on site during lunchtime, in an effort to encourage healthier choices, which increased the number of students present in the canteen during lunchtime. The subsequent increases in queue length prompted schools to adapt in order to minimise students' time spent in queues. Adaptive efforts included adding more tills to their canteens, introducing collapsible kiosks to other areas in the school and opening separate café units, operated by the local authority. The initiative was deemed a success, both in terms of increasing uptake and facilitating healthier food choices; however, stakeholders also conceded that enacting such an initiative on a larger scale (e.g. for more than 1 year group) would be difficult for schools to accommodate. Finally, staggered lunches were mooted by some participants, but teachers felt this was not possible in practice. Thus, despite multiple stakeholders, including researchers[29], policymakers[227], school staff and students[14] advocating for queue length to be reduced, the practicalities of implementing this needs to be fully considered, as does the amenability of all stakeholders involved to the various implications and knock-on effects of shortening queue length.

Social aspects were a pervasive, ever-present factor in determining students' food choices and associated behaviours within the school environment. This was a key distinction between the school and home environments and illustrated a greater complexity and ambiguity associated with school food choices. A fruitful endeavour would therefore be to try and make the healthy choice the socially accepted choice[71] (e.g. asking students what fruits/vegetarian foods are appealing to them, offering healthier options at discounted prices). In this way, researchers and catering providers can look to utilise social norms, rather than overcome them. In line with this, suggested shorter term goals include reformulation or replacement of less healthy "fun" school foods (cookies, pizzas, muffins etc.), along with promotion of healthy grab-and-go options (e.g. salad bowls, fruit slices, plant-based snacks), which others have also advocated [29,185].

As emphasised in Chapter 6, it is important that initiatives such as the ones suggested above look to involve students as thought leaders and coproducers in the design and implementation processes[20,107,251,332,333,353]. This would not only improve intervention fidelity[354] but also provides the best starting point to aligning public health concerns with adolescent norms and beliefs. Consistent with the World Health Organisation's Health Promoting Schools (HPS) framework[355], these initiatives should also be multicomponent, integrating educational approaches, promotion in schools, student and staff consultation and support and parental/community engagement[290,356].

7.7 Strengths & Limitations

The focus group approach and naturalistic environment enabled candid conversations among students. The schedule and subsequent discussions succeeded in focusing on specific aspects of adolescents' school food choices (e.g. influence of friends and family), thus gaining a deeper level of insight. Finally, the inclusion of mixed groups provided a wide array of perspectives and experiences.

This study does also have some limitations and as such, the findings should be considered within context. One limitation of this study was that students were recruited directly by school staff. This leaves potential that the students in the discussions may differ from the typical student; for example, the students who agreed to participate may have a greater personal interest in or knowledge of nutrition compared to the average student. Being in the same year group in the same school, the students all knew each other, which may also have influenced the responses. Although efforts were made to mitigate against social desirability bias[255], it still poses a limitation. While the school was not atypical (e.g. number of pupils on roll approximated national averages) it had a higher FSM% compared to national averages, which is also worth noting.

A final limitation lies in the school's location; the school was situated on the outskirts of the closest urban area. As such, students in this school had much fewer nearby food outlets compared to students attending schools in large urban areas, for instance. Consequently, the inclusion of two primary environments throughout the discussions may have been influenced/informed by lack of food outlets nearby. In addition, the method of students' commute to and from school (i.e. walking, cycling to school as opposed to commuting via car or bus), along with the routes students take to get to school (e.g. along busy retail streets compared to quieter residential roads) may have been different in this school than a school in a large urban area, which also may have influenced the depictions students gave throughout the discussions. Moreover, the depictions of the school environment in this study may be overly focused on the immediate school environment (i.e. what's within the school gates) and not give a clear picture of the broader school food environment, which encapsulates and considers the areas surrounding schools also (i.e. outside the school gates).

7.8 Implications for PhD Project

Similar to chapter 6, the findings from the present chapter contribute to this thesis by providing valuable context and insight to some of the findings from chapters 3 to 5. For example, factors such as long queues, food costs and the social aspects of school food were prevalent in students' discussions and give insight into why students may choose convenient food options, or not choose anything at school. Moreover, this chapter gives additional support to some of the findings from chapter 6 (e.g. long queues, manic school dining experience, high food costs) and indicates that these are pertinent issues to adolescents' school food choices generally.

Another key contribution of this chapter is the dietary rationalisations described by students. For example, the home as healthier concept illustrates how students consider their food choices across environmental contexts. The relevance of the home environment in adolescents' school food choices also supports whole-school thinking[105] that parents should be involved in any school-based health promotion efforts. Another noteworthy finding was some adolescents' reporting of purchasing food at break and saving this until lunch. This was also evident in the chapter 5 results, as break accounted for large percentages of overall item sales. Thus, these findings together suggest that adolescents consider their school food choices across both time and environments; as such, overt concentration on lunchtime provision may be inadequate.

7.9 Conclusion

The school and home environments both (in)directly influence adolescents' school food choices, which involve an integration of multiple, often conflicting influences. Students may adopt a number of unhelpful dietary rationalisations as they try to manage and reconcile these influences. Consistent consultation with students, together with consideration of relevant food choice models, is required to successfully identify key opportunities and challenges to influence food choice processes amongst this unique cohort.

Chapter 8. Discussion

8.1 Overview of PhD Thesis, Aims & Objectives

This thesis focused on adolescents' dietary behaviours and the UK school food environment. The thesis employed a mixed methods approach to gain insight into English secondary school food, from both sides of the counter. As outlined at the end of chapter 1, the aims and objectives of this thesis were as follows:

Aims:

- To gain valuable and needed insight into how school food is prepared and provided in secondary schools.
- To examine food provision in English secondary schools and evaluate the nutritional composition thereof.
- To examine the school food choices of English secondary school students using and the nutritional composition thereof.
- To explore how students make their food choices within the school environment, how they interact with their environment, and what their school lunchtime experience is like, from their perspective.

Objectives:

1. To conduct immersive observations in school kitchens and school dining areas to gain insight into school food preparation and provision practices
2. To assess the nutritional composition of school food provision and compare to dietary reference values, apportioned for a school lunch.
3. To collect food choice datasets and examine adolescents' school food choices. To link food choice data with nutritional composition data, and evaluate the nutritional composition of adolescents' school food choices.
4. To conduct focus group discussions with students to gain insight into their lunchtime experience, how and why they make their school food choices within the school environment, and identify key opportunities and barriers to promoting healthy school food choices.

5. To conduct focus group discussions with students to discuss their lunchtime experience, their school food choices, and the role that family and friends play in said food choices.
6. To synthesise findings from the quantitative and qualitative studies and identify key areas of consideration, with regards to school food preparation, school food provision and adolescents' food choice behaviours.

The following sections will outline how the five study chapters addressed the aims and objectives of the thesis and consider how the thesis findings relate to previous research, along with policy and practice.

8.2 Main Findings

Figure 8.1 presents the key findings from each of the study chapters (chapters 3-7 inclusive). Given the relevance of the SEM and socio-ecological thinking[31,179,266,267] to school food, the findings presented in figure 8.1 are mapped onto the 5 levels of the SEM. Linkages are also included, to illustrate how findings from the study chapters relate to one another. The proceeding sections then go on to discuss the main findings of the thesis in further depth. Findings are considered under three headings, which together encompass the scope and aims of the five study chapters; these headings are as follows: (1) school food as prepared and provided, (2) adolescents' school food choices, and (3) how adolescents make their school food choices.

Figure 8.1. Mapping of Key Thesis Findings Along 5 levels of Analysis. Levels of analysis correspond to the 5 levels of the SEM[31]

8.2.1 School Food as Prepared and Provided

One of the key takeaways from Chapter 1 was a lack of current knowledge regarding secondary school food preparation and the nutritional composition of school food as provided. In light of this, a key motivation for this PhD was to conduct an in-depth exploration of school food catering practices (including how school food is prepared and provided) and assess the nutritional composition of school food provision.

An observant participant approach was taken, in order to gain an "insider" perspective on school catering practices, school food preparation and provision methods. A key finding from the observation visits (chapter 3) was that catering staff in both schools used a level of discretion when preparing and providing school foods. Similar to previous research[14], staff acknowledged that school food may be some students' only hot meal for the day. Therefore, staff's reporting of giving more food to students whom they felt needed it was an understandable discretionary practice that showed a level of care. Staff also reported feeling a duty of care to the students and wanting students to choose healthier options. This is also consistent with previous research[177,178] and suggests that school catering staff generally place emphasis on students' health and healthy food choices. However, the focus group findings (chapters 6, 7) highlighted how school food initiatives to promote healthy dietary behaviours (e.g. mandatory provision of side salads in school 1) can be refused by students if not delivered correctly (e.g. some students criticised the mandatory provision as it led to food waste, students called the inclusion of salad in chicken wraps a "scam", citing it was no longer good value for money). This emphasises the importance of whole-school thinking[105], and encouraging dialogue between school food providers and students as it pertains to school food provision and choice.

That said, discretionary practices can also be inappropriate and may impede the effectiveness of school food standards. For example, discretionary practices can easily lead to deviation from preparation guidelines and provision of excessive nutrients and/or foods[177], even if catering staff are well-intentioned. A prime example of this was found in school 1, where staff added 279g of cheese to pizzas (on average) as they felt students wouldn't enjoy the pizzas if they only had the recommended 150g. The knock-on effect of these discretionary practices was illustrated when considering the nutritional composition findings (Chapter 4), as pizzas were found to be high in saturated fat and calcium due, at least in part, to the excessive amount of cheese applied during preparation (e.g. on average, cheese applied to pizzas accounted for 7.6g of saturated fat, 93.8% of the 8.1g listed for a pizza serving, and 226.8 mg of calcium, 66.1% of the total 343 mg of listed for a pizza serving). Some of the variation observed between schools may also be connected to discretionary practices; school 2 had recently moved their catering in-house and as such, catering staff in school 2 may have had greater autonomy to exercise their discretion compared to staff in school 1. This may have contributed to school 2 provision generally being less preferable than school 1. Given that catering staff play such a vital role in preparing and providing the actual food that students choose from, there is a need to equip them with adequate knowledge and skills to maintain a sense of agency, but still provide healthy, nutritious foods.

Indications from the observation visits were that provision in both schools was favourable; for example, both schools provided one or more portions of fruit and vegetables every day, one or more portions of starchy foods every day and no more than two portions of batter-coated food per week. Moreover, indications were (from observation visits at least) that both schools largely complied with FBS; school 1 met all 26 of the FBS, while school 2 met all but one of the 26 criteria (the exception being the provision of oily fish over the 3-week observation period). This suggests that despite their discretionary practices, catering staff in both schools largely followed the current school food standards.

