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What exactly are ‘me’ sized meals for one- to five-year-olds?

Alice Porter

December 2021

A dissertation submitted to the University of Bristol in accordance with the requirements for award of the degree of Doctor of Philosophy in the Faculty of Health Sciences, Bristol Medical School

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Abstract

Large portion size is associated with excessive weight gain during the preschool years (one-to-five-years). This multi methods thesis comprises three studies, which identified and explored the use of portion size guidance and potential environmental-level factors associated with the consumption of larger portions.

A systematic grey literature review identified 22 portion size guidance resources in the UK and Ireland for parents and childcare settings regarding feeding preschool children. Resources presented recommended portion sizes as individual foods or within meals. The median portion sizes recommended for dairy, starchy and protein food groups and meals varied across resources.

Reflexive thematic analysis was used to qualitatively explore the portioning practices of first-time parents of one- to two-year-olds, as well as their awareness of and opinions on six portion size guidance resources aimed at parents identified in the grey literature review. First-time parents used dishware and packaging, as well as experience of previous feeding occasions to serve portions. Most first-time parents did not recognise the resources. Although parents liked aspects of the resources, they did not want to strictly follow guidance recommendations, preferring instead to use child-led practices to ensure their child was well fed.

A secondary data analysis of preschool children within the National Diet and Nutrition Survey dataset was conducted. Variation in consumed portion size among preschool children was mostly attributed to differences within-children rather than between children. Eating in eateries, sitting at the table, in childcare settings, with family and friends, and while watching TV were associated with the consumption of larger portions.

This thesis suggests guidance resources may not be effective in promoting the consumption of age-appropriate portion sizes for healthy weight. Instead, a range of policy strategies are needed to promote age-appropriate portion sizes, which align with parent feeding goals, especially in eating contexts associated with consumption of larger portions.

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Covid-19 Statement

This statement details the impact of the COVID-19 pandemic on the completion of this thesis. Due to the COVID-19 pandemic I had to pause the qualitative study described in Chapter 4 because I had planned to conduct and submitted ethics for face-to-face interviews and to recruit participants (parents) through in-person visits to toddler groups and children's centres. I overcame this issue by submitting an ethics amendment to change my recruitment strategy and interviews to be online, however, recruitment was delayed by seven months. During this time, I started the secondary data analysis described in Chapter 5. The analysis involved multilevel modelling and mediation, which I had no prior experience of. Due to the COVID-19 pandemic, no formal training was available at this time, so I had to teach myself these methods using online resources.

Author's Declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's *Regulations and Code of Practice for Research Degree Programmes* and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED:..... DATE: 21/12/2021

Publications of work presented in this thesis

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I agree that the student's contributions to this publication are correct to the best of my knowledge.

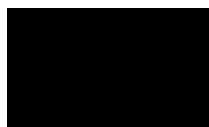


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I agree that the student's contributions to this publication are correct to the best of my knowledge.



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LIST OF ABBREVIATIONS

A, academic
AfC, Action for Children
ALSPAC – Avon Longitudinal Study of Parents and Children
 β , beta coefficient
B, breakfast
BEY, Bristol Early Years
BHF, British Heart Foundation
BMI, Body mass index
BNF, British Nutrition Foundation
CAPI, computer assisted personal interview
CEBQ, Child Eating Behaviour Questionnaire
CFT, Children’s Food Trust
CI, confidence intervals
CO, commercial organisation
COM-B, Capability, Opportunity, Motivation – Behaviour
CP, childcare provider
CSFII, Continuing Survey of Food Intake by Individuals
CWT, Caroline Walker Trust
D, dairy
Di, dietitian
DA, Discourse Analysis
DINO – Diet In Nutrients Out
DoH, Department of Health
DRVs – Dietary reference values
ENHS – Exercise, Nutrition and Health Sciences
F, F statistic
FA, Framework Analysis
FPS, food/drink portion sizes
FSA, Food Standards Agency
FSNT, First Steps Nutrition Trust
FTO, Fat Mass and Obesity Associated gene

FV, fruit and vegetables
 G, grams
 GNVQs, General National Vocational Qualification
 GO, government organisation
 Gov, Government
 GP, general practitioner
 GT, Grounded Theory
 HCP, Health Child Programme
 HFHS – foods high in fat and sugar
 HP, healthcare professionals
 IFB, Bord Bia Irish Food Board
 IPA, Interpretative Phenomenological Analysis
 IQR – inter-quartile range
 ITF, Infant & Toddler Forum
 Kcal, kilocalories
 L/D, lunch/dinner/main meals
 MC4R, Melanocortin 4 Receptor gene
 MPS, meal portion sizes
 N, nutritionist
 NDNS, National Diet and Nutrition Survey
 NDS, Nutrition and Dietetics Service
 NFCS, Nationwide Food Consumption Survey
 NGO, non-government organisation
 NHANES, National Health and Nutrition Examination Survey
 NHS, National Health Service
 NIHR, National Institute for Health Research
 NS-SEC, National Statistics Socio-economic classification
 NVQs, National Vocational Qualification
 OR, odds ratio
 Pa, parents
 P, protein
 P= / P< / P>, p-value
 PDF – portable document format

PH, Public Health
PHE, Public Health England
PI, preschool inspectors
PM, Preschool manager
PPI, patient and public engagement
PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses
S, snacks
St, starchy foods
SACN, Scientific Advisory Committee on Nutrition
SD, standard deviation
SDS, standardised deviation score
SES, socioeconomic status
SMD, standard mean difference
STOR, Standards for Reporting Qualitative Research
STROBE, STrengthening the Reporting of OBservational studies in Epidemiology
t, t statistic
TA, Thematic analysis
UK, United Kingdom
URL – uniform resource locator
USA, United States of America
WHO, World Health Organization

GLOSSARY

Agency	The level of personal resources required to change behaviour
Doubly labelled water	Considered the gold standard method for assessing energy expenditure
Energy density	The amount of energy/calories in a given volume or weight of food
Eating context	The environment in which an eating occasion occurs
Eating occasion	Refers to a time in which a meal or snack is consumed
Eating occasion frequency	The number of eating occasions consumed (usually per day)
Eating occasion size	The portion size of an eating occasion
Eating rate	The total energy or mouthfuls of food consumed within a given time interval
Feeding style	General attitudes and philosophies related to feeding children, categorised by the level of responsiveness and demandingness
Feeding practice	Practices used to influence the development of children's attitudes, behaviours and preferences towards food
Food responsiveness	The tendency to eat in response to food cues
Grey literature	Publicly available, open source information, which is not controlled by commercial publishers
Health visitor	A specialist public health nurse trained in child health, health promotion, public health and education

Multilevel modelling	Statistical method to explore variation and associations, taking into account the structure of the data
NVivo	Qualitative data analysis software
Parents	Parents, carers, and guardians of children
Portioning practices	How parents (or others) decide the portion sizes of food and drinks to serve children
Portion size	The amount of food or drink, either served or consumed. Measured in weight (grams) or energy (calories)
Preschool children	Children aged one-to-five-years
Reflexive thematic analysis	An approach to qualitative data analysis
Satiety responsiveness	The ability to recognise internal feelings of fullness
Self-regulation	The ability to respond to internal cues of hunger and fullness
Standard mean difference	Summary statistic used to summarise an outcome across different studies when measured in a variety of ways
Stata	Data analysis and statistical software
The portion size effect	The exposure to larger amounts of food or drink, which leads to an increase in energy intake
Weaning	The process of gradually introducing an infant food and withdrawing the supply of milk
z-scores	The distance from the mean in units of standard deviations. A positive z-score indicates that the value is above the mean and a negative z-score indicates that the value is below the mean. Z-scores are commonly standardised by age (sometimes additionally by gender).

1.1 INTRODUCTION

This chapter places the thesis within the context of the challenges of childhood obesity and outlines the role of diet and portion size in relation to childhood obesity. The chapter introduces preschool children as the focus of this thesis. The chapter presents the aims, objectives and structure of the thesis.

1.2 CHILDHOOD OBESITY

Childhood obesity is a major worldwide public health concern. According to the World Health Organization (WHO), childhood obesity is a condition in which a child has a body mass index (BMI) more than three standard deviations above the WHO growth standard median.¹ The WHO classified 38.3 million children as being overweight or obese in 2019.¹ In high-income countries, such as the USA and UK, the rates of childhood obesity increased rapidly between 1970 and 1990 and have since stayed constant.² According to the Health Survey for England 2018/19, 21% of two- to four-year-olds were classified as overweight and obese, which increased to 36% by age 15.³ According to the National Child Measurement Programme in England, prevalence of overweight and obesity increased from 23% in 2019/20 to 28% in 2020/21 among four- to five-year-olds, and increased from 35% in 2019/20 to 41% in 2020/21 among 10- to 11-year-olds.⁴ The prevalence of childhood obesity is also shown to be higher among children with lower versus higher socioeconomic status and when parents are obese versus normal-weight.^{3,4} Childhood obesity increases the risk of developing physical and psychological health problems during childhood and adulthood, which can reduce life expectancy.^{5,6} Childhood obesity is associated with uncontrolled eating, unhealthy and extreme weight control behaviours, bullying, stigma, depression, low self-esteem, and impaired social relationships.⁷ In addition, childhood obesity is likely to lead to adulthood obesity,⁶ which is associated with developing type 2 diabetes, cardiovascular disease and high blood pressure.⁷⁻⁹ The estimated societal cost of obesity (including children and adults) in the UK, including the cost to the NHS, is £27 billion per year.¹⁰ The UK Government has set out a plan which promises to halve the prevalence of childhood obesity by 2030.¹¹ However, research found previous government obesity policies were unlikely to lead to implementation of action because of their reliance on individual behaviour change.¹²

Therefore high-quality, public health research is required to inform effectiveness of future policies and drive action to reduce childhood obesity.