However, whilst provision in both schools was largely FBS compliant, findings from chapter 4 suggest that provision in both schools could be greatly improved upon. For example, a number of popular food/drink (sub)categories (e.g. pizzas, paninis, sweet snacks, drinks) were identified as noteworthy; pizzas and paninis provided the highest levels of saturated fat (school 1 only) and sodium (both schools) among main meals, while FoP nutrient profiling[312] found that almost all of these items were high in saturated fat and salt. Juice-based drinks and sweet snacks contained high amounts of free sugars in both schools, while 14 of the 15 juice-based drinks were profiled as high in total sugar, all of which can be considered as free sugar. Further, in considering food provision across the menu cycle, the nutritional composition of an average lunch in both schools fell short when compared against energy and nutrient reference values. In both schools, an average lunch, based on an example compliant menu cycle, had more than triple the maximum recommended value for free sugars, and was significantly below minimum values for levels of fibre, calcium, iron, zinc, magnesium, potassium, iodine, folate or vitamins A and D. Finally, all "typical" lunches in both schools failed to meet several of the reference values, with deviation of 20% or more observed for several values. This echoes previous evaluations of school food[213,228,231,237], which found that FBS-compliant provision failed to meet the NBS.

Findings from the work on school food provision and choice (Chapters 4 and 5) indicated that micronutrient content was a consistent issue, notably for levels of calcium, iron and zinc. Interestingly, guidance documents accompanying the current FBS specifically highlight ways to improve levels of calcium, iron and zinc in the top tips section[229]. Sources of these nutrients are highlighted under the key food groups, for example, under milk and dairy foods, cheese is highlighted as a rich source of zinc and calcium; under starchy foods, wholemeal bread is highlighted as a source of iron. Some of these measures were evident during the observation visits, e.g. both schools looked to provide wholemeal bread and tried to encourage students to select wholemeal sandwiches over white bread items (e.g. school 2 noticed that students were more likely to select wholemeal bread in the shape of a roll rather than wholemeal bread slices). However, the researcher did not explicitly ask the staff about boosting micronutrient levels or following the standards, thus it is unclear if these were related to the guidelines or otherwise. Therefore, it is unclear to what extent catering staff are cognisant of or prioritise increasing micronutrient levels. Following on, it is difficult to comment specifically on either schools' efforts to increase levels of iron, calcium or zinc across their provision.

However, consideration of the nutritional composition findings (chapter 4) does illustrate the density of these micronutrients across current provision and findings from chapter 4 suggest that this is still a challenge, as levels of calcium, iron and zinc were consistently low across typical lunches, an average lunch, and all lunch combinations. Increasing levels for these micronutrients has been a consistent struggle for school food providers, even when NBS were still in place[213,232]. Chapter 4 also found school food provision was lacking in other micronutrients and vitamins, such as iodine, magnesium, potassium, vitamin A and vitamin D. This suggests that whilst the three highlighted micronutrients of calcium, iron and zinc remain a challenge for school food providers, micronutrient and vitamin density needs bolstering generally also.

The energy and nutrient reference values used in chapters 4 and 5 are based on the previous NBS[4] and are derived from DRVs[9], thus the findings from this thesis suggest that school lunches do not contribute sufficiently to students' daily energy and nutrient requirements. Given that provision is somewhat theoretical (i.e. chapter 5 findings indicated that students' choices were substantially lower in energy and nutrient content than provision), the observation that provision does not correspond to healthy, nutritious food (as per previous NBS) signals a pitfall of current school food provision. As expected, (based on chapter 4 findings) levels of these micronutrients were also low among students' food choices, as was seen in chapter 5. Again, this aligns with previous research[231,232,324] and NDNS findings[3], and illustrates that increasing micronutrient content (especially iron, calcium and zinc) remains a challenge both for school food and adolescent diets in general.

Comparisons across schools indicated variation between schools in the energy and nutrient content of common categories and subcategories (e.g. pizzas, pastas, dessert main meal) (chapter 4). For many of these differences, explanations were found by reflecting on the observation visits (chapter 3). For example, all school 1 pizzas were provided with a mandatory side salad, and this was reflected in the nutritional composition findings (chapter 4), as school 1 pizzas were significantly ($P < 0.05$) higher than school 2 pizzas in levels of all B, C and D vitamins considered. Several school 2 dessert items were provided with custard and again this led to differences in the nutritional composition findings, as school 2 desserts were significantly ($P < 0.05$) higher than their school 1 equivalent for energy content, along with levels of fat and free sugars (custard alone contributed an additional 74.2 kcal and 5g of free sugars). This suggests that the same school food categories (e.g. pizzas, dessert items) can vary substantially in terms of food preparation practices and subsequently, in the nutritional composition. Furthermore, the finding of wide and significant variations between two largely FBS-compliant schools suggests that in terms of the nutritional composition of what's provided, FBS compliance may correspond to a range of energy/nutrient values. Furthermore, the scope of what is FBS compliant may be wider than what was observed in this thesis, in terms of the energy/nutrient content of school food provision. Follow-up research is needed to explore what the range of outcomes are in terms of energy/nutrient content for FBS compliant school food provision (e.g. average lunch based on FBS compliant menu has a free sugar range from 6g to 32g).

When the shift from FBS and NBS to solely FBS was proposed, Mucavele, Nicholas and Sharp[228] assessed the nutritional composition of a FBS compliant menu over a 1 week period. They found that a FBS compliant menu failed to meet NBS for iron, calcium and zinc but met all other standards, suggesting that using FBS alone could largely but not fully ensure healthy, nutritious school food provision. However, a separate evaluation published a year earlier found that even whilst operating under FBS and NBS, schools failed to meet standards for saturated fat, sodium, folate, calcium, iron and zinc[213], indicating that compliance with NBS has always proved difficult for schools. Given that NBS are derived from dietary reference values (DRVs)[9], these contrasting findings call the decision to shift to solely FBS into question.

Mucavele, Nicholas and Sharp[228] also reported that catering staff viewed the FBS as easier to follow and adhere to compared to the more prescriptive and detailed NBS[228], which was viewed as a key benefit of FBS. However, findings from chapter 4 illustrate the inherent flexibility of FBS, while staff members' use of discretion, reported in chapter 3, highlights how easily the standards (and their effectiveness) can be influenced/mediated by factors acting on the ground level. Furthermore, in the intervening years since the shift from FBS and NBS to solely FBS, there has been an absence of school food evaluations, along with inadequate monitoring of food-based standards (FBS)[5] compliance. Meanwhile, results from chapter 4, and their alignment with previous work[213,231,232] (e.g. high free sugar content, low levels of calcium, iron and zinc) suggest that since shifting to solely FBS, the nutritional composition of school food has not improved. However, further research with a much larger number of schools is needed to verify these suggestions.

8.2.2 Adolescents' School Food Choices

Chapter 1 explored previous research on adolescents' food choices and their food choice parameters, highlighting various factors such as food prices, taste, time and convenience, food availability and social norms. Within the school food environment, the literature indicated a preference for grab and go, convenience items over more nutritionally favourable main meals. This was also reflected in staff perceptions of students' preferences (chapter 3), as staff lamented that the time and effort spent preparing the meals of the day would most likely go to waste (along with much of the food itself in school 1), as students were much more likely to choose convenient items. Perhaps unsurprisingly, findings from the cashless catering data analysis (Chapter 5) indicated that students' choices were dominated by grab and go items, particularly sweet snacks, savoury snacks and drinks which comprised 78.2% of item sales in school 1 and 76.8% in school 2. Moreover, the 20 most popular items sold in each school were dominated by sweet snacks, savoury snacks and drinks. This bias toward grab and go selections mirrors previous quantitative[15] and qualitative[20,25,291] research, and suggests that this is indicative of adolescents' school food choices generally.

Findings from chapter 4 suggested that the more popular items, such as juice-based drinks, sweet snacks and pizzas (mentioned by staff in chapter 3) were amongst the least favourable items in terms of nutritional content. In terms of nutritional composition, the findings from Chapter 5 followed on from the food provision findings in Chapter 4. Chapter 4 highlighted high levels of free sugars, and low amounts of fibre and important micronutrients such as calcium, iron and zinc among the foods/drinks provided. Chapter 5 identified these same issues among students' choices; for example, an average lunch as chosen was high in free sugar content and significantly below reference values for fibre and several micronutrients (e.g. calcium, iron and zinc). These findings align with previous work exploring the nutritional quality of school food provision and choices[213,228,231,232,237] and indicates that these remain a challenge for policymakers and school food providers alike.

Some level of consistency between provision and choices is to be expected, given that choice is directly influenced by what is provided (i.e. students can only choose from what's provided). That said, when compared to an average lunch as provided, an average lunch based on students' choices was substantially lower for all energy and nutrient values considered (e.g. fibre, calcium, potassium, iodine, vitamin A, vitamin C). This suggests that students' lunchtime choices are even lower in micronutrient content than an average lunch as provided; in essence, a gradation of the micronutrient issues highlighted in chapter 4. Interestingly, an average lunch as chosen was much lower in free sugars than an average lunch as provided, albeit still well above the desired level of 8.6g.

In chapter 5, the food choice data revealed break as an important service time in terms of students' school food choices. In both schools, breaktime transactions accounted for a large proportion of total transactions for the school day, meanwhile large percentages of all lunchtime transactions were preceded by a breaktime transaction (school 1: 51.0%, school 2: 56.2%). The relevance of break was also evident in the qualitative work (Chapters 6 and 7), as students described how their food choices are not made in isolation but instead are considered in the context of the day (e.g. some students reported buying something at break and saving it to eat at lunch, thus freeing up more time for socialising). This suggests that further consideration should be given to adolescents' choices not just at lunchtime but throughout the school day, in order to gain a more complete picture of their school food choice behaviours.

Following on from this, Chapter 5 explored how students' daily school food choices corresponded to DRVs[9]. Previous research has reported that adolescents consume up to a third of their daily energy whilst at school[170,357], while some researchers have claimed the percentage is between 35 and 40%[14]. Moreover, NBS maximum and minimum figures are derived as a portion of DRVs (e.g. not less than 35% of RNI for calcium, iron, zinc), giving another indication of how school food should correspond to daily intakes. Findings from chapter 5 suggest that adolescents' food choices at school accounted for over 75% of their daily recommended value for free sugars, whilst taking 25.9 to 32.6% of their daily recommended amount for energy. Total school food choices (i.e. sum of choices at breakfast, break and lunch) accounted for well below the desired amount for several nutrients, including fibre (S1: 15.1%, S2: 20.4%), iron (S1: 16.2%, S2: 18.9%), zinc (S1: 23.2%, S2: 24.2%), iodine (S1: 16.2%, S2: 13.9%), magnesium (S1: 16.9%, S2: 20.1%) and potassium (S1: 12.8%, S2: 14.8%). This is similar to previous research which reported that school lunches account for 29% of adolescents' daily energy requirements but don't provide students with adequate proportions of their daily nutrient requirements, particularly calcium, iron and vitamin C[357]. It is worth reiterating at this point that choice is not consumption (e.g. school 1 students who chose a pizza had to choose a mandatory side salad but very few consumed the side salad; some students may have supplemented school food choices with food from elsewhere). However, these findings do illustrate the maximum contribution that school food currently makes towards adolescents' dietary intake on average (this is the maximum as students most likely don't consume 100% of what they purchase, for example, previous research suggests that students waste roughly 7% of the school food they choose[213]). Thus, by broadening the focus of school food and framing the findings within a whole-day context, chapter 5 brings further attention to areas of school food needing attention (e.g. levels of free sugar, iron, calcium, zinc).

Chapter 4 highlighted many categories and sub-categories of note (e.g. grab and go items including pizzas, sweet snacks, juice-based drinks etc.), while chapter 5 illustrated how students' choices were dominated by these same grab-and-go items. This echoes previous research[15,20,25,291] and validated the descriptions of students' preferences made by school catering staff in chapter 3. Together, these findings present a catch-22 scenario for school food policymakers and providers, as the foods which are most likely to increase take-up and ensure school food viability are also the least healthy items. Additionally, students often purchased multiple of the same less favourable item (e.g. cookies, muffins etc.) during the same purchase event. This was also mentioned by catering staff in chapter 3 and has been raised in previous research[14], whereby staff highlighted how students' ability to purchase multiple "regulated" items can render the school food standards irrelevant. Meanwhile, overt provision of popular items (i.e. energy dense, grab-and-go items) may facilitate more sales but may also undermine school health messaging efforts[14].

It could be argued that the evident popularity of these items offers a mechanism to improve the nutritional composition of provision, i.e. by making the popular items healthier school food providers can encourage healthier student choices. However, this targeted reformulation represents a big gamble for schools and school food providers, as reformulation could negatively affect subsequent selection of these items (e.g. some students in chapter 6 reported dissatisfaction with changes made to popular chicken wraps, and reported not choosing them since), and therefore negatively affect school food uptake. These points highlight a flaw in the tactic put forth in the School Food Plan[227], that increasing take-up would facilitate healthier provision and by virtue encourage healthier choices. This also illustrates some of the many challenges in overcoming students' food choice preferences and reiterates the need for dialogue between school food providers and students regarding school food.

An aim of school food policy, and something that was highlighted in the School Food Plan[227], is protecting school food viability. Whilst health and nutrition should be the primary focus, school food viability is an important and necessary consideration for schools and school food providers. School food provision operates at a substantial financial loss, without government subsidies[214,227]; for example, findings from the seventh annual survey of take up of school lunches in England reported that secondary school meals were charged at an average of £2.03, while production and labour costs stood at £2.41[214]. This is mirrored internationally also, as healthy school food provision is associated with increased costs and decreased canteen profits and revenue[209], highlighting financial concerns as a key barrier to successful school food policy implementation and healthy school food provision.

The School Food Plan[227] describes increasing take-up as "both the means and the end: the means, because it would make the service economically viable; the end, because eating a school dinner is so much better than the alternatives." The plan cites economies of scale as a pivotal point at which school food provision can become increasingly profitable and healthy, reporting that schools need to reach an average school lunch uptake of 50% nationally (or 100 meals per day) in order to achieve financial viability. However, most schools struggle to reach this 50% tipping point, with reports stating that secondary school food uptake stands at 39.8%[214] to 41.1%[17]. Findings from chapter 5 indicated that uptake was relatively high in both schools; 65.1% of school 1 students and 80.0% of school 2 students used the canteen over the three weeks considered. However, these figures relate to students using the canteen at any point over the three weeks; meanwhile the daily average percentage of students using the canteen at lunch ranged from 25.9% in school 1 to 42.9% in school 2. It is possible that some students may have purchased their lunch at breaktime; however these cases are unlikely to increase uptake to above 50%. Thus, these findings suggest that school food viability remains an unresolved issue and efforts are needed to increase take-up.

Cost was a prominent food choice factor among students (chapters 6 and 7); however, to the author's knowledge, little is known about what price points are amenable to students or at what price school food uptake could increase sufficiently to achieve viability, or if such a balance between price and uptake exists. Analysis of cashless catering data indicated that the average student spend at lunch was £1.95 in school 1 and £1.81 in school 2, both below the price of a more favourable "full lunch" of a freshly prepared meal of the day plus a drink (circa £3.20 in school 1; £2.80 in school 2). At present, it is unclear how to strike a balance between health and school food take up. The economies of scale concept (put forward in the School Food Plan) proposes that a rising tide raises both boats (i.e. as uptake increases, the school has more profits with which to improve the quality of the provision, which then leads to more intake and more profit and so on). However, indications from this thesis suggest that rather than a rising tide lifting both boats, the two "boats" of health and take up are negatively correlated, i.e. if health goes up then take up decreases.

8.2.3 How and Why Adolescents make their School Food Choices

Chapters 6 and 7 looked to gain a deeper understanding and insight into how and why adolescents made their school food choices. In both schools, students' school dining experience was depicted as busy, time-pressured, and urgent. This experience was typified by long queues, uncertainties regarding food availability and crowded dining areas.

Schools must compete for students' custom and in both FG studies, adolescents compared and contrasted their school dining experience with alternatives (e.g. at home or at nearby outlets). Students cited lower costs, greater convenience and greater availability as key reasons for opting for nearby outlets or packed lunches over school food. In chapter 7, students reported a preference for the food at home, as the food was healthier, more varied, tastier and more diligently prepared than school food. Many of these same values were also attributed to bringing in packed lunches, which enabled students to avoid long canteen queues and have more time to socialise with their friends. Previous research has illustrated that packed lunches[231,232] and lunches from nearby outlets[17,26] are less favourable (nutritionally) than school lunches; however the findings from chapters 6 and 7 illustrated how alternatives to school food may be chosen if they better align with students' values of cost, taste and convenience. These findings align with FCPM[32] principles and highlight how efforts to improve school food take-up or to encourage healthier choices must first consider and satisfy these priority values (e.g. cost, convenience, having time to socialise).

The comparisons and contrasts made by students illustrate how they must navigate multiple different environments and environmental influences whilst making school food choices. As chapter 7 highlighted, students' school food choices may be influenced directly within the school environment (queues, availability, cost) but also indirectly by other environments (home environment, parental views on/modelling of food). This represented a novel finding of this work, and once again highlighted how adolescents' food choices are not made in isolation, either in terms of time of the day or environment. Furthermore, these findings also align with whole-school thinking[105] in suggesting that efforts to influence student behaviour must consider the wider school environment, in this case parents and the home environment.

Chapter 7 also illustrated how students try to manage these different environments. For example, findings indicated that adolescents may adopt a number of dietary rationalisations (e.g. balancing unhealthy school food with healthy home food) as they look to reconcile their multiple influences on food choice. Dietary rationalisations were evident in chapter 6 also, as students rationalised that school food was just as unhealthy as food from nearby outlets, making the cheaper prices at nearby outlets the reasonable choice. Consistent with whole-school thinking[105] and SEM principles[31,179,266,267], these findings point to the importance of the wider school environment (i.e. nearby outlets, parents, community) in influencing adolescents and fostering healthy school food environments. These findings also highlight areas of relevance for schools, namely communicating the healthiness of school food more effectively (so that students don't consider school food as equally unhealthy as cheaper, more convenient nearby outlets) and increasing the appeal of school food (e.g. by promoting it as a healthier choice, by having competitive prices, by providing a dining environment that is conducive to students being able to socialise and have time to enjoy their lunch) to students in comparison to nearby outlets and/or packed lunches.

Findings from both chapters highlighted the importance of various food choice factors in influencing adolescents' food choices within school. Echoing previous research[23,24,339], students identified long queues, the cost of school food, and the availability of certain food/drink items as particularly relevant to determining their school food choices. This suggests that these factors are salient to adolescents generally in determining their school food choices. The prevalence of these factors also gives some insight as to why grab and go/convenience items may be so popular (reported in chapters 3 and 5) as they are cheaper than more substantial meals (e.g. a school 1 pizza costs £1.64 compared to £2.27 for a meat main meal of the day), taste nice (likely due to their high levels of free sugars (e.g. juice-based drinks, cookies, brownies), fat, and sodium (e.g. pizzas)) and enable students to eat their food quickly and maximise their time for socialising.

Following on from this, social aspects of school food were found to be pertinent to students' food choices; in both chapters, perceived norms surrounding school food (e.g. "everyone throws salad in the bin", "no one eats healthy"), along with wider social aspects of school food (not wanting to queue alone, not wanting to sit at large benches in small groups, wanting to spend more time with friends) directly impacted students' school food choices. These social aspects point to the added complexity associated with school food choices and emphasise a need for researchers to better understand contextual factors in order to positively influence students' food choices[358]. A prime example of this was found in chapter 6, whereby the mandatory provision of a side salad with pizzas was rejected by students, as the reported norm was to immediately put the salad in the bin. This example illustrates how easily students' food choice behaviours can negate school food providers' efforts to instill healthy habits, echoing the concerns reported by catering staff in chapter 3.

In both chapters, but particularly in chapter 6, students made multiple suggestions pertaining to school food; these included proposed changes to the school menu, to food provision styles and to the canteen design. Interestingly, some of the students' suggestions, particularly reducing queue length, have previously been mentioned in policy outputs such as the School Food Plan[227] and current school food standards guidance[229]. These suggestions illustrated students' capacity to be thought leaders in understanding their own food choice behaviours and pinpointing opportunities to intervene (e.g. providing salad bar, having free fruit items, staggered queues). Moreover, students' suggestions indicated that they may be amenable to choosing and consuming healthy foods if they have input into what is provided and how it is provided (e.g. salad bar offering variety of options, free fruit pots to encourage selection, wider variety of fruit and vegetables provided). That said, it is also possible that social desirability effects[255] were at play during the focus groups and influenced these suggestions.

8.3 Implications for Policy & Practice

This thesis examined school food preparation and provision and evaluated the nutritional composition thereof. Findings from chapters 3 and 4 indicate that despite schools largely complying with the current FBS, provision falls down with respect to several energy and nutrient values, most notably free sugars, fibre and calcium, iron and zinc. In light of this, policymakers should consider providing additional guidance and supports to catering staff, or perhaps reintroducing some aspects of NBS (e.g. maximum standards for free sugar, minimum standards for fibre, calcium, iron and zinc, as these were all noted in chapter 4). Whilst full NBS may be too restrictive and difficult to meet (e.g. previous research found that schools struggled to provide an average lunch which met all NBS, even when NBS were still in place[213]), an awareness by school food providers of appropriate energy and nutrient amounts for school lunches could be worthwhile. Moreover, research by Haroun et al.[237] found that schools that followed both FBS and NBS provided lunches significantly lower in fat, saturated fat and sodium compared to schools only following FBS, giving additional reason to consider reintroducing some aspects of NBS.