Childhood obesity is a complex disease and public health issue, with many factors contributing to its development and prevalence, including child, family, and environmental factors.^{13,14} Parents being overweight and obese has been identified as one of the most significant risk factors for the development of preschool children being overweight.^{14,15} This is not only because children may inherit genes associated with obesity but also because parents create a food and activity environment for their children, which may be obesogenic.^{15,13} Research suggests appetite traits such as satiety responsiveness (the ability to recognise internal feelings of fullness),¹⁶ food responsiveness (the tendency to eat in response to food cues), eating rate (the total energy or mouthfuls of food consumed within a given time interval)¹⁶ and enjoyment of food are partly heritable and may influence children's risk of excessive weight gain.^{16,17} A parent's diet and eating behaviours are often mirrored by their children,¹³ making parents a key influence on their children's diet and eating behaviours. This in turn influences their risk of being overweight, because parents provide the food served to their children, establish food rules and routines, determine portion sizes and use feeding practices to encourage or discourage eating.^{13,18-20} It is important parents encourage and enable the consumption of a healthy balanced diet, in line with dietary recommendations. Parents should also encourage the consumption of age-appropriate portion sizes to ensure the adequate intake of energy and nutrients and promote a healthy weight. To note, in this thesis the term parents also refers to carers and guardians. Though many factors contribute to eating behaviours and risk of overweight among preschool children,²¹ this thesis focuses specifically on the role of portion size as a contributing factor.

1.3 THE HEALTHY CHILD PROGRAMME

The role of public health is paramount in preventing and treating childhood obesity. As part of the UK Government's Child Health Strategy, the Healthy Child 0-5 programme (HCP) exists in England, offering families support through pregnancy and the first five years of life. This evidence-based intervention was developed by the Department of Health and Public Health England. The overall aim of the programme is to prevent poor health in children, including obesity. The programme consists of screening tests, immunisations, developmental reviews, and information and guidance, aiming to support

parents with the initiation and continuation of breastfeeding, parent-child attachment, child safety, healthy eating and appropriate activity rates, prevention of disease, readiness for school, and recognition of growth disorders and risk of obesity.²² Public health teams within local authorities are responsible for commissioning the programme. The programme is led by health visitors, who are specialist public health nurses trained in child health, health promotion, public health and education. The programme is delivered in family homes, as well as local community and primary care settings.²³ For obesity prevention, health visitors measure children's height and weight to monitor growth, and promote exclusive breastfeeding, the commencement of weaning after six months, healthy eating and physical activity.²³

1.4 PRESCHOOL CHILDREN

In the UK, preschool children are defined as three- to four-year-olds (up to fifth birthday) and early years is defined as birth to five years²⁴ but research and guidelines often expand the preschool definition to one- to five-year-olds.¹⁴ This thesis focuses on children in the post-weaning stage age one-to-five, referred to as preschool children throughout the thesis, unless otherwise stated.

1.5 PRESCHOOL CHILDREN'S DIET

Early childhood is a critical age for the development of healthy food intake, dietary habits and healthy behaviours.^{25,26} Children from birth to five years have unique dietary and nutrient requirements due to their rapid growth and need for high energy relative to their body size.²⁷ The WHO recommends children from birth to six months should be exclusively breastfed.²⁸ From six months children should be introduced to solid foods in a period defined as complementary feeding or weaning.²⁹ From seven to 12 months children should transition from complementary feeding to consuming three meals a day plus snacks.²⁹ Breastfeeding alongside food is recommended for up to two years or longer²⁸ but should be reduced over time to ensure adequate nutrition from an increasing intake of more nutrient dense food.²⁹ Between the ages of two and five it is recommended in the UK that children gradually transition to a healthy modified adult diet, in line with the Eatwell Guide.³⁰ This diet should include a variety of nutrient dense foods, including starchy foods, fruit and vegetables, protein and dairy²⁷; foods high in fat and sugar should be limited to once per week.³¹ Salt should also be limited to between two grams per day

(for one- to three-year-olds) and three grams per day (for four- to five-year-olds). Unlike the adult Eatwell diet, low fat and high fibre foods are not recommended for this age group due to their high energy requirements (low-fat foods contain fewer calories and high fibre foods promote fullness).²⁷

1.6 FEEDING PRESCHOOL CHILDREN

Young children learn about food through familiarisation (repeated exposure to taste, texture and appearance), observational learning (such as imitating the eating behaviours of others around them), categorisation (ability to recognise foods and food types), and to some extent associate learning (flavour-flavour learning, where a liked flavour is paired with a new neutral flavour).³² Research suggests food preferences (such as a liking for fruit and vegetables) are partly genetic, therefore young children may have an innate preference for certain foods or be innately fussy,³³ which can track into later adulthood.¹⁴ In addition, children under the age of one are generally good at self-regulating their own appetite (in tune with internal signs of hunger and fullness).^{34,35} However, as children from birth to five learn to feed themselves, they are increasingly influenced by the home environment, which shapes their preferences and intake. Children may start to eat in response to external cues, such as portion size, parental feeding practices and social influences, which over time may override children's internal appetite control.^{14,36}

1.7 PORTION SIZE

Portion size is defined in several ways in the research. Some research focuses on served portions and some on consumed portions but both are important to understand the effects of portion size in preschool children. In this thesis, portion size has broadly been defined as the amount of food or drink, either served or consumed, measured in weight (grams) or energy (calories). Portion size may be a key driver of childhood obesity.³⁷⁻³⁹ A recent survey by the Infant and Toddler Forum showed 79% of parents reported routinely serving their preschool children larger than recommended portions of meals and snacks.⁴⁰ As parents provide a key role in determining portion sizes for their preschool children,⁴¹ it is important to understand the practices parents use to serve portion sizes and the influences affecting these practices.

The habitual consumption of too many calories, leading to a positive energy balance (energy intake exceeds energy expenditure), is one of the main drivers of obesity.⁴² There

is a body of experimental evidence establishing the role of large portion sizes in promoting increased energy intake (which can lead to weight gain if it consistently exceeds energy expenditure).^{38,39,43} This research has defined the ‘portion size effect’ as exposure to a larger amount of food or drink, which leads to an increase in energy intake⁴⁴ (see section 2.6 for a literature review on the portion size effect in children). The portion size effect was observed in preschool children over the course of five days,⁴⁵ suggesting serving large portions at a meal may not be compensated for by consuming less energy at later meals. Although large portions of all foods in a meal may tip energy balance positively, large portions of energy dense foods high in fat and sugar are likely to have the greatest impact on weight gain.³⁷ In contrast, large portions of fruit and vegetables may be beneficial for health and weight management.^{46,47}

Research suggests there is individual variability in the portion size effect, meaning some children may be more susceptible to the portion size effect than others.⁴⁸ Understanding this variability and contribution that individual, family, and environmental-level factors play in the role of increasing susceptibility to consuming large portions among preschool children is important. Previous research has explored factors such as child characteristics and appetite traits, food characteristics, and parental characteristics and feeding styles to better understand this variability (see section 2.6.3 for a literature review on factors associated with portion size in children). However, more research is needed to build this evidence base.

Observational research exploring portion size and children’s weight outcomes is mainly cross-sectional and limited by the dietary assessment methods used to measure portion size⁴⁹ (see section 2.3 for more detail on measurements of portion size). However, food and drink portion sizes (especially those with high energy density) have increased in the last few decades with many now exceeding the recommended serving sizes.^{20,50} This trend towards larger portions has coincided with the rise in obesity since the 1970s (see section 2.4 for a literature review of the portion size trends research). Cross-sectional evidence suggests excessive energy intake is associated with higher BMI in children.^{51,52} In addition, evidence suggests portion size accounts for around 20% of the variability in energy intake and therefore may contribute to excessive intake and higher BMI.⁵³ To date, the most robust evidence linking portion size and preschool children’s weight is from a prospective study of a large cohort (n=1939) of preschool children.⁵⁴ This study

found a 10kcal larger meal size was associated with an excessive weight gain of 4%, from two to five years (see section 2.5 for a literature review on the relationship between portion size and BMI). In addition, the study found meal frequency (i.e. the number of meals or snacks consumed) was not associated with excessive weight gain. This is important to note, as if large meal portions are offset by a lower meal frequency, energy intake may not be surplus and therefore not lead to weight gain. This prospective evidence suggests larger portions can lead to excessive energy intake and weight gain and highlights the need for research understanding why portion sizes may be larger in preschool children. In addition, research is needed to effectively identify, develop and disseminate guidance recommendations to promote age-appropriate portion sizes across individual foods and meals, to ensure adequate intake of nutrient-rich foods and reduced intake of energy-dense foods. The extent of portion size guidance for preschool children in the UK and its use among parents is not well known.

1.8 AIMS AND OBJECTIVES

Using a multi methods approach, the aim of this thesis is to explore the portion sizes of preschool children (one-to-five-years), with a focus on informing future childhood obesity policy recommendations around portion sizes in the UK.

The objectives of the thesis are:

- 1) i) To identify existing guidance available on portion size aimed at feeding preschool children in the UK.

ii) To describe its content, presentation, intended audience and how resources were informed.

iii) To compare portion size recommendations across guidance resources.
- 2) i) To understand the portioning practices of first-time parents of one- to two-year-olds in the UK.