Certainly, indications are that under current FBS, catering staff can't be assured that they are providing healthy, nutritious food (which align with DRVs apportioned for a school lunch) to their students. Additional measures could be taken to enhance the current FBS, such as placing stricter provision restrictions for high sugar items and mandating greater provision of fruits and vegetables (e.g. minimum of 3 types of fruit provided each day as opposed to each week, based on suggestions made by students in the focus groups that there should be a wider array of fruit provided in school). Findings from chapter 4 indicate that increasing micronutrient content without providing excess calories may be challenging, as such guidance illustrating ways to balance nutrient and energy density (e.g. increasing the water and/or fibre content of meals[318,359]) may be needed. Strong consideration should also be given to introducing formal monitoring and assessment of FBS compliance. Along with this, FBS compliance should hold more explicit inclusion in Ofsted's inspection framework, rather than as an implied component of schools' requirement to promote good physical health.

Promisingly, the Government's recent Levelling Up White Paper[44] states such initiatives are planned; the white paper has pledged to carry out some of the recommendations made in the National Food Strategy[43]. These include launching a project to pilot test compliance with school food standards across a number of local authorities and explore how to assure and support compliance with the standards. In line with this, schools will be encouraged to "complete a statement on their school websites, which sets out their whole school approach to food", with the longer term intention to make this mandatory once schools can do this effectively. The white paper also promises to financially support the development of food and cooking curriculum content, provide bursaries for associated teacher training and pilot test training to support school governors and academy trusts to adopt whole school approaches to food. A stated aim with these measures is for "every child leaving secondary school to know at least six basic recipes that will support healthy living into adulthood." In light of this thesis' findings, and the lack of formal school food monitoring or reporting, these initiatives are particularly welcomed. However, it remains to be seen what these initiatives will look like in practice, or if these actions will take place.

Both the NBS and FBS focus predominantly on lunchtime, and much of the previous school food evaluation research[212,231,232,237,243,324,326] has done so also. However, findings from chapter 5 illustrate that students frequently purchase items at break and again at lunch. Moreover, chapters 6 and 7 showed how adolescents do not make their food choices in isolation but instead consider them throughout the day (e.g. some students reported buying something at break to eat at lunch, some reported buying an unhealthy "treat" at lunch as they would eat healthy food at home). As such, the traditional overt focus on lunchtime in school food research and policy may be blinkering the school food discourse. Some previous school food research has looked at other service times, such as breakfast[360,361] and mid-morning break[362,363]; however, there remains a need for researchers to broaden the scope of school food research (especially evaluations) to encompass the entire school day. This would provide a more nuanced perspective of adolescents' school food choices and would better inform policy and support school food providers in terms of how best to support healthy dietary behaviours.

One of the key theoretical strengths of the school environment is its capacity to instil healthy behaviours in children and young people and give them the knowledge and skills to make healthy food choices and lead healthy lives. Students exhibited a good level of food knowledge in chapters 6 and 7 (e.g. student referred to a balanced meal and the Eatwell plate, taking on some cooking duties, managing their diet and not having too much sugary drinks). This gives some indications that schools may have been successful in giving students appropriate food knowledge which would have formed part of their Ofsted requirement to support students to know "how to keep physically healthy, eat healthily"[238]. Despite this however, students consistently showed a preference for convenient and/or cheap grab and go foods (as evidenced in the cashless catering data in chapter 5). Together with previous research[71,205,206,251,351,364,365], this illustrates how knowledge alone holds limited influence over adolescents' food choices. This is especially true when considering that students reported that their choices at school were less healthy than the choices they make at home, as reported in chapter 7.

The findings from the thesis on students' school food choices suggest a gap in terms of translating this knowledge into healthy food choices. The knowledge-behaviour gap is a common phenomenon in health behaviour research[366–370] and was evident in chapter 6 and 7 also. For example, some students acknowledged the importance of health knowledge and of choosing healthy foods but saw this knowledge as relevant for later in life rather than at present. Many of students' dietary rationalisations (e.g. balancing unhealthy school food with healthy home food, needing sugary foods at school for a fast energy source) are indicative of knowledge-behaviour gaps. This aligns with previous research on sustainable food/drink choices drinks, which reported rationalisations as an important contributor to knowledge and attitude-behaviour gaps[371,372]. That said, it is also possible that these rationalisations are actually students' sincere beliefs, in which case, they signify a limit of students' food knowledge.

Some research has gone a step further, postulating that even when individuals have sufficient knowledge and willingness to engage in a healthy behaviour, they may still fail to enact the intended behaviour, i.e. an intention-behaviour gap[373–375]. This was also evident in chapters 6 and 7, as students mentioned how certain factors (availability, visibility of healthy foods, cost of school food, time to queue for school food, lack of salad bar, lack of fruit samples, lack of fruit variation) may lead them to choose less healthy options, even if they liked eating healthy foods (e.g. at home) or wanted to eat healthily in school. Therefore, a challenge for school food providers and policy-makers is to try and bridge these gaps between knowledge, intentions, and behaviour, i.e. to encourage well-intentioned students to act on their dietary intentions, and to persuade non-well intentioned students to value healthy diets and to incorporate this into their dietary behaviours.

As mentioned earlier, indications were that adolescents' school food choices bias toward convenient (and often energy dense) options. This was lamented by catering staff in chapter 3, identified objectively in the cashless catering data in chapter 5 and reported by students themselves in chapters 6 and 7. School food standards seek to facilitate healthy choices (and intakes) among students by focusing on the provision of healthy, nutritious foods. However, it is apparent that adolescents' food choices and food choice behaviours can greatly diminish (and in some cases nullify) the intended effectiveness of school food standards. For example, students can undermine the school food standards by choosing less favourable options; meanwhile, school food standards are nullified in cases where students choose to have a packed lunch or purchase something from a nearby outlet. This suggests a need for greater understanding and consideration of adolescents' food choice behaviours within the school environment.

Chapters 6 and 7 helped to improve understanding of adolescents' food choice behaviours with the school environment, as discussions with students highlighted cost, convenience and social aspects of school food as key drivers of their school food choices. For example, students purchasing school food frequently listed cost as a key determinant of what they chose. Furthermore, some students mentioned not having school food at all, as the cost associated was too much. Analysis of the cashless catering data (chapter 5) indicated that students' average expenditure on school food was quite low (e.g. average student spend at lunch was £1.95 in school 1 and £1.81 in school 2, both below the FSM allocation of £2.34 and even further below the price of a more favourable "full lunch" of a freshly prepared meal of the day plus a drink (circa £3.20 in school 1; £2.80 in school 2). Some have called for providing additional financial support for school lunch, either by widening the FSM eligibility criteria, or by subsidising school lunches entirely, via a universal FSM policy[15,376]. This would enable schools to provide free or at least much cheaper lunches to students, in essence a return to the welfare state of 1940s[221] mentioned in Chapter 1.

UK evaluation research has found many benefits for universal FSM policies in primary schools[377,378], whereby food provision is free to select groups of students (e.g. all students up to key stage 2[378] or all primary students (72); such benefits include increases in take-up, healthier food choices and improved energy levels and alertness among students, as reported by teachers[377,378]. However, the feasibility of these options in a secondary school setting is unclear, as is students' reception of such initiatives. Moreover, it is estimated that universal FSM provision would cost the state £1.07 billion for primary schools and £816 million for secondary schools each year[379]. That said, there is potential that this could be offset by reductions in obesity-related health costs[15], which latest figures suggest cost the UK government up to an estimated £6 billion per year[11].

Alongside cost, the inconvenience associated with getting school food was frequently mentioned as a key deterrent by students. For example, some students reported not getting anything at lunch, as the time required to queue left little time to enjoy one's lunch and spend time with friends, moreover, students described how the sheer number of students in the queue meant that there was no guarantee that their desired food/drink item would be available by the time they reached the counter. Efforts are therefore needed to make healthy school food (e.g. meals of the day, fruit) more appealing to students in terms of cost and convenience. For example, previous research by Hanks et al. [29] found that providing a shorter, convenience line for healthier items influenced students to select those foods, with a reported 18% increase in sales of healthy items. Price incentives were mentioned by some students in the focus group discussions (e.g. offering fruit at reduced prices) and there is evidence to suggest that financial incentives can positively influence subsequent take-up, both in university[380] and school settings[381,382]. However, a study by Angelucci et al.[383] implemented price incentives in an American secondary school setting and found that when students observed others being incentivized to purchase grapes, the negative spillover effect counteracted the positive effect of the incentive. Therefore, any incentive program in schools would need to be tailored to that specific school setting and would greatly benefit from coproduction with young people during the piloting, intervention and evaluation stages.

Given the clear importance of context, another strategy for influencing adolescents' school food choices is via nudging or choice architecture ("organising the context in which people make decisions"[183]). This approach involves changing or altering aspects of the environment to influence food choices. Within a school context, previous research has explored various techniques, including shorter queues for healthier items[29], strategically placing healthier items and adding attractive labelling to their packaging[184,185,253]. Nudging approaches hold appeal as they are relatively easy and cheap to implement, for instance, they don't require the upfront investment that universal FSM provision would. Nudging strategies are also relatively inobtrusive and preserve the participants' freedom of choice[183,185] (e.g. removing foods from a menu or implementing stay on-site policies would not constitute a nudge). Moreover, previous research has found evidence for the effectiveness of nudge strategies within schools, particularly in terms of increasing fruit intake[184,253]. However, relatively few nudge interventions have been conducted in UK secondary schools[330]. Therefore, it is uncertain whether nudging has longer term effectiveness, or if nudging could bring about the whole-system level changes needed in school food.

Schools are also a unique social context and findings from chapter 6 and 7 indicated that social aspects of school food were relevant to adolescents' school food choices. Examples of these social aspects included students in school 1 almost unanimously throwing the mandatory side salad into the bin, students foregoing their own food choice preference to go where their friends wanted to go to get school food; students reportedly skipping lunch or getting something convenient so they would have more time to socialise with their friends. These examples illustrate the added complexity associated with school food choices and give additional support for the need for researchers to better understand the contextual factors in order to positively influence students' food choices[358].

Whilst several measures can be taken to try and encourage adolescents to choose school food, it is likely that substantial percentages of students will continue to choose alternatives, namely packed lunches and nearby outlets. In this regard, there are a number of strategies policymakers could employ to directly impact school food choices. For example, some have advocated for stay-on-site policies in schools[232,384] or 400 meter no fast food zone surrounding schools[385,386]. Nearby outlets pose direct competition to school food and are often viewed as cheaper and more convenient (as illustrated in chapters 6, 7); therefore these initiatives could diminish competition with these outlets and encourage more students to purchase school food. Moreover, this could facilitate healthier choices, as research indicates that lunches from nearby outlets are associated with poorer food choices[26] and decreased diet quality[17]. However, some students may view such policies as an impingement on their freedom of choice.

Packed lunches are also very popular among adolescents; in chapters 6 and 7, many students reported bringing lunches from home, citing key reasons as the decreased cost associated, the convenience and the ability to tailor the lunch to their individual preferences. Moreover, previous research[17] has cited that as much as 36.6% of students bring lunches from home; which generally have an inferior nutrient profile compared to school food[231,232]. Therefore another measure could be to enforce policies to promote healthier packed lunches, as others have previously advocated for[231,232,235]. Such policies could include providing more information to parents and students, to encourage better food choices in their packed lunches[232,235], restricting foods that are high in fat, sugar and salt, however as Pearce et al. point out[231], this may prove difficult to implement. Another option mentioned was to ban packed lunches and insist that students have school lunch[232]. However, this may prompt students to purchase more food from nearby outlets. In light of their popularity, it is important that efforts be made to improve the nutritional quality of packed lunches, as the longer they go without oversight, the wider the nutritional gap becomes between school and packed lunches[231,235].

Whilst there are multiple ways policymakers can look to influence adolescents' food choices, findings from this thesis relay the importance of and need for effective dialogue across organisational levels. For example, findings from chapter 3 illustrated how catering staff must manage conflicting priorities from schools (health) and catering companies (financial returns) when preparing and providing school food. Meanwhile, findings from chapters 4, 5 and 6 illustrated how schools need to communicate the healthiness of specific food items to students, to encourage selection of these items, and detract selection of the more popular convenience items. Consistent stakeholder consultation and collaboration is warranted, particularly with those affected on the ground-level, namely catering staff and students. For example, findings from chapter 3 indicated that catering staff need to be supported to implement the FBS fully, whilst also maintaining a sense of agency and engagement with their role. As the "the final arbiters" of school food[290], they can play a vital role in engaging students and encouraging healthy choices[253]. Catering staff are also well placed to feedback on how school food initiatives do or don't trickle down to influence student choices, along with highlighting key impediments/barriers thereof, for example, conflicting interests of health priorities and financial viability.

School food policy discussions should also integrate students' views[22,107,291] and food choice behaviours, along with their associated nutritional intakes (e.g. free sugar content in drinks). For example, findings from chapter 6 illustrated adolescents' capacity to make suggestions for school food changes, both in terms of adapting the school food environment, and altering food provision. Some schools have encouraged students to engage in discussions around school food as school food ambassadors, as has been highlighted on the School Food Plan website[387]. Greater inclusion of a student perspective can serve multiple purposes, including (1) highlighting key areas of concern, (2) bolstering schools' ability to maintain/increase school food uptake, and (3) co-designing amenable strategies to replace/reformulate less favourable school foods. In line with whole-school thinking[105] dialogue should also be sought with parents, catering companies and members of school leadership, in order to incorporate wider stakeholder perspectives (e.g. deducing catering staff's level of enthusiasm to encourage healthy choices, identifying schools' financial capacity to modify canteen areas, getting parents' help in ensuring students have a healthy packed lunch).

Given the unique and complex context of the school environment, any future school-based dietary intervention should look to have students, school staff and catering staff as co-producers, in order to bolster intervention fidelity and long-term effectiveness. Co-design and co-production approaches have gained popularity in public health research in recent years, due to their potential to facilitate high-quality, relevant research that is salient to its participants and yields a direct impact on policy and practice[388–390]. Co-production involves consistent dialogue between researchers, citizens and policy makers, and emphasises actively involving participants as "experts by experience" in question development, study design and communication of findings. Researchers have claimed that the involvement of participants in the study design can improve recruitment and the quality of the research, bolstering the impact of research results[391,392]. Co-production is best suited to longer term partnerships, rather than shorter (1-5 years) project related timelines[393]; therefore, Beran and colleagues have called for research funders to support "partnerships rather than projects"[394]. Embedding positive changes to school food environments and influencing adolescent dietary behaviour will most likely require years of wide-scale, consistent research and implementation efforts. Therefore, it is vital that cross-sectoral partnerships between researchers, funding bodies, schools, students and policymakers be encouraged, rather than stand-alone projects.

8.4 Future Work

This thesis has raised several important questions regarding the current state of UK secondary school food (e.g. what is the range of FBS compliant menus in terms of nutritional composition; what prices are amenable to students but also maintain school food viability, how can the micronutrient density (namely fibre, calcium, iron, zinc) of school food be increased, whilst not excessively increasing energy density, how can students be encouraged to select fewer convenience items and more favourable items, namely meals of the day) and has several important implications for policy and practice (emphasising consultation with students and coproduction approaches, decreasing free sugar content of school foods, giving additional supports to catering staff to prepare healthy school food and encourage healthy student choices). A key takeaway from the thesis is that there is a need for more high-quality, large-scale research on school food, in order to fully answer some of these questions. Research including several schools would give a more comprehensive outline of school food provision and could better inform the national discussion pertaining to school food and school food policy.

For example, findings from chapter 4 indicate that two schools can both comply with FBS, yet provide very different foods; meanwhile, compliance with FBS does not guarantee healthy school food provision (as per previous NBS). Large scale research, with a larger group of schools, could elucidate the nutritional composition of school food provision more generally, and also explore differences across schools. In line with this, research with a larger group of schools could explore the range of FBS compliance in terms of energy and nutrient content (i.e. how FBS-compliant schools could provide food which varies substantially in terms of nutritional composition). Moreover, this thesis has reference values largely based on the previous NBS as a standard to evaluate school food. Versions of the NBS are still in place in other parts of the UK (e.g. Scotland[395] and Wales[396]) and with large scale research, it would be possible to compare the nutritional quality of school food provision and choices across these constituent UK countries. This would give a better sense of how schools which have continued with NBS have performed, compared to schools which now operate solely under FBS.

In addition, large scale research could generate more comprehensive conclusions regarding adolescents' school food choices. For example, whilst many of the findings from chapter 5 were supported by previous research, the fact that only two schools were involved in the thesis raises questions regarding the representativeness of the findings. Research with a larger group of schools could describe adolescents' school food choice behaviours within a national context. For example, future research could explore how choices are distributed across key categories (e.g. savoury snacks, drinks) and sub-categories (juice-based drinks, meals of the day) with a nationally representative sample.

Cashless catering data remains a greatly under-utilised resource within school food research. By using this data, future researchers could efficiently collect choice data on thousands of adolescents from hundreds of schools. As Woodside et al[256] point out, collection of such data would facilitate research with routine outcome assessment and enable important data linkages, for example, to health and educational outcomes. Given the relevance of cost to students' food choices, analysis of catering data could also explore a variety of cost-related food choice questions, such as (1) what tipping points can be identified between price and uptake, (2) how much different sub-groups spend on school food, and (3) how do students' spending habits correspond to energy/nutrient intakes from school foods (e.g. can a student have a nutritious school lunch with a budget of £2.34). Collection of such large-scale data can also highlight potentially vulnerable groups and communicate this to policymakers (e.g. how many students who are eligible for free school meals do not take them? How do the food choices of students attending schools in deprived areas compare to students attending schools in less deprived areas? How might school food choice change if all students were given a free school meal allowance?). Finally, collection of large cashless catering datasets from several schools would facilitate the adoption of more sophisticated statistical analyses (e.g. dietary pattern analysis), to explore what dietary patterns are present nationally and regionally.

Chapter 1 highlighted how intervention research in secondary school settings is quite far behind primary schools, both in terms of number of studies and intervention quality[192]. Multiple intervention approaches have been employed in schools (e.g. policy, nudging, price incentives, social norms intervention) but more high-quality research is needed to identify which are most effective, and for whom. Consultation with students and co-production approaches to school food research have been highlighted throughout this thesis (e.g. chapters 3, 6 and 7) and in previous research[20,107,331–334]. For example, students' suggestions for school food (chapter 6) further illustrate adolescents' value as experts by experience. Qualitative methods and co-production approaches (together with consideration of relevant food choice models e.g. SEM, FCPM) are useful ways to elucidate which factors are most pertinent to students' choices, from their perspective, along with which interventions may be most effective in influencing adolescents' school food choices [388–392,397]. For example, one promising method is the use of the CHAT (choosing all together) tool[398,399]. This tool uses a finite crediting system which encourages participants to prioritise key areas for them (e.g. participants have to assign 5 credits across 10 problem areas). One way this could be applied to school food interventions could be to categorise problem areas across the 5 levels of the SEM and ask participants to identify the priority areas therewithin. Whilst the CHAT tool is untested in a UK school context, approaches such as these hold great promise in facilitating co-production, setting priorities, and placing greater ownership of the research in the hands of those for whom it looks to serve.

8.5 Thesis Strengths & Limitations

Strengths:

One of the key strengths of this thesis is the adoption of a mixed methods approach, which enabled the researchers to gather a depth and breadth of data. Moreover, as the data collection occurred in the same period (observations, catering data download and focus groups all occurred during the period May to June 2019), the quantitative and qualitative arms of the thesis directly related to one another. Furthermore, the incorporation of a mixed method approach allowed the researcher to synthesise findings across the thesis, with the qualitative and quantitative elements acting symbiotically. For example, findings from the observations and focus groups gave context to the nutritional composition findings, whilst the nutritional composition findings gave valuable support and validation to some of the findings from the observations and focus group discussions. In addition, the collection of data from two schools enabled comparisons across schools, providing another level of insight (e.g. two schools can both be compliant with FBS yet provide food which varies significantly in terms of nutritional composition).

Another strength of the thesis is that it gathered perspectives on school food from both sides of the counter. Carrying out immersive observation visits gave the researcher a “lived” experience of school food preparation and provision practices and enabled the researcher to have candid conversations with catering staff regarding school food. In doing so, the researcher was able to learn a great deal about (1) how school food is prepared and provided, (2) how catering staff feel about school food provision, (3) students’ reception to school food (from their perspective) and (4) the different priorities at play in relation to school food preparation and provision practices.

A novel aspect of the qualitative component of the thesis was the development of two separate FG schedules. This approach had advantages and disadvantages; for example, inclusion of one schedule in both schools would have enabled comparisons across the two schools, and facilitated exploration of how each specific school environment may have influenced students’ school food choices and experiences of school food (e.g. students in school 2 using the canteen more as there were fewer nearby food outlets compared to school 1). That said, using a different schedule in each school enabled the research team to explore food choice broadly (e.g. queues were an important influence on food choice in both schools) but also delve into different aspects of adolescent food choice behaviours. It also enabled the incorporation of both deductive and inductive approaches, thus the qualitative findings from this thesis added to the literature base on existing theoretical concepts of food choice, but also explored previously under-investigated aspects of adolescent dietary behaviour.

Another key strength of the thesis is how the nutritional composition analysis was carried out. To the author’s knowledge, conducting three-week immersive observations represents a novel approach to gathering nutritional composition data. In particular, the collection of data over a full three-week menu cycle represents a novel contribution, as much of the previous research[228,231,232,237] in this domain (i.e. nutritional assessment of school food) has collected data over shorter timeframes, often 3 to 5 days. By carrying out prolonged observations and analysing school food provision and choices over three weeks, the thesis could extend previous work and provide a more comprehensive and detailed evaluation of school food.