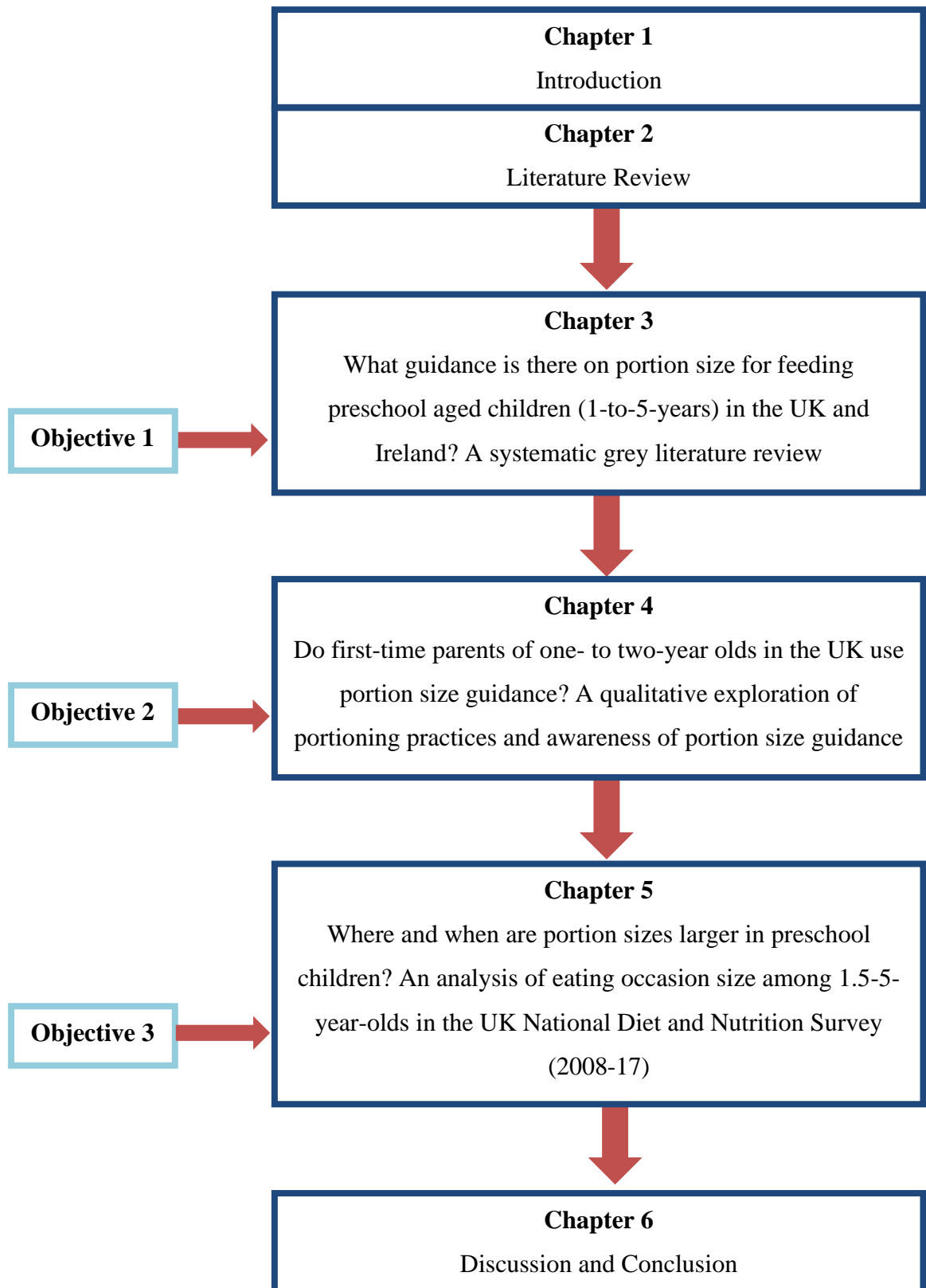
ii) To identify the influences on parental portion size decisions.

- iii) To explore first-time parents' awareness of and opinions on existing portion size guidance resources, including specific aspects relating to the content and structure that vary between resources.
- 3) i) To explore the within and between variation in consumed portion size among preschool children, to better understand the contribution of individual versus environmental-level factors that may lead to the consumption of larger portions.
- ii) To explore whether certain individual characteristics and eating contexts are associated with larger portion sizes.

1.9 STRUCTURE OF THE THESIS

The thesis is organised into six chapters (see Figure 1.1), starting with a review of relevant literature (CHAPTER 2). This thesis consists of three studies. CHAPTER 3 presents a systematic grey literature review identifying existing portion size guidance resources aimed at feeding one- to five-year-olds in the UK and Ireland. CHAPTER 4 presents a qualitative study interviewing first-time parents of one- to two-year-olds about their portioning practices, the influences affecting their portion size decisions and their awareness of and opinions on six portion size guidance resources identified in the grey literature review. The results from CHAPTER 3 were used to inform the objectives of the study presented in CHAPTER 4. CHAPTER 5 presents a secondary data analysis of the National Diet and Nutrition Survey, which aimed to explore the variation in portion size using multilevel model analysis and explore whether certain individual characteristics and eating contexts are associated with larger portion sizes in preschool children. The final chapter (CHAPTER 6) draws together the findings from the three studies and discusses these in relation to other relevant literature. CHAPTER 6 also details implications for policy and future research, discusses key strengths and limitations of the thesis and draws a conclusion.

Figure 1.1. Outline of thesis structure



CHAPTER 2. LITERATURE REVIEW

2.1 OVERVIEW

In this chapter, I review research literature relevant to my thesis. The aims of my PhD were to identify existing portion size guidance aimed at feeding preschool children, explore portioning practices of parents with preschool children and their use of guidance, and investigate potential factors associated with consumption of large portions in preschool children.

The literature review begins by reviewing how portion size is measured in preschool children (2.3). I then review trend data (2.4), looking at whether portion sizes have increased over time in line with the rise in childhood obesity rates. Research exploring the association between portion size and children's weight is then discussed (2.5). The experimental evidence is then reviewed (2.6), discussing literature on the portion size effect in preschool children, which underpins much of the current portion size research. Within this section, factors which may affect or moderate children's susceptibility to the portion size effect are reviewed (2.6.3). Finally, literature on parental portioning practices is summarised (2.7). Throughout the literature review, limitations of the current research and gaps in the research field are discussed.

2.2 METHOD

A protocol for systematically searching the literature was developed with the help of a subject librarian. Several academic databases were searched in 2019 and 2020 to identify relevant literature, including Ovid MEDLINE, PubMed, Ovid psycINFO and Cochrane Central Database, as well as the reference lists of identified literature. Searches were updated between May and August 2021. Several search terms were used to identify relevant articles. Alternate search terms for "portion size" were used which included "food portion", "meal portion", "snack portion", "serving", "eating occasion", "eating" and "food intake". Alternate search terms for "preschool children" were used which included "preschooler" and "pre-school children". Searches were also expanded to include children of all ages to review the literature more thoroughly. Alternate search terms were used for "parents" included "parental", "parenting" and "carer". Alerts were set up with Google Scholar and Obesity Intelligence to inform me of any newly published

potentially relevant articles. For each section, systematic reviews, and meta-analyses for searched for first. Where no systematic reviews were available, empirical studies were reviewed. Only articles in English were considered. Literature was retrieved from the databases, reviewed for relevance and quality, saved in relevant folders, summarised in tables, and then finally reviewed in this chapter.

2.3 MEASUREMENTS OF PORTION SIZE

Portion size is measured differently depending on the study design used. In experimental studies, served portion size is the exposure (or independent) variable and is measured by weighing food or drink items to the nearest 0.1 grams (e.g portion size = 60g).⁴⁵ The outcome (or dependent) variable in experimental studies is the amount consumed of the served portion, which is either measured as food intake reported in grams⁴³ or energy intake reported in kilocalories.⁴⁵ Energy intake (kcal) is calculated from the weight of the food plus information provided by food manufacturers and food composition databases. The amount consumed is calculated from the portion size served minus the amount leftover after consumption. Further description of the experimental methods is provided in section 2.6.1.

In observational studies, consumed portion size is often the outcome variable of interest and is reported as grams or kilocalories and is measured using dietary assessment methods. Two main dietary assessment methods have been used to measure consumed portion size in children in previous literature; 24-hour diet recalls and estimated food diaries. The 24-hour diet recall method involves participants being asked (via a computer or interviewer) to recall and describe in detail the foods and drinks consumed over the previous day, including type and quantity. 24-hour diet recalls are often repeated over two to three consecutive days to increase the likelihood of collecting data on a day representative of the participant's usual diet. Estimated food diaries require participants to record the food and drinks consumed in real-time by entering details into a food diary, for usually for between three to seven days. Participants are asked to estimate the portion size of foods and drinks recorded using household measures or information on packaging.⁵⁵ Weighed food diaries have also been used in previous research⁵⁶ but are used less frequently due to the high participant burden (participants are required to weigh all food and drinks rather than estimate the quantity).⁵⁷

With both methods, participants are usually asked either to record the time foods or drinks were consumed or at which eating occasion the foods or drinks were consumed (e.g exact time or breakfast, morning snack, lunch, afternoon snack, dinner, evening snack). Data can then be used to explore the portion size of whole eating occasions (i.e the portion size of all food and drinks consumed at lunch), as well as the portion size of individual foods. The types and quantities of foods and drinks reported are used to calculate energy intake, using food composition databases.⁵⁵ Children younger than eight years cannot accurately self-report dietary intake⁵⁸ and therefore parents are used as proxy reporters. For children aged eight and older, dietary intake can be parent-reported with help from the child or child-reported with or without help from a parent.⁵⁹

24-hour diet recalls can be advantageous because they are relatively inexpensive to administer and are not particularly a burden for participants to complete, compared to food diaries, which are more time consuming. 24-hour diet recalls rely on participant memory and are therefore more subject to recall bias, compared to food dairies, which require participants to record the food at the time of consumption. However, both methods are subject to mis-reporting (inaccurate reporting) and social desirability bias (giving socially desirable rather than accurate information).^{49,60} In addition, inaccurate calculation of energy intake can occur when food composition databases contain limited information on packaged foods or foods prepared out-of-home.⁵⁵ When comparing dietary assessment methods to the most accurate estimate of energy intake (i.e. doubly labelled water) in children, Burrows et al.,⁴⁹ found all dietary assessment methods (including 24-hour diet recalls and estimated food dairies) to lack validity and result in some level of misreporting. Therefore, misreporting should be considered as a limitation in all observational studies using dietary assessment methods, when exploring consumed portions among children.

In the UK, the National Diet and Nutrition Survey (NDNS), a nationally representative cross-sectional survey, and the Gemini cohort, a prospective birth cohort of twins have both used estimated food diaries to assess dietary intake of preschool children, which has been used to explore portion size in previous research.^{54,61-63} A more detailed description of the NDNS is provided in Appendix 1, as the data was analysed in CHAPTER 5.

2.4 PORTION SIZE TRENDS

With the increasing rate of obesity in many countries since the 1970s,¹ research has examined whether an increase in available and consumed portion sizes has occurred alongside. Eating larger portions (and therefore more calories if food composition does not change) could be one reason for an energy imbalance, where energy intake exceeds energy expenditure. If larger portions are regularly consumed, leading to a long-term positive energy balance, this would promote weight gain and increase the risk of obesity. Although it is difficult to establish causal links, the increase in both obesity and portion sizes at the same time suggests that large portion sizes could be an important contributing factor in the obesity epidemic.⁶⁴

Previous research has examined portion size trends over the last few decades in two ways: 1) analysing trends of available portion sizes in eateries (fast-food outlets, restaurants, cafés and take-aways) and packaged food (purchased in shops). This has involved collecting information on weights of commercially available foods and drinks over time, via menu and label information (often through contacting manufacturers), to explore whether available foods and drinks have increased in portion size; and 2) analysing trends of consumed portion sizes from dietary intake surveys. This has involved comparing participant-reported dietary intake data from national cross-sectional surveys over time, to explore whether an estimate of consumed portions of foods and drinks (in weight or calorie content) has increased.

2.4.1 Trends in available portion sizes in eateries and packaged foods

Most of the research into trends in available portion sizes in eateries has been conducted in the USA. Young & Nestle^{50,65} were the first to explore the change in portion sizes of ready-to-eat foods purchased from eateries. Their research focused on portion sizes of popular foods (ranked highly in sales) and foods reported in national surveys to contribute substantially to the diets of the US adult population.⁵⁰ Available data from when first introduced in 1916 up to 1976 on portion sizes of beer, chocolate bars, French fries, hamburgers, and soda (soft drinks) was collected and compared to available portion sizes in 2002. Across all five food and drink items in 2002, larger portion sizes were available to purchase with notably only some of these items being still available in their original portion sizes. For example, in 2002 a 6.9-ounce portion of Burger King French

fries was available, compared to a 2.6-ounce portion in 1954. In 2001, the US food industry was challenged by the USA Surgeon General's Call to Action to provide smaller, more appropriate portion sizes.⁶⁴ As a result, by 2006 McDonalds had discontinued their 'Supersize' portions of soda and French fries and reduced the portion size of their medium and large fries. However, Burger King and Wendy's had either made no changes or introduced larger portions of French fries, hamburgers and/or soda. In addition, more recently McCorry et al.,⁶⁶ analysed trends in the portion sizes of main meals, side dishes and desserts from popular US fast-food chains from 1986 to 2016. The portion sizes of main meals and desserts were found to have increased by a mean average of 13g/30kcal and 24g/62kcal per decade, respectively. Side dishes had increased in calorie content but not in grams. Although these studies only explored a small number of foods and drinks, these findings from the USA suggest portion sizes of popular commercially available energy-dense foods have increased over time. This evidence prompted other countries to similarly explore their portion size trends and set out government policies to reduce portion sizes.

In the UK, Wrieden et al.,⁶⁷ obtained portion size data (in grams) for confectionary and fast-food items sold in supermarkets and eateries in 1990 and 2000. Of the 71 confectionary items, many portions had remained the same. However, 12 increased and 12 decreased in portion size. Of the 26 fast-food items, 12 had increased in portion size (mainly hamburgers and chicken items) and none had decreased. However, larger portion sizes (described as king or giant sized) had been introduced alongside the original portion sizes. Similar results were found in a study comparing portion sizes of common marketplace foods and drinks in the UK from 1988 to 1998,⁶⁸ which suggests the increase in availability of larger portions may have started in the 1980s or even earlier in the UK.

Two reports (not peer reviewed academic articles) have been published in the UK, exploring trends in available portion sizes (in grams): one by The Food Standards Agency (FSA), compared energy-dense foods between 1990 and 2008,⁶⁹ and The British Heart Foundation (BHF),⁷⁰ compared popular packaged food and drink items purchased from supermarkets between 1993 and 2013. The most apparent increase in portion size was observed for individual ready meals. The BHF reported a 45% average increase in the portion size of a pasta bake and the FSA reported a doubling of beef lasagne portion size from 250g to 500g. The FSA reported an increase in portion size of fast-food items: 6%

for hamburgers; and between 4-50% for fries. Both reports found that although portion sizes of crisps, bread, pizza, meat products, desserts, cakes, ice-cream, and chocolate had either remained stable or decreased, larger ‘supersized’ or family portions had been introduced and were available alongside (but portion size recommendations remained the same). Similar trends have been observed in other European countries.^{71,72} In response to evidence, in 2018 the UK government challenged the food industry to reformulate and reduce portion sizes of energy-dense foods to help reduce population-level energy intake.⁷³

Evidence suggests that the availability of larger portion sizes has increased for many energy-dense foods in the USA, UK, and Europe and although smaller portion sizes are available, consumers may choose to buy and consume the larger portion sizes. If the composition of these foods has remained the same over time, an increase in grams would also increase the calorie content, which could increase consumers’ risk of weight gain and obesity. However, previous studies exploring trends in available portion sizes have tended to collect data on the weight of food and drink items, and not the calorie content. In addition, over the same time period the sale and consumption of low fat or low calorie foods has risen as well as the sale of larger portion sizes.⁷⁴ This was not explored in any of these studies but may offset some of the implications (e.g. weight gain and obesity) caused by the increase in portion size.

Examining data provided by food manufacturers, supermarkets and eateries is a good way to estimate changes in the availability of portion sizes but does not give an accurate indication of actual intake or who is consuming these foods. Focusing on only the portion sizes of energy-dense foods does not give insight into how foods are consumed as part of a meal or how portion size contributes to total daily energy intake.

2.4.2 Trends in consumed portion sizes from national dietary intake surveys in children

Again, most studies exploring portion size trends from national dietary intake surveys have been conducted in the USA. In adults, evidence suggests consumed portions of energy-dense foods have increased over time and the increase in portion size has contributed to an increase in total daily energy intake.^{75,76} Here I will only review studies exploring portion size trends in children. Figure 2.1 and Figure 2.2 illustrates the changes

over time in estimated consumed portion size of foods and drinks, respectively, among one- to five-year-olds. Figures are reported from five studies exploring trends in this age group.^{52,56,77-79} To note, as there is limited trend evidence focusing on preschool children, this section also draws on evidence from studies exploring portion size trends in children one- to 19-years-old.

National dietary intake surveys collect data on food and nutrient intake from a nationally representative sample of the population, to generalise findings to the whole population. The surveys discussed in this section are cross-sectional and so collect dietary data from a different sample of participants across the survey waves (years). Three surveys in the USA have been used to explore portion size trends: The Nationwide Food Consumption Survey (NFCS), conducted in 1977/78; the Continuing Survey of Food Intake by Individuals (CSFII), conducted in 1989-91 to 1994-98; and the National Health and Nutrition Examination Survey (NHANES), conducted in 2003/04 to 2005-10. These surveys all used the 24-hour dietary recall method to collect dietary data.

Using data from the three US surveys described above, Piernas & Popkin⁸⁰ selected 10 foods (salty snacks, desserts, soft drinks, fruit drinks, French fries, hamburgers, cheeseburgers, pizzas, Mexican fast foods, and hot dogs), which had the greatest increase in energy content between 1977 and 1996. They explored portion size trends (in grams and kcal) between 1997 and 2006, among children two- to 18-years-old who had participated in one of the three national surveys. An increase in kilocalories and grams between 1997 and 2006 was observed for all foods per portion, except desserts (which had remained similar). For example, the kilocalories of pizza increased from 140kcal to 406kcal per portion and the average volume of soft drinks increased from 95ml to 294ml per portion. In addition, results suggested the increased calorie content of pizza and soft drinks were directly related to an increase in energy intake from an entire eating occasion containing them (i.e. children consumed more total energy during an eating occasion if the meal contained pizza or soft drinks). This suggests if larger portions of energy-dense foods and drinks are regularly consumed this may lead to an excessive energy intake and increased risk of weight gain. However, as the age range of children was wide, it is not known whether portion size trends were consistent across different age groups of children in this study.

Smiciklas-Wright et al.,⁷⁷ compared estimated consumed portion sizes (grams) of 107 food and drink items reported in CFSII surveys between 1989 and 1998. Results were stratified by participant age group (two- to five-years, six- to 11-years and 12- to 19-years). Two food portion sizes decreased among two- to five-year-olds; two increased and three decreased among six- to 11-year-olds; and seven increased among 12- to 19-year-olds (four among males and three among females). The volume of soft drinks and fruit drinks had increased among 12- to 19-year-old females.⁷⁷ However, this was the only similarity that could be drawn with Piernas & Popkin⁸⁰ who analysed the same surveys, which may be due to the shorter follow-up period and different selected foods. More similar to Smiciklas-Wright et al.,⁷⁷ McConahy et al.,⁵² suggested portion sizes reported in the CSFII and NFCS surveys to have remained stable among one- to two-year-olds between 1977 and 1998. For foods reported to have increased in portion size, many of the lower confidence interval values were similar between the two time points, but there was much larger variability between the upper confidence intervals.⁷⁷ Similar to the evidence from available portion sizes from eateries and packaged foods, these findings from McConahy et al.,⁵² suggest that larger portion sizes have become available, and children consume these larger portions, despite smaller ones still being available. A strength of these studies was average portion size was calculated only for those who consumed the food or drink items, meaning the average was not skewed towards non-consumers (i.e a recorded portion size of 0 grams or kcal).