Furthermore, encapsulating the full menu cycle facilitated easy comparison to school food standards (both current FBS and previous NBS). A final strength of the thesis is that it examined school food in terms of specific food and drink (sub)categories, specific foods and energy/nutrient values; meanwhile, findings were considered in relation to the FBS, NBS and DRVs. This enabled identification of nutrient values of note (e.g. free sugars), along with key food/drink sub-categories (e.g. juice-based drinks, sweet snacks) that may be contributing towards these nutritional values.

Limitations:

Specific limitations for each study were provided in the respective study chapters. Overall and for the thesis, there are a few limitations worth considering and reiterating. For example, only two schools were included; following on from this, one of the schools used in-house catering, while the other worked with a large catering company, which may have impacted the catering practices observed in each school. However, it is difficult to make inferences on this with only two schools included. As was discussed in the study chapters, the schools were not atypical in terms of number of pupils on roll or percentage of students eligible for FSM and as such, the findings from this thesis may well be applicable to secondary schools in England and the UK more generally. However, this small sample size remains a limitation of this research.

One of the main reasons for this small sample size was the observation visits. This is a key strength of the work, in that it enabled in depth exploration of school food preparation and provision. However, the consequence of this approach is that it was quite labour intensive and time-consuming. As such, this approach may not be easily replicated by other researchers. Moreover, it may not be easily applicable over a larger, nationally representative scale, as this would require substantial financial investment. This may partly explain why previous researchers have not carried out fieldwork over such long time periods.

Social desirability biases[255] and observer effects[254] were consistent limitations throughout this thesis. For example, whilst the immersive nature of the observant participant approach was designed to mitigate against them, observer effects may still have influenced how foods were prepared and provided by catering staff. This would have had a cascading effect on the thesis as a whole, as it would impact the food preparation data and nutritional composition data. During the focus group discussions, students may not have wanted to mention certain things, for example, students may have been reticent to criticise their school and/or the school food, for fear of getting in trouble. Again, the researcher and research team took multiple measures to try and mitigate against this possibility (e.g. using ice-breakers, assuring students that their responses would remain anonymous, assuring them that there were no right or wrong answers, asking students for their own opinion etc.); however, this is a limitation to any qualitative or observational research.

Another limitation of this study is that the analysis of provision and choices both focused on three week periods only. It was decided to isolate the three weeks immediately preceding the observation period as (1) the researcher could more easily account for every item sold, (2) the researcher could assume that the model of preparation and provision would be largely identical to that observed. However doing so meant the findings from this thesis are quite specific and may not fully represent school food provision or choices across the school year. For example, the thesis did not capture provision/choices across different menu cycles (schools typically operate two cycles per year). Moreover, the thesis did not explore potential seasonality effects, which previous research has shown to influence school food choice and dietary patterns of primary school-aged children[400,401].

A final limitation of the thesis concerns the development of the nutritional composition data. As described in chapter 4, calculation methods of ascertaining nutritional composition values are less accurate than direct analysis in a laboratory setting, due to the use of estimated yield/retention factors, estimated edible proportions, reliance on food composition databases, which may have limited or missing information for some values, and the heightened chance of researcher error. Despite these inherent issues, the methodology employed in the thesis tried to be as rigorous and true to real-life as possible (e.g. gathering brand, back of pack information and weights for each individual ingredient, weighing foods before and after preparation, comparing nutritional composition data across 3 separate databases, noting any deviations from written recipes during preparation, following published guidance[297,320,321] on using yield and retention factors for nutrients in composite foods etc.). Nonetheless, the nutritional composition findings in this thesis should be considered within the context of these limitations. Following on from this, for items described broadly on the cashless catering data (e.g. radnors, juice bursts), the nutritional compositions assigned relied on manual tallies to estimate how much of each constituent item was chosen by students. However, these manual tallies may have over or under-estimated the extent to which students chose a particular item (i.e. students may have chosen more chocolate flavoured milk or less banana flavoured milk than estimated).

8.6 Reflexivity of my PhD Thesis

Reflexivity was consistently promoted throughout the PhD process and was an integral part of the methodological approach taken. For example, reflective notes were taken during each day of the observation visits, and also during and after the focus group discussions, moreover, these notes were discussed among the research team at regular meetings, as were the approaches taken to developing the nutritional composition data and assigning nutritional composition data to the items listed in the cashless catering data.

Reflexive accounting of how the researcher's background and experience may have influenced data collection and/or interpretation is important in terms of mitigating against personal and intellectual biases[402,403]. Given the importance of the observation periods in the thesis, and the relevance of the observation visits for the rest of the thesis (e.g. food preparation data collected during the observation visits informed the development of the nutritional composition tables, which was analysed and discussed in chapters 4 and 5), it is particularly important to consider the researcher's position in the observation visits and how the researcher may or may not have impacted the thesis. Likewise, it is important to consider the potential for social desirability effects[255] influencing participants' responses during the focus group discussions.

A good starting point in this regard is the researcher's background. As an Irish national, the researcher had an "outsider" perspective insofar as English schools are concerned. Irish secondary schools differ to English ones in terms of food provision; for example school lunches are much more commonly consumed by students in the UK than in Ireland. Many Irish schools have very limited food provision services, while canteens are a smaller part of the school. This is in contrast to the UK, where food provision is a more considerable part of the school services, while school canteens are much larger, more developed areas. Moreover, hot meals are not typically provided in Irish schools and school lunch provision focuses more on snack foods[326], whilst in English schools students are provided with various different food and drink options, whilst hot meals (especially freshly prepared meals) form the cornerstone of the overall provision. Thus, by previously attending secondary school in Ireland, the researcher had a very different experience of secondary school and school food compared to the participants.

The researcher's background had benefits and drawbacks. For instance, the researcher approached the data collection as a blank slate and asked simple questions. This proved beneficial during the focus groups, as the researcher could ask students to walk him through the lunchtime experience. Moreover, having left secondary school relatively recently, the researcher was not too far away from the focus group participants in age; this may have also benefitted the focus group discussions and let participants feel more comfortable talking. Students explained in detail how they get lunch at school and, crucially, how they make their food choices at school and may have included information which they may have considered obvious if speaking to an English researcher.

That said, having an Irish background did mean that the researcher had less personal knowledge to fall back on, particularly early on in the PhD. This meant that the researcher had to learn and become familiar with the English school food landscape, e.g. the range of items provided in schools, the number of services each day, the popularity of school lunch, the public opinion of school food, the relevance of catering companies or in-house catering, school food standards etc. Much of this may well have also been new for an English researcher; however, the researcher may have been better able to consider the social and cultural aspects of the school food environment if he had attended school in England.

8.7 Complexities of Working with Schools

There were a number of inherent complexities to carrying out this research, and the research team faced many of the same challenges encountered by previous school-based researchers. For example, previous research[404,405] has identified recruitment as a practical challenge of school-based research, as it can be difficult to get in touch with key school contacts and establish a line of communication. With the present research, recruitment was approached in a systematic and persistent manner. This involved identifying influential staff members in each school, ringing school reception and asking directly for these individuals, pre-preparing study information documents (single page information sheet to send to schools initially, longer information sheet if schools expressed interest in the study, student information sheets, parent information sheets, student consent forms), sending follow up emails and being readily available to quickly respond to any school queries. Nonetheless, recruitment remained a challenge, for example while two schools were successfully recruited, school leadership in another school initially agreed to participate but prior to moving forward, the catering team expressed reluctance to participate in the direct observations and the collection of food preparation information. As such, the school could not be included.

A second challenge of school-based research is the heightened duty of care researchers must have, particularly when considering the involvement of adolescents. In addition, dietary behaviour and/or obesity may be sensitive topics for some students (e.g. if students have an eating disorder or are weight-conscious etc.). Consultation with school staff was invaluable in this regard, as the staff could advise regarding selection of potentially vulnerable students for the focus group discussions. The researchers also employed a rigorous consent process. Detailed information sheets were distributed to school staff, students, and parents, which provided details including what the studies involved, where the data would be stored and how the findings would be disseminated. Opt-in consent was sought from all focus group participants, while opt-out consent was requested from the parents of students, on the students' behalf. Students were also reminded of their freedom to stop or not participate at any time during the focus groups. As a final precaution, the research team identified and contacted the appropriate school staff members responsible for student welfare (e.g. school counsellor) prior to conducting the focus groups, just in case students became distressed during the discussion and needed support.

There were also some additional challenges associated with conducting focus groups with students. One such challenge involved successfully securing student participation. Student attrition was high in school 2, and an additional day of focus groups was organised to make up for students not attending the original discussions. This mirrors the experience of other researchers, whom have reported organising make-up study dates to collect data from students who were absent on the originally scheduled date[405]. During the focus groups themselves, the researcher had to be sure to avoid any potential observer effects[254] or social desirability biases[255], and ensure students did not look at the researcher as a teacher type figure, but rather as an interested and impartial listener.

A final challenge of conducting school-based research is managing the contextual variables associated with school-based research. For example, previous research has highlighted how the aims of the research team may not necessarily align with those of the school. Schools may view health improvement initiatives as detracting from the main purpose of schools, academic achievement[406–408]. School staff can face pressures to produce academic results and as such, staff may feel that health improvement initiatives are hoisted upon them and may not have sufficient time or motivation to help with implementing any health improvement initiative[409]. This was not the case in the present research, where staff in both schools expressed an interest in student health and had a desire to promote healthy eating. It is also important to consider catering teams' priorities and concerns, for example, catering companies have commercial interests and dissemination of research findings could have commercial implications for them. Therefore, during the observation visits in school 1, the researcher made sure to approach any correspondence or dialogue with the catering company (or any of their employees) professionally and with transparency. The researcher was open and available to discuss the research aims and objectives and give assurances in relation to anonymity in reporting (for individuals, schools and catering companies) and that all data would be handled in line with GDPR regulations.

This last point gives an indication of how school catering is positioned within a commercially focused sphere, which may not align with health promotion initiatives. As it pertains to school food provision, different actors (i.e. school staff, catering staff, catering companies, students) may have different priorities. For example, in one of the schools, the researcher observed some differing views on school food preparation and provision between school and catering staff, rooted in the fact that the latter worked for a catering company and therefore, at times, held contrasting views on best practice. As both parties would discuss the topic of school food with the researcher, it was important that the researcher remained neutral and impartial throughout. These examples point to the complexity of the school context and illustrate how researchers must navigate these potential conflicts and issues when carrying out school-based health research.