Similar findings have been reported in two studies in Australia, using three nationally representative dietary intake surveys conducted between 1995 and 2012, which used 24-hour dietary recall methods.^{78,79} Studies examined portion size trends of a wide range of foods and drinks among two to 16-year-olds. The studies showed most portion sizes had remained the same, with 15% of foods increasing in portion size, again with variability across age groups. The Australian studies reported median portion size (rather than mean as reported in US studies), which suggests the potential skewed distribution of food portions was considered. However, unlike the US studies, the authors did not report that medians were calculated only for those who consumed the foods. It should be noted that when examining portion size trends, the increase in energy-dense foods should be of concern when considering energy intake and obesity risk. A decrease in estimated consumed fruit and vegetable portions was also observed. For example, Collins et al.,⁷⁸ observed a decrease in consumed portion size of banana by 11g, canned fruit by 50g, peas

by 12g and melon by 75g among two- to four-year-olds. This may also be of concern for the general health of children.⁸¹

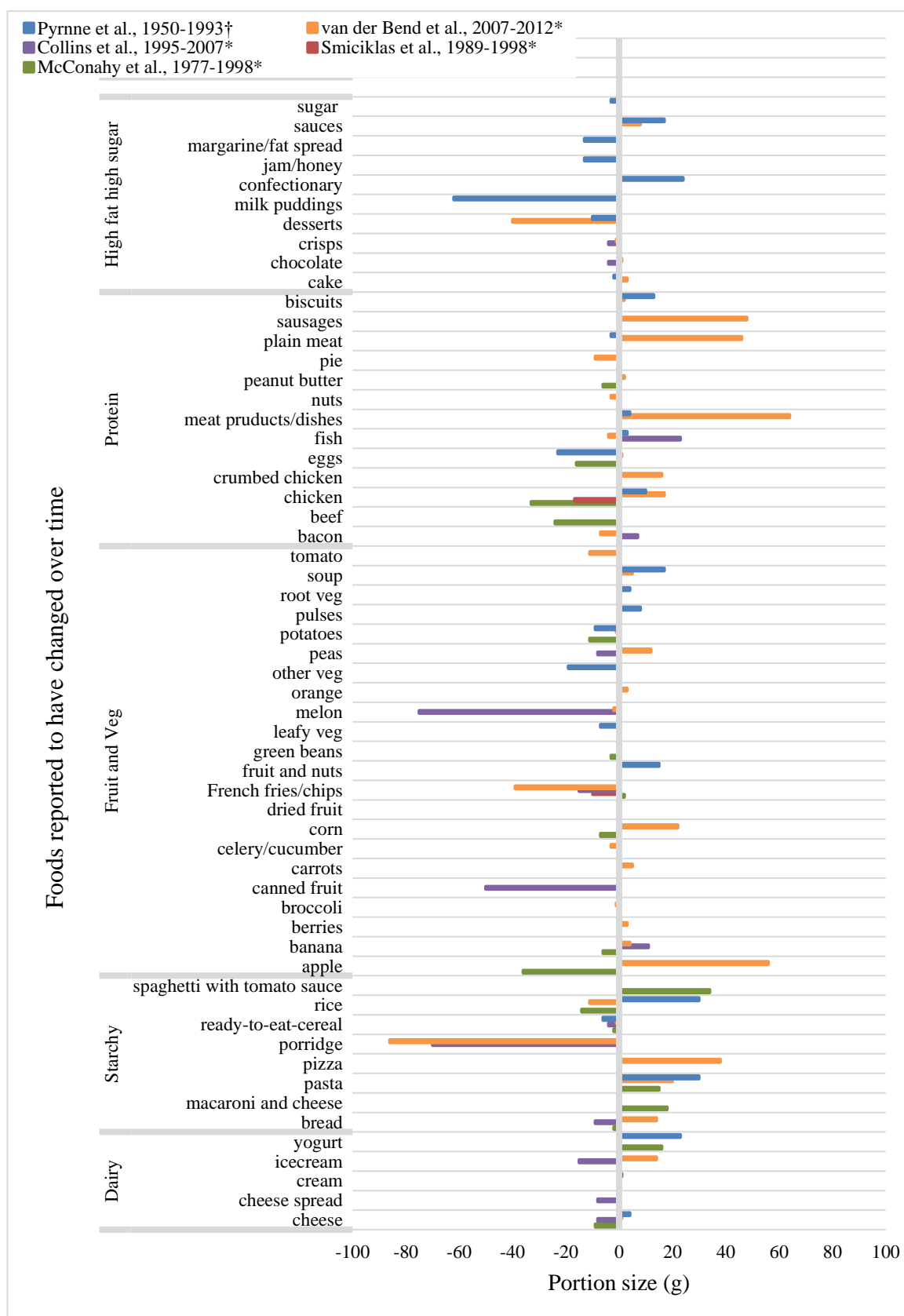
Duffey & Popkin⁸² used a mathematical decomposition analysis method to estimate the contributions that changes in portion size, number of eating occasions and energy density had on overall changes to total daily energy intake over a 33-year period, among children aged two- to 18-year-olds, using three US cross-sectional surveys (NFCS, CSFII, NHANES). Total daily energy intake was found to have increased by 108kcal per day from $1,867 \pm 15$ kcal in 1977 to $1,975 \pm 16$ kcal in 2010. Unlike the similar study among adults,⁷⁶ portion size (grams) was not found to positively contribute to the annualised change in total daily energy intake. Instead, an increase in the number of daily eating occasions and a small increase in energy density per eating occasion were suggested to have contributed to the increase in total daily energy intake over time. In addition, food portion size was actually shown to have decreased by 49g per eating occasion over time. In contrast to McConahy et al.,⁵² the increase in food portion sizes of one- to two-year-olds was found to partly mediate the increase in energy intake and body weight.⁵³ In contrast to other studies, Duffey & Popkin⁸² suggest portion size may not be a contributing factor towards positive energy balance and weight gain among children in the USA. As described in section 2.3, the 24-hour diet recall method used to collect dietary intake data, as used in all three US and Australian surveys are subject to response bias and under-reporting,⁵⁹ especially in children where parents are asked to report their children's intake. In addition, although 24-hour diet recalls were used across surveys, response rates differed and the methods were improved over time, which could reduce the ability to reliably compare across survey years.

There is scarce data on portion size trends using national survey data in the UK: Prynne et al.,⁵⁶ reported changes in grams consumed per day of individual foods and percentage energy contribution of food groups to total daily energy intake among four-year-old children over a 40-year period. The National Survey of Health and Development conducted in the 1950s was compared to the 1992/93 National Diet and Nutrition Survey. Methods to collect dietary data were different between surveys (24-hour recall versus weighed food diaries), as were sample sizes ($N=4599$ vs 493), which limits the accuracy to compare consumed portion sizes. Like previous studies, the largest mean increase in individual consumed portion size was observed for soft drinks and juices (estimated

consumption increased from 13g/day to 446g/day). Of the 30 items examined, 14 were reported to have increased in portion size (grams per day), including biscuits (by 13g/day), pulses (by 8g/day), fruit and nuts (by 15g/day), confectionary (by 25g/day), and yogurts (by 23g/day). Diets were reported to be made up of a higher percentage of carbohydrates (47% vs 52%) and sugar (16% vs 28%) and a lower percentage of fat (40% vs 35%) and starch (31% vs 24%) in 1992/93 compared to the 1950s, which may reflect a change in dietary patterns during this time.

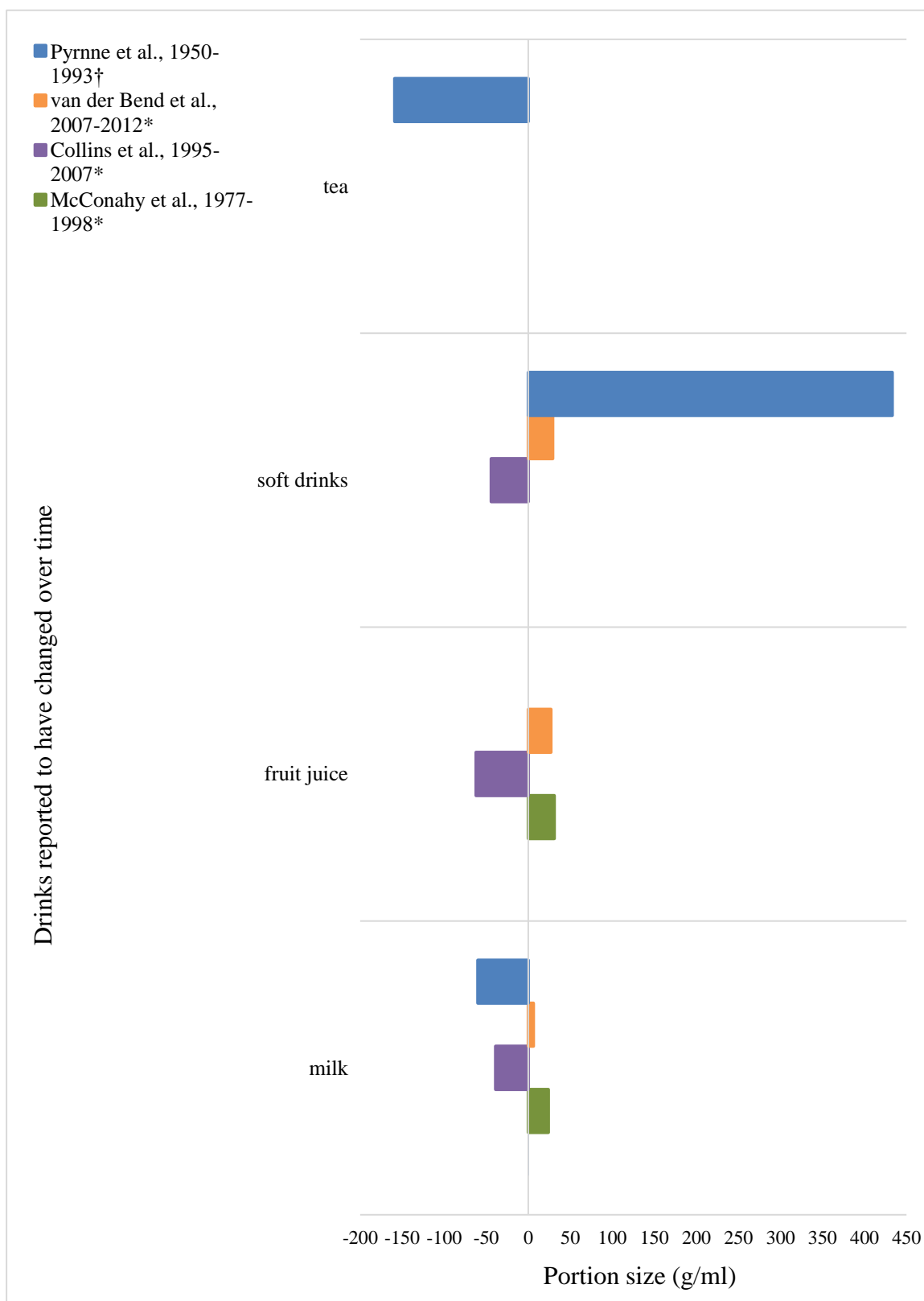
In line with evidence from available portions of packaged food and in eateries, evidence from national dietary intake surveys suggests children may be consuming larger portions of some (but not all) foods, including energy-dense foods. However, this evidence is more compelling in the USA and in older children. It may be that larger portion sizes of packaged food and in eateries are distorting children and parents' perceptions of appropriate portion sizes and driving an increase in consumed portions.⁸³ Although researchers suggest the trends in portion size could have contributed to the rise in obesity,⁶⁴ many of the studies discussed above did not include body weight as a variable in the analyses. The current evidence for portion size trends is not strong enough to conclude that large portion sizes of individual foods contribute to larger eating occasions, higher total daily energy intake or increased body weight in children. In addition, little is known about portion size trends from the last decade or how trends may differ by demographics, other than age. Due to the methodological limitations of comparing portion sizes across cross-sectional surveys, it may be more appropriate for research to explore the effects of increasing portion size on energy intake and the prospective relationships between portion size and weight gain in children.

Figure 2.1. Changes in food portion size over time among one- to five-year-olds across five studies. Only food reported to have changed are presented



*Portion size presented as grams per serving of food/drink, †Portion size presented as grams per day

Figure 2.2. Changes in drink portion size over time among one- to five-year-olds across four studies. Only drinks reported to have changed are presented



*Portion size presented as grams per serving of food/drink, †Portion size presented as grams per day

2.5 RELATIONSHIP BETWEEN PORTION SIZE AND BMI

To argue that large portion sizes have contributed to the obesity epidemic, Herman et al.,⁸⁴ suggest, evidence must show that a) large portions have increased in prevalence during a similar timeline to the increase in obesity and b) large portions lead to an increase in BMI. However, research exploring the association between portion size and BMI is sparse, especially among preschool children.

Table 2.1 presents a summary of cross-sectional studies exploring the association between portion size and BMI among children and adolescents. McConahy et al.,⁵² analysed US national food consumption surveys from 1978 to 1998 among one- to two-year-olds and found that a higher portion size z-score (calculated as average grams per food, averaged across 21 commonly consumed foods) was positively associated with greater energy intake and percentile body weight. Huang et al.,⁵¹ analysed the same US food consumption surveys from 1994 to 1998 and found meal portion size, meal energy (but not snack portion size or energy) and total energy intake were positively associated with BMI among six- to 11-year-olds and 12- to 19-year-olds, but not among three- to five-year-olds. Other cross-sectional studies have similarly used national food consumption surveys to explore the relationship between larger portions of individual foods and BMI, among children⁸⁵ and adolescents.^{86,87} Overall, these studies suggest larger portions of some foods (such as soft drinks, pastries, breakfast cereals, bread and cream),⁸⁵⁻⁸⁸ are associated with higher BMI. In addition, Tripicchio et al.,⁸⁹ showed normal weight adolescents consumed smaller snack portions than overweight and obese adolescents.

A review by Pereira et al.,⁸⁸ suggests gradual weight gain among children and adolescents may occur due to consuming 70kcal to 160kcal above daily energy requirements over time. Albar et al.,⁸⁶ and Hebestreit et al.,⁹⁰ showed an increase in total daily energy intake of 100kcal was cross-sectionally associated with a 0.19kg/m² greater BMI among adolescents,⁸⁶ and a 0.03 unit increase in BMI z-score among children,⁹⁰ respectively. Considering the associations between portion size, energy intake and BMI together, cross-sectional evidence suggests habitual consumption of large portions among children and adolescents may lead to increased energy intake, which may tip energy balance

positively and result in excessive weight gain. However, causation cannot be established from cross-sectional studies and the current evidence is limited for preschool children.

Table 2.1 Summary of observational, cross-sectional studies exploring the association between portion size and BMI in children and adolescents

	Sample			Methods			Main findings	
	n	Country	Age (years)	Portion size assessment method	Outcome	Measure of portion size	Association	Additional detail
Huang et al., (2002)*	1077	USA	3 to 5	Two 24-hour dietary recalls	BMI percentile	Meal portion size (g) Meal energy content (kcal)	None None	
	537	USA	6 to 11	Two 24-hour dietary recalls	BMI percentile	Meal portion size (g) Meal energy content (kcal)	+ +	For boys only For boys only
	381	USA	12 to 19	Two 24-hour dietary recalls	BMI percentile	Meal portion size (g) Meal energy content (kcal)	+ +	For boys and girls For boys and girls
McConahy et al., (2002)	100	USA	1 to 2	Two 24-hour dietary recalls	Percentile body weight	Portion size z-score	+	
Lioret et al., (2009)	748	France	3 to 11	7 day estimated food diary	Weight status (overweight vs normal weight)	Portion size (g)	+	For croissant-like and sweetened pastries. No association observed for the other 20 food/drinks

	Sample			Methods			Main Findings	
	n	Country	Age (years)	Portion size assessment method	Outcome	Measure of portion size	Association	Additional detail
Flieh et al., (2021)	1889	Europe	12.5 to 17.5	Two 24-hour dietary recalls	Probability of having obesity	Portion size (g)	+ + -	For carbonated drinks among males For bread and rolls among females For sweet bakery treats among females No association with other 8 foods
Albar et al., (2014)	636	UK	11 to 18	4 day Estimated food diary	BMI	Portion size (g)	+ + -	For high-fibre breakfast cereals For cream For high energy-carbonated drinks No association with other 17 food/ drinks
Tripicchio et al., (2019)	6545	USA	12 to 19	Two 24-hour dietary recalls	Weight status (over weight and obesity vs normal weight)	Snack size (kcal) per snack occasion	+	Adolescents with overweight and obesity consumed larger snack sizes per snack occasion

Lin et al.,⁹¹ observed mealtimes among preschool children in kindergartens in China. An observational recording method was used to estimate consumed portion sizes (served portions were weighed, second servings were recorded, and trained researchers estimated the portion sizes consumed by each child, however leftovers were not measured). Results found for every 100kcal increase in lunch portion, the likelihood of being overweight was increased (adjusted OR ratio=1.445). Increased portions of rice (adjusted OR=2.274) and cooked dishes (adjusted OR=1.390) were both associated with being overweight. The current limited observational evidence suggests that portion size and child BMI may be associated however without prospective evidence from randomised controlled trials and longitudinal studies, the direction of association remains unclear.

One randomised controlled trial in Germany recruited eight- to 16-year-old children diagnosed with being overweight or obese and their parents and explored the use of an educational programme intervention to reduce children's weight.⁹² The programme included guidance on how to reduce portion size and eating rate, and improve dietary habits. The intervention was found to reduce BMI z-score, portion size and eating rate after one and two years. In addition, after adjusting for confounders, the reduction in BMI z-score was positively associated with the reduction in portion size at one ($\beta=0.14$ (95% CI 0.07, 0.22) and two years post-intervention ($\beta=0.14$ (95% CI 0.06, 0.23), as was the reduction in eating rate but to a lesser extent. To my knowledge, this is the first randomised controlled trial to explore the direct relationship between reducing portion size and reducing body weight among children and provides stronger evidence for the downsizing of portion sizes to help combat childhood obesity, however the study did not include preschool children.

The most compelling evidence for the positive association between large portions and weight gain among preschool children comes from a longitudinal study, using a UK twin birth cohort (Gemini cohort). Syrad et al.,⁵⁴ collected parent reported three-day diet diaries when children were 21 months old and body weight measurements between 21 months and five years. Multilevel mixed-effects linear regression analysis was conducted to explore the relationship between meal size (average energy consumed per eating occasion), meal frequency (average number of meals per day) and weight gain (g/week). Results showed meal size, but not meal frequency, was associated with weight gain from 21 months to five-years; for every 10kcal increase in meal size, children gained an excess

of 1.5g/week (4%) above the average growth rate. In addition, cross-sectional analyses showed meal size was positively associated with child weight at baseline; for every additional 10kcal consumed per eating occasion, children weighed an additional 21g.

Although the evidence is limited, cross-sectional and prospective studies suggest large portion sizes may contribute to increased body weight from a young age. Therefore, future research should strengthen this body of research, as well as establish *how* large portions may lead to weight gain and explore the factors associated with large portions.

2.6 THE PORTION SIZE EFFECT IN CHILDREN

Much of the portion size research in children has been focused on establishing whether serving children larger portions results in an increase in energy intake. This phenomenon has been defined as the ‘portion size effect’ and is described as ‘the exposure to larger amounts of foods or drinks, which lead to an increase in energy intake.’⁴⁴ Similar to the trends research, much of the portion size effect research has been conducted in the USA, particularly the earliest work.