8.8 Conclusions

This thesis identified some key gaps in the school food discourse; these include a lack of recent school food evaluations, ambiguity surrounding school catering practices, and subsequently, a lack of clarity regarding the current nutritional composition of secondary school food. Findings from this thesis indicate that whilst schools may be providing food of an acceptable standard (as per current FBS), the nutritional composition of school food provision could be improved, particularly in relation to reference values (NBS and DRVs apportioned for a school lunch). Across school food provision and choices, convenience items such as pizzas, juice-based drinks and sweet/savoury snacks emerged as key foods to consider , whilst free sugars, fibre, calcium, iron and zinc emerged as nutrients of note. Finally, qualitative findings indicated that adolescents consider their food choices across environmental and diurnal contexts, meanwhile time, cost and social aspects are key factors underpinning adolescents' school food choices.

The UK has a long history of school food policy, and policy aims have always reflected the specific needs of the young population at that time. This holds true today; large percentages of UK adolescents are overweight and/or obese[1] and have diets which are simultaneously high in energy and sugar and low in several valuable micronutrients[3]. Current school food policymakers and providers aim to provide healthy, nutritious food to young people and encourage take-up. However, the findings from this thesis highlight how efforts to promote healthy adolescent diets can be mediated by higher (e.g. removal of NBS, use of overly flexible FBS, lack of formal Oftsed monitoring, lack of school reporting) and lower level factors (e.g. staff use of discretion, long queues and busy lunch periods, students' food choices, students' dietary rationalisations, cost of school food, social norms surrounding school food etc.).

Embedding changes to school food environments and positively influencing adolescent dietary behaviour will most likely require years of wide-scale, consistent research, routine data collection and outcome assessment (e.g. via cashless catering data), and implementation efforts. This will require substantial time and financial investment, which in the aftermath of the recent coronavirus pandemic, may not be so readily available. In order to maximise available resources and expedite knowledge generation, it is vital that cross-sectoral partnerships between researchers, funding bodies, schools, students and policymakers be encouraged, rather than stand-alone projects. At the core of these partnerships should be the students themselves. A shortcoming of school food research (and policy) to date has been an inadequate consideration of the contextual factors at play[358]; as both the architects and victims of many of these contextual factors (e.g. social aspects of school food), students are best placed to describe these influences and provide invaluable insight. This can help to give much-needed direction and focus to future school food inquiries and highlight priority areas of change.

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University of Leeds

Appendix 1. Information Sheets & Consent Forms

Parent Information Sheet: Choosing Food in Schools

We are researchers from the University of Leeds, and we are conducting a study on students' food choices in school. Please take a moment to read the following information to be sure you are happy for your child to be involved in this study.

What is the purpose of this study?
We're aiming to explore the food choices made by secondary school students. We are also interested in students' views on their food options, including how and why they make their food choices.

Why has our child been invited to take part?
Your child has been invited to take part as Pudsey Grangefield School has agreed to participate in our study.

Does my child have to take part?
Not at all. Your child does not have to take part in this study and you and/or your child are free to decline this invitation without any reason.

What does participation involve?
Data will be gathered from the school's cashless catering system. This data will show what students are choosing to purchase from the canteen during the school day. Students will also be invited to take part in a focus group discussion. The discussions will be in groups of 5-6 students and last roughly 45 minutes to 1 hour. During the focus group discussion, we would ask the students about their food choices in school and why and how they make these choices. The focus groups would be conducted on the school premises and during normal school hours.

What are the disadvantages of my child taking part?
Taking part in focus groups will take up some of your child's time, roughly 45 minutes to an hour. We don't anticipate that the discussion will upset anyone. However, if a participant does become upset or if any issues arise during the focus groups, the researcher will notify a member of school staff.

What are the benefits of my child taking part?
The findings will help us to understand the foods that students choose to eat and students will be able to give feedback on their school canteen food options. For their participation, students will also receive a signed certificate from the research team.

What will happen to the data that is collected?
Focus group discussions will be audio recorded and transcribed (typed up). Recordings will be deleted once they have been transcribed. Collected data will be stored in restricted access folders at the University of Leeds. Data will only be accessible to members of the research team.

Will the data be kept confidential?
We will keep all data confidential, and all data will be anonymised and only accessible to members of the research team. Personally identifiable information (names of local places, people, shops, schools etc.) will be removed and will not appear in any written reports or publications.

The findings from this study will be published for other researchers, and organisations interested in our work and will be included as part of a PhD thesis. These publications might include quotations from the focus group discussions, but these will be anonymous and pseudonyms (false names) will be used in place of your child's real name.

Who is organising/funding this research?
The research is solely organised and funded by the University of Leeds, no funding from other parties is being received.

Who has ethically reviewed this study?
This study has been reviewed by a Faculty Ethics Committee at The University of Leeds

Thank you for your time and for reading this information. If you have any further questions or wish to know more about the study, please contact:

Researcher:	**Project Supervisor:**	**Co-Supervisor:**
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- School of Food Science and Nutrition, University of Leeds, LS2 9JT

What do I need to do next?

If you are happy for your child to be included in this study then you do not need to do anything. Please keep this information sheet for reference. **If you <u>do not</u> want your child to take part in this study and wish to opt out**, please email **<u>abcd@pudseygrangefield.co.uk</u>** and state that you want to opt out of this study. Alternatively, you can complete the opt-out form below and return to your child's school.

Parent Opt-Out Form

Title: Choosing Food in Schools: <u>Pudsey Grangefield School</u> *Please tick the box below*

I **<u>do not</u>** want my child to take part in the study ☐

Name of child: …………………………………… Class: ……………………………………

Signature of parent/guardian: …………………………… Date: ……………………………………

Please return this completed opt out form to your child's school. Thank you for your time.

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Student Information Sheet: Choosing Food in Schools

We are researchers from the University of Leeds, and we are conducting a study on students' food choices in school. Please take a moment to carefully read through the following information to be sure you are happy to be involved in this study.

What is the purpose of this study?
We're aiming to explore the food choices you make as secondary school students. We are also interested in how and why you make your food choices.

Why has my school been invited to take part?
Your school has been invited to take part as it is a large secondary school in the Leeds area.

If I decide to take part, what will I be asked to do?
You will be invited to take part in a focus group discussion. The discussion will be in a group of 5-6 students and will last roughly 45 minutes to 1 hour. During the discussion, we will ask you about your food choices at school and why and how you make these choices.

What are the disadvantages for me taking part?
Taking part in this study will take up some of your time. There is also a possibility that, during the discussion, different viewpoints may come up. However, you do not need to speak if you do not want to. If you feel uncomfortable or want to stop at any point during the focus group, you are free to do so.

What are the benefits for me taking part?
You will be given a chance to voice your opinion on the school food options and choices available to you. For your participation, you will also receive a signed certificate of participation from the research team.

Do I have to take part?
Not at all. You do not have to take part in this study and you are free to decline this invitation without any reason. You can decide to not take part at any point up to and during the focus groups. You may also withdraw from the study up to 2 weeks after participating in the focus group.

What will happen to the data that is collected?
The focus group discussion will be audio-recorded and later transcribed (typed up). The recordings will be deleted once they have been transcribed. Collected data will be stored in restricted access folders at the University of Leeds and will only be accessible to members of the research team.

Will the data be kept confidential?

We will keep all data confidential, and all data will be anonymised. Personally identifiable information (names of local places, people, shops, schools etc.) will be removed from focus group transcripts and will not appear in any written reports or publications. As a participant, we would ask you to respect the anonymity of other participants and not disclose who participates in the focus group with you.

What will happen to the findings of the study?
The findings from this study will be published for other researchers, and organisations interested in our work and will be included as part of a PhD thesis. These publications might include quotations from the discussions, but these will be anonymous and pseudonyms (false names) will be used in place of your real name.

Who is organising/funding this research?
The research is solely organised and funded by the University of Leeds, no funding from other parties is being received.

Who has ethically reviewed this study? This study has been reviewed by a Faculty Ethics Committee at The University of Leeds

Thank you for your time and for reading this information. If you have any further questions or if you want to know more about the study, please ask the focus group facilitator.

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Consent Form: Choosing Food in Schools

(Please Tick the box next to the statement if you agree)

- I confirm that I have read and understand the information sheet. ☐
- Any questions I have about my participation have been answered. ☐
- I understand that my participation is voluntary and that I am free to withdraw at any time during the focus group or up to 2 weeks after the focus group. I understand that I do not need to answer any question if I do not want to. ☐
- I give permission for the research team to analyse my responses and potentially include quotations in written reports and publications. ☐
- I understand and consent for the discussions to be audio recorded for data analysis. ☐
- I agree for the data collected from me to be stored by the research team and used in relevant future research (in an anonymised form). ☐
- I agree to take part in the research study. ☐

Name of participant: ………………………………………………..

Participant's signature: ……………………………………………. Date: ……/……/…………

Name of Researcher: ………………………………………………..

Researcher's Signature: ……………………………………………….. Date: ……/……/…………

Appendix 2. Reflection Notes examples

School: School 1 Day & Date: Tuesday 07/05/2019
Time: Break (10:50 – 11:10), Lunch (13:05 - 13:40)

1. Comments/Reflections on day
- grab & go is by far the most popular option. The canteen staff prepare meals each day but end up throwing out the vast majority of it. They freeze what they can but it's disheartening for them.
- same breads are served each day – almost all are wholemeal, except paninis and bagels as these are too expensive for the school to purchase...2X as expensive to buy WM bagels than white
- Kitchen get most food items from ****** – sometimes ****** send incorrect items (e.g. they sent choc chip cookies this week rather than plain cookies) but school sells them in place of original order (even if they may be less healthy)
- disposable snacks are brought in separate to ******
- salad served with main meals and wraps but lots of kids throw it into the bin straight away
- plain pasta is hugely popular...as it's much cheaper than main meals, 60p cheaper than having sauce included...price appears to be a big factor in students' choice parameters
- sandwiches, baguettes, wraps have butter/light mayo on most of them... applied quite heavily.
- free wholemeal bread offered to students who purchase anything.

2. How do today's insights affect the study?
- there are huge amounts of food waste every day
- beige foods are much more popular
- school's must balance having healthy foods and staying within budget
- religion and food – staff spoke of student passing out at counter during Ramadan
- school and canteen staff feel like they are fighting a losing battle

3. What Questions do I have after today?
- which items do the school get that are not supplied by ******?
- what's the price difference between pasta options/grab & go and meals of the day?
- do the staff keep detailed recipes for each food item?
- how are different pasta/sandwich/baguette options logged on the system?

School: School 1 Day & Date: Wednesday 22/05/2019
Time: Break (10:50 – 11:10), Lunch (13:05 - 13:40)

1. Comments/Reflections on day
- Pasta sauces have written down recipes but the staff make it from memory…I have written down weights for these.
- Pizzas today = BBQ, pepperoni and margerita
- Wraps leftover from yesterday sold today
- All muffins are iced as otherwise kids may not eat them
- All muffins, brownies, trey bakes down as tray bakes….need to estimate frequency
- I still see different members of staff entering sandwiches differently….mainly due to a perceived overly-complicated, populated till layout, which is further exacerbated by a real time pressure and need to get the students through quickly…pressure brought on by school orders.