Research has established the portion size effect among preschool children.⁹³ The portion size effect research originates from an understanding of children’s ability to self-regulate their own energy intake, listening to their internal cues of hunger and fullness and consuming food in response to this, rather than from external cues.³⁴ Some research suggests that young children are efficient at self-regulating and therefore will not consume excess energy in response to external cues, such as being served a portion size larger than appropriate.³⁴ However, other research suggests this ability to self-regulate may depend on individual variability, parental feeding practices and environmental factors. Research also suggests this ability lessens with age and may be overridden when served large portions.⁹⁴⁻⁹⁶ However, less is known about the factors contributing to the variability within the effect. In this section, I review the portion size effect research, with emphasis on preschool children and discuss factors associated with portion size.

2.6.1 The experimental methods

The portion size effect has typically been explored using within-subject, crossover experimental study designs (where participants are all exposed to a number of study conditions). Studies have recruited a sample of children to consume a meal across several

study conditions, where the meal portion size varies in each condition. Earlier studies tended to manipulate the portion size of one food item (often macaroni cheese, which is well liked by children) during a single meal, whilst keeping other food items constant. The food item is served as a reference portion size (often in line with recommendations) with portion sizes 25% to 200% larger than the reference, in a randomised order, often days or weeks apart. The served portion size is often measured in grams and is the exposure of the study, with the outcome being the weight (grams) or energy (calories) of food consumed. The difference in intake of the manipulated food being either one food item or a total meal is compared between portion size conditions to examine whether children consume a larger portion as a result of being served a larger portion. Earlier studies tended to conduct these experiments in a laboratory setting,⁴³ however more recent studies have used free-living settings such as childcare.⁹⁷ In addition, later studies have explored manipulating multiple food items during a meal, multiple meals and across multiple days.⁴⁵ Factors such as child demographics, child weight, child appetite traits and parental feeding practices have also been explored as covariates in studies to help explain the relationship between portion size and subsequent energy intake.

2.6.2 The portion size effect research

An early study conducted by Rolls et al.,⁴³ found increased portion sizes of macaroni cheese served was associated with increased grams consumed of macaroni cheese and increased total meal energy intake in five-year-olds, but not three-year-olds. Since this study was published, several others have observed similar results and several narrative and systematic reviews have been published in this area. Two narrative reviews^{38,98} have reviewed experimental studies, which manipulated portion sizes at a single meal or multiple meals. The age range of children included in these reviews was two- to nine-years. All studies observed the portion size effect, with a doubling of the served portion associated with an increase ranging between 25 to 31% in the consumption of the manipulated food (grams) and a 13 to 22% increase in total meal energy intake (kcal). One study found no effect on energy intake when portion size was reduced by 100g, which may be problematic for designing interventions to reduce portion sizes in preschool children.⁹⁹

Several narrative reviews have concluded that the portion size of food, especially energy-dense food is strongly associated with energy intake, both when children are served the

portion or self-serve.^{39,44,48,100} Although these narrative reviews provide a good overview of the portion size research in children, systematic reviews and meta-analyses strengthen the review of evidence. Three systematic reviews (including two meta-analyses) have been published, all supporting the positive effect of portion size on energy intake^{93,101,102} among children aged two- to 15-years. Reale et al.,¹⁰¹ pooled 14 studies for meta-analysis and showed a 50-100% increase in portion size was associated with a standard mean difference (SMD) of 0.47 (95% CI, 0.39-0.55), equivalent to a 13% increase in daily energy intake among two- to 12-year-olds. This effect was observed regardless of whether the food served was amorphous (without a clearly defined shape) or unit (distinct shape). Similarly, Zlatevska et al.,¹⁰² pooled 25 studies and showed a doubling of portion size was associated with an average 20% increase in food consumption (grams) among two- to 15-year-olds. In addition, sub-analyses were conducted to explore a potential ceiling effect. Studies (both adult and child) that used three or more portion size conditions were analysed to explore the effect of increasing portions. Findings showed effect size became increasingly smaller as the portion size condition increased (i.e. increasing a small portion size to a medium portion size elicited a greater increase in intake than increasing a large portion size to an even larger portion size). Using 65 of the included studies (adult and children), served portion size was plotted against the grams consumed and illustrated a curvilinear relationship. These results suggest there is a ceiling to the portion size effect, whereby children are likely to consume more food when serve more but only up to a certain point. This explains why studies often show only approximately a 25% increase in food consumption from the 150% portion size served.

Although important, these findings were based on single meal studies, so provide little evidence about the longer-term implications of the portion size effect and whether larger portion sizes during one meal or during a whole day are compensated for at later meals or subsequent days. In addition, many studies included in the systematic reviews, served the same foods, included small heterogeneous samples (often because studies were conducted by the same research group in the USA), and were conducted in well-controlled study conditions, which do not reflect real-life.

McCrickered et al.,⁹⁷ found when teachers doubled the portion size of their regular serving size in a kindergarten setting in Singapore, total food weight (grams) and energy consumed increased among six-year-olds (but not 3-year-olds). Fisher et al.,¹⁰³ showed

that a doubling of five food items across several meals in a 24-hour period (breakfast, lunch, dinner and afternoon snack) among five-year-olds, was associated with a 23% increase in energy intake from two of the five food items (chicken nuggets and cereal). A 12% increase in total daily energy intake was also observed. Smethers et al.,⁴⁵ increased the portion size by 50% of all foods and drinks across all meals and snacks (meals were only consumed in childcare, snacks were consumed in childcare and also at home) across five consecutive days among three- to five-year-olds. This resulted in an average increase in food consumption of 143 ± 21 g (effect size=0.42, $p < 0.0001$) per day and average increase in total daily energy intake of 18% ($+167 \pm 22$ kcal/day, effect size=0.59, $p < 0.0001$). In addition, a cumulative increase of 733 ± 131 g and 784 ± 110 kcal from the increased portions over the five days were observed, where children consumed an average of 15% more energy per day than their estimated daily energy requirements.

Evidence suggests being served larger portions results in an increase in energy intake during a single meal. The portion size effect can affect children as young as two-years-old, although there is likely a ceiling to this effect among children of all ages. Studies exploring the portion size effect in free-living settings, across several meals and days provide evidence that large portion sizes could result in excessive energy intake over time, which could in turn lead to excess weight gain. However, longer-term prospective studies are needed to strengthen this evidence. In addition, more research is needed to establish the age at which children become susceptible to the portion size effect and which other factors may lead to the consumption of large portions.

2.6.3 Factors associated with portion size in children

Previous research has explored several potential factors associated with portion size. Factors include those related to children (demographics, appetite traits, weight, hunger, and food preference), the food (palatability, and energy density), parents (demographics, weight, parental serving size, and feeding styles and practices), and the eating environment (location, eating with others, watching TV, and visual cues). Experimental research has measured and included several of these factors as covariates in models when analysing the effect of portion size condition on food and energy intake. In addition, a few observational studies have analysed intake data to explore potential factors associated with consumed portions of certain individual foods. I will review the experimental and

observational research to discuss the current evidence on some of the key factors associated with the consumption of larger portion sizes.

2.6.3.1 Child age

Current evidence is inconclusive as to whether susceptibility to the portion size effect increases with age among preschool children. Much of this research has been conducted in the USA. An early study observed the portion size effect among five-year-olds but not three-year-olds,⁴³ which was similarly observed in a later free-living study (three versus six-year-olds).⁹⁷ It has been suggested younger children (less than five years) have a greater ability to self-regulate intake and are therefore less susceptible to consuming large portions.¹⁰⁴ However, several other studies have observed the portion size effect in children as young as two and three-years-old.^{45,103} Study methodologies were similar across studies (in terms of the foods and portion sizes served and the study settings), so it is difficult to conclude the reason(s) for these observed differences in results. Cox et al.,¹⁰⁵ explored the correlation between portions children in the UK served themselves and the portions they subsequently consumed and found age contributed to 9.4% of the variance in this correlation. It may be that age explains a small percentage of the variance in the portion size effect, but it is also likely that age interacts with other factors,⁴⁸ which may be why age-related differences are not always observed.

2.6.3.2 Other child characteristics

Gender, ethnicity, and weight (status or BMI) have been explored as possible factors associated with portion size. Gender and ethnicity have only been explored in observational studies, perhaps because experimental studies rarely have the power to detect differences between genders or ethnic groups. Observational studies using surveys to measure portion size, conducted in the UK and Canada, found boys selected and consumed larger portions of energy dense foods (such as biscuits, chocolate, savoury snacks, and French fries)^{61,106} and White children consumed larger (although fewer) portions of vegetables.⁶² Among a sample of 145 parent-child dyads, Johnson et al.,¹⁰⁷ observed greater served and consumed portions among African American versus Hispanic preschool children but no gender differences. Previous observational studies have explored these relationships across a wide age range (one- to 18-years) so less is

known about factors associated with large portions among preschool children specifically.

It is hypothesised overweight children may be more susceptible to the portion size effect than normal-weight children.⁴⁸ Smethers et al.,⁴⁵ found children with overweight and obesity consumed on average 215 ± 19 more grams of food per day as a result of being served larger meals and snacks over five consecutive days compared to normal-weight children. Similar findings were observed for other measures of body size (BMI z-score and BMI percentiles). Reale et al.,¹⁰⁸ showed weak association between parental selection of larger portion of energy dense snacks and child BMI z-score (OR=1.03 95% CI 1.00, 1.06). In contrast, several other single-day experimental studies found no moderating effect of weight status or BMI on the portion size effect, when added as covariates to the models.^{97,103,107}

Two studies have explored the direct association (rather than exploring BMI as a moderator in the relationship between portion size and energy intake) between served and consumed portion size and BMI. Savage et al.,¹⁰⁹ allowed children aged three-to-five-years to self-serve a portion of macaroni cheese, served alongside a fixed portion of other meal items. Results showed BMI z-score was an independent predictor of self-served portion (grams) and intake (grams) of macaroni cheese and total meal intake (kcal). However, in hierarchical regression analyses BMI z-score was only associated with total meal intake (after adjusting for responsiveness to portion size and self-served portion size (grams)). Potter et al.,¹¹⁰ found children's ideal and maximum selected portion sizes of seven main meal items (portions selected using a computerised task) were not associated with child BMI. However, maternal selection of ideal and maximum portion sizes were positively associated with child BMI. It may be that overweight children are more susceptible to consuming large portions because of their appetite traits (discussed below) or because parents serve them larger portions. However, evidence suggests the portion size effect can affect both normal and overweight children. Most of the current evidence exploring the association between BMI and portion size (as described here and in section 2.5) is cross-sectional and so the direction of association is not clear.