2. How do today's insights affect the study?
- I need to do tallies for drinks, pizzas, tray bake items, sandwiches to counteract limitations in the till.

3. What Questions do I have after today?
- How much do tray bakes differ month to month….do they just repeat the same 4-5 options?

School: School 2 Day & Date: Monday 08/07/2019
Time: Break (10:30 – 10:50, 10:50 - 11:10), Lunch (12:10 – 12:40, 13:10 - 13:40)

1. Comments/Reflections on day
- got weights for cucumber, tomato and lettuce, which all need to be integrated into the food prep table.
- Sausage sandwich sold every Monday to use up leftover stock from Friday.
- They used to do bacon and egg every day but numbers are dropping…now only do 8 or so every other day.
- Same amount of ham in ham baguette as in ham & cheese baguette.
- Made circa 24 sausage sandwiches at break today…all sold out.
- Sales are down as students eat less when the weather improves, as staff member states.
- Did roast dinner today as it is sports day tomorrow.

2. How do today's insights affect the study?
- I need to jot down sandwich tallies.

3. What Questions do I have after today?
- How often and how much does the menu cycle change?
- Where do they order the baguette/sandwich fillings from?

4. List of Things Left to do
- Go through freezer contents
- Main Meal Recipes
- Tills

- Tallies for Drinks
- Estimates for Sandwiches
- Weights of Remaining Items
- Look Up Delivery Companies
- Food Waste Records
- Tallies for Pizzas
- Tallies for Pasta pots

Appendix 3. Photographs taken during Observation Visits

School 1

School 2

Appendix 4. Focus Group Schedule for School 1 Discussions

Checklist:

- Pens
- Post-it Notes
- Consent Forms
- Student Information Sheets
- 2 recorders
- Name tags and black marker
- Demographic Questionnaires

(Name labels ready when students walk in)
Intro (5 mins):
Hello, so thank you all for taking part in this focus group/discussion today. My name is David and I'm a researcher at the University of Leeds. XXX is also here today, just to observe and take notes. So today we're going to talk for roughly an hour or so about food choices in school. We want to discuss how and why you, as students, make your food choices during the school day.
Before we begin, I just want to go through the **consent form** with you. There should be a copy in front of each of you, along with an information sheet. (check they're there)

- Voluntary
- Able to stop/not answer at any point
- Anonymity
- Use of responses in publication/reports
- Being recorded

So, finally before we start I thought we would just go through some ground rules:

- there are no right or wrong answers
- please respect each other – if you disagree with something or if you think someone's point is stupid or silly, please be respectful of one another
- don't talk all at once – respect the speaker - listen to each other
- talk to each other, not to me
- protect other participants' anonymity
- mobile phones on silent please

Does anyone have any questions?

- *collect signed consent forms*
- *name labels*
- *post it notes & pens*
- *turn on audio recorder*

Ice-breakers/Games
1) For the next couple of minutes, can you think about **what is served** in the school canteen and write down every item you can remember on these **post-it notes** please?
Questions:
1. Typical Lunch
So, what do students typically have for lunch?

- Which foods are most popular?
- How would you describe the food and drinks students generally have at school?
- What do most students think about when choosing lunch? What's important to them?

2.1 Your Lunch Yesterday
What did you have for lunch yesterday?
- Can you write it down, on these **post-it notes**, along with **3 words to describe** your lunch yesterday please?
- (go around the room) What did you write down? Why did you choose these words?

2.2 Your Lunch (cont'd)
What do you like to have for lunch in school?
- How would you **describe** your lunch?
- Does it **vary** day to day?
- How do you decide what to eat and drink at school?
- What is **most important** when you're making this decision? Do you weigh up different factors? e.g. taste, price, how filling it is, day of the week etc. Are some food options better value for money?

3. Experience in Canteen
Do you eat your lunch in the canteen? How do you find eating lunch in the canteen? (In Ireland we don't have canteens so if you could walk me through it please). What's the **overall experience** like?

- At the start of lunch - what's it like? How would you describe it?
- Can you tell me how the **queues** work? In the queue – are you deciding what to have? What are you thinking about?
- When you get to the **counter**, what do you see in front of you? What's visible? What does the food look like? Can this influence your decision?
- When do you decide what to eat/drink?
- Do you sit with the same people? What do they eat?

4. Bringing in Lunches from home
Does anybody here bring their lunch in from home?
- Why do you bring lunches from home?
- How do lunches from home **compare** to school lunch?
- Do you have a mix? Buy extra food/treats in school? Buy school food on certain days?

5. Food/Drinks at Break
During the school day do you have food/drinks during **break**?
- What kinds of foods/drinks do you have?
- Brought in from outside school or purchased in school?
- Why do you have them? (skip breakfast, hungry, nicer options at break?)

6. New Meal
If you could pick a **new food/drink option** for the school canteen, what would you choose?
<u>Please write this down on your post it note</u>

- (go around the room)
- Why this choice?

7. Food Outside of School

Does the food/drinks you eat at school differ from what you choose to have when you are not in school? (i.e. at home or at weekends)

- How do they differ?
- What are the **main differences**?
- Why are there differences?
- Preference between food outside of school and food at school?
- Are there different rules at **home** and at school in terms of food?
- If your parent/guardian saw what you have at school, what would they say? (where applicable)
- Do you ever discuss food with your parents/guardians?

Conclusion:

Okay, so before we finish is there anything we haven't touched on that any of you feel is important to talk about?

Summary:

- What we talked about
- What will happen with the findings – school report, publication etc.

Thank you again for your time

UNIVERSITY OF LEEDS

Demographic Questions: Choosing Food in Schools

Please answer the following questions by placing a tick (✓) in the appropriate box.

1. How old are you?

11 years old	☐
12 years old	☐
13 years old	☐
14 years old	☐
15 years old	☐
16 years old	☐
17 years old	☐
18 years old	☐

2. What gender do you identify as?

Male	☐	Other	☐
Female	☐	Prefer not to say	☐

3. Please specify your ethnicity:

White		**Asian or Asian British**	
British	☐	Bangladeshi	☐
Irish	☐	Indian	☐
Any Other White background	☐	Pakistani	☐
Mixed	☐	Chinese	☐
White and Asian	☐	Any other Asian background	☐
White and Black African	☐	**Black or Black British**	☐
White and Black Caribbean	☐	African	☐
Any Other Mixed background	☐	Caribbean	☐
		Any other Black Background	☐
		Any other Ethnic background. Please specify……………………………..	☐

4. How many people live in your household (including yourself)?

	1	2	3	4	5+		1	2	3	4	5+
Adults (18 years old or over)	☐	☐	☐	☐	☐	Children (less than 18 years old)	☐	☐	☐	☐	☐

5. What is your postcode?

6. How would you describe your diet?

Very Unhealthy	Unhealthy	Neither healthy nor unhealthy	Healthy	Very Healthy
☐	☐	☐	☐	☐

7. Is there anything special about your diet?
Yes ☐
No ☐

If you answered yes to question 7, (a) What is special about your diet?

(b) Why do you have a special diet? (Please tick all that apply)

Religious/ cultural practices	☐	To be healthy	☐
Ethical Reasons	☐	Food Preference (e.g. taste, texture)	☐
Environmental Reasons	☐	Prefer to not say	☐
		Other (please specify)	☐

***Thank you** for answering these questions.*
Once completed, please return this form to the focus group facilitator.

Appendix 5. Focus Group Schedule for School 2 Discussions

Checklist:

- Pens
- Post-it Notes
- Consent Forms
- Student Information Sheets
- 2 recorders
- Name tags and black marker
- Demographic Questionnaires

Intro (5 mins):
Hello, so thank you all for taking part in this focus group/discussion today. My name is David and I'm a researcher at the University of Leeds. XXX is also here today, just to observe and take notes. So today we're going to talk for roughly an hour or so about food choices in school. We want to discuss how and why you, as students, make your food choices during the school day.
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- don't talk over each other/all at once – respect the speaker - listen to each other
- talk to each other, not to me
- protect other participants' anonymity
- mobile phones on silent please

Does anyone have any questions?

- *collect signed consent forms*
- *name labels*
- *post it notes & pens*
- *turn on audio recorder*

Ice-breakers/Games (5 mins)
1) For the next couple of minutes, can you think about what is served in the school canteen and write down every item you can remember on these post-it notes please?
Questions (40 mins):
1. Typical Lunch
So, what do students typically have for lunch?

- Which foods are most **popular**?

- How would you **describe** the food and drinks students generally have at school?
- What do most students think about when choosing lunch? What's important to them?

2.1 Your Lunch Yesterday
What did you have for lunch yesterday?
- Can you write it down, on these **post-it notes**, along with **3 words to describe** your lunch yesterday please?
- (go around the room) What did you write down? Why did you choose these words?

2.2 Your Lunch (cont'd)
What do you like to have for lunch in school?
- How would you **describe** your lunch?
- Does it **vary** day to day?
- How do you decide what to eat and drink at school?
- What is **most important** when you're making this decision?

3. Food Choice Changes
What was the food like in **primary school**?
- Do you eat the same kinds of food now in secondary school? How do the two compare?
- How did you feel about this change in secondary school (if there was one)?
- Have your food choices **changed in general** as you've gotten older? Why do you think this is so? What are the **main reasons**?
- Since starting secondary school, have your food choices outside of school changed at all? How so?

4. Norms & Food (@ 35 mins in)
How does what you have to eat/drink **compare to other students**?
- Is it **different** in any way or the same?
- How so, why so?
- Is there anything in your life in particular that influences how you eat or what you eat? (e.g. playing sport, at home alone in evenings, studying at night)
- What does someone's diet tell you about them? Does it tell you anything?

5. Food and Friends
- Do you usually have lunch with the **same people**?
- What do **they choose** to have for lunch? How would you **describe their choices**?
- How does it **compare** to what you have?

6. Food at Home
Do the foods/drinks you eat at school differ from what you have when you are at **home** or are they similar?
- (**How** do they differ? What are the **main differences**?)
- **Do you prefer** the food at home or at school?
- Are there different **rules** at home and at school in terms of food?
- Do you ever discuss food with your parents/guardians?
- If your parent/guardian saw what you have at school, what would they say? (where applicable)

- Do you and your parents **like different kinds of food**? How so?

7. Food Choice & Autonomy

- Who chooses what you eat/drink? (e.g. parents, school, individual)
- How **responsible** would you say you are for your food choices?
- Why is this the case?
- How do the food choices you make for yourself **compare** to choices made for/with you? (if relevant)
- (Does anyone here cook? What do you cook? Does anyone here add items to their parent's shopping list? What types of food/drinks?)
- How **knowledgeable** would you say you are when it comes to food/food choices?
- Is it important to know about food?

Conclusion (5 mins):
Okay so before we finish is there anything we haven't touched on that any of you feel is important to talk about?
Summary
- what we talked about
- what will happen with the findings – school report, publication etc.

Thank you again for your time