2.6.3.3 Child appetite traits

Child appetite traits, such as satiety responsiveness, food responsiveness, enjoyment of food, and eating in the absence of hunger are hypothesised to moderate and explain variance in the portion size effect.⁴⁸ Children with high satiety responsiveness may be less susceptible to the portion size effect because they respond to internal cues of satiety by stopping eating when full, even when larger than appropriate portions are served. In contrast, children with high food responsiveness, enjoyment of food, and tendency to eat in the absence of hunger, may override their internal satiety cues to consume larger portions of food they like and want more of.^{16,44,48,111} Experimental studies have used parent-reported questionnaires (such as the Child Eating Behaviour Questionnaire¹¹² (CEBQ)) to measure child appetite traits and explore their potential moderating effect on the consumption of large portions. Studies showed energy intake as a result of larger served portions was negatively associated with child satiety responsiveness and positively associated with food responsiveness and enjoyment of food.^{45,113,114} However, in one study, only food responsiveness remained associated with energy intake after child BMI was also added to the model.⁴⁵ This strengthens evidence that children's weight may be closely correlated with appetite traits and interact together to affect susceptibility. In addition, children's appetite traits may be bidirectionally associated with portion size through determining the portions parents serve to their children. Studies found satiety responsiveness was negatively associated and food responsiveness positively associated with maternal serving size (which was highly correlated to child consumption).^{108,115} Evidence suggests children's appetite traits are partly heritable (between 51 and 84%) and linked to obesity-associated genes, such as FTO and MC4R.^{16,17} It is hypothesised the genes controlling appetite traits may partly determine a child's response to large portions (i.e. energy intake),^{44,48} which could also be exacerbated through the use of certain parental feeding practices (discussed below).¹¹⁶ Children with low satiety responsiveness and high food responsiveness may be most susceptible to the portion size effect.

2.6.3.4 Hunger, food preference, palatability and energy density

It is suggested children's hunger may moderate the portion size effect because children who are more hungry may consume more energy from a larger portion to satisfy their appetite.^{44,117} Schwartz et al.,¹¹⁸ found larger portion sizes of brownie and applesauce reduced residual hunger more than smaller recommended portion sizes ($\beta=-0.76$,

SE=0.07, $P<0.001$) among children aged eight- to 11-years. However other experimental studies have found no association between children's hunger and portion size.^{105,119} Rather, Stromberg et al.,¹²⁰ found maternal perception of children's hunger was correlated with the portion size served to the child ($\beta=77.95$, $t=2.258$, $P<0.032$). It may be that children (especially preschool) are unable to accurately report their hunger, which may explain the observed lack of association with energy intake. Alternatively, children's hunger could drive the amount consumed through parental serving size.

How well liked a food is may also moderate the portion size effect with children consuming larger portions of foods they enjoy.⁴⁴ Using a computerised task, Forde et al.,¹¹⁶ found six-year-old children selected larger portions of well-liked foods, which led to greater consumption of these foods during an *ab libitum* lunch (can consume as much as desired). In addition, how well liked a food is, is likely related to palatability and energy density. Many experimental studies observing the portion size effect manipulated portion sizes of well-liked, palatable, energy-dense foods such as macaroni cheese.¹⁰¹

In contrast, experimental studies manipulating portion sizes of less palatable, low energy-dense foods, such as vegetables have yielded mixed results. Several studies have attempted to increase vegetable consumption through increasing the portion size of vegetable side dishes alongside a fixed main meal portion, or by reducing the main meal portion alongside a fixed vegetable portion. However, these studies did not observe an increase in vegetable consumption.^{45,121,122} On the other hand, Spill et al.,⁴⁶ observed an increased vegetable intake (by 47%) when vegetable portion size was doubled and served as a first course (before a fixed main meal portion). Mathias et al.,¹²³ found fruit and vegetable intake did increase (by 70% and 37%, respectively) when a side dish was doubled and served alongside a fixed main meal portion, however this was only observed among children who liked the fruit and vegetables. The strongest evidence comes from Roe et al.,¹²⁴ who conducted a cluster-randomised crossover study during childcare, whereby all meals and snacks were provided to preschool children over five consecutive days and three experimental conditions. In one condition (control), children were served typical portions of all foods, in the second condition (addition) children were served larger portions of fruit and vegetables (50% increase) alongside typical portions of the other foods, and in the third condition (substitution) children were served larger portions of fruit and vegetables (50% increase) alongside a smaller portion of the other foods. In

the addition condition, daily intake of fruit and vegetables increased by 33% and 24%, respectively, and in the substitution condition by 38% and 41%, respectively. Collective evidence suggests the portion size effect can occur with a range of foods and may actually be beneficial for increasing fruit and vegetable intake among preschool children.

Several studies suggest energy density may combine with portion size to increase energy intake to a greater extent.⁹⁸ Kling et al.,¹¹⁴ served a meal of chicken (grilled or breaded), macaroni cheese, green vegetables and milk as varying portion sizes and energy densities to three- to five-year-olds. Kling et al.,¹¹⁴ found meal energy intake was increased by 24% in the large portion condition and 40% in the higher energy density condition. When combined, the large and high energy dense condition resulted in a 79% increase in meal energy intake. In contrast, Looney et al.,¹²⁵ served applesauce (low energy density) and chocolate pudding (high energy density) to two- to five-year-olds and found intake was increased when portion size increased but was unaffected by energy density. An effect of energy density may not have been observed due to applesauce being well liked (and therefore consumed in larger portions) by children. This is supported by Diktas et al.,¹²⁶ who found liking the food was a stronger predictor of portion size selection than energy density among young children. Evidence suggests child preference and energy density may interact to moderate the portion size effect, which could be detrimental to child health if children are regularly served high energy dense foods.

2.6.3.5 Eating environment

The food and eating environment may also play a role in determining the portions served to and consumed by children. Factors such as the home and school food environment (including who children eat with, and mealtime routines); exposure to advertising; neighbourhood characteristics (including proximity to eateries); parent restaurant choices; and food availability, cost, and packaging are all suggested to be associated with portion size and interact with a child's behavioural susceptibility to the portion size effect.⁴⁸ Despite these hypotheses, only a few observational studies have explored the association between environmental factors and the consumption of large portions. Among children and adolescents, portion sizes of energy dense foods (such as pizza, biscuits, chocolate, and fried food) were greater when consumed out-of-home, such as at eateries (restaurants, cafes, fast-food outlets) and on-the-go,^{61,106,127,128} when consumed with friends,¹²⁷ and when watching TV.¹⁰⁶ In addition, portion sizes of vegetables were greater

when consumed at home and when eating with others.⁶² More research is needed to identify the environmental influences on consumption of large portions, especially among preschool children, and to understand the relative importance of environmental factors versus child and parent factors.

2.6.3.6 Visual cues

Visual cues may act as an external influence on the serving and consumption of large portions by partly underpinning how appropriately sized a portion is perceived to be.^{84,100} These visual cues may include the size of dishware (plates, bowls and utensils), units, packaging and containers. They act as a reference for parents or children to estimate and decide how much to serve or consume.¹⁰⁰ In terms of dishware, the same portion of food would appear smaller if using a larger plate, bowl, or utensil (e.g serving spoon). Larger dishware also allows more space for food to be served. If using larger dishware, parents or children may serve larger portions and subsequently consume more.¹⁰⁰ In terms of unit, package or container size, the same portion of food may appear larger if the food is presented as multiple units (one large cookie appears less than three smaller pieces of the same sized cookie because the number of food items is more) or if the package or container is larger (because the package/container appears emptier). Therefore, foods served in smaller units or larger packaging may lead children to consume more energy from that food. This “unit bias”¹⁰⁰ is suggested to distort judgement about how much to serve and consume.

Although theorised, few studies have explored the effect of visual cues and unit bias in children. A systematic review and meta-analysis of dishware studies in children and adults showed a marginal effect on food intake (SMD = 0.18, 95% CI -0.35, 0.00) and concluded that evidence was not consistent.¹²⁹ DiSantis et al.,¹³⁰ found six- to seven-year-old children served themselves a larger portion of main meal and vegetable side (but not fruit side) when using an adult versus child-sized plate (100% increase in surface area), which indirectly increased energy intake of the total lunchtime meal (for every 1kcal increase in portion size served, an extra 0.43kcal was consumed). Similarly, Fisher et al.,¹³¹ found four- to six-year-olds served a 13% larger portion of a pasta main meal when using a tablespoon to self-serve versus a teaspoon, which was indirectly associated with greater energy intake within the total meal (an additional gram served, equated to a 0.54kcal increase in total meal intake). In terms of unit/package size, Marchiori et al.,¹¹⁹

showed reducing the unit size of a cookie (splitting one cookie into two pieces) served as an afternoon snack at school among six- to eleven-year-olds, led to a 25% reduction in cookie intake (68kcal reduction in energy intake). Aerts & Smits¹³² found three- to seven-year-olds consumed more grams of snack foods from larger packets versus regular sized packets. This effect was observed to be greater when children were served high-sugar, palatable foods (sugared popcorn and cookies) versus savoury, less palatable foods (salted popcorn and baby carrots). Although evidence is limited, studies in children suggest visual cues could play a role in determining the portions consumed and could be used as an environmental strategy to reduce population-level portion sizes of energy-dense foods.¹³³

2.6.3.7 Parental characteristics

Parental characteristics, such as ethnicity, socioeconomic status, and weight status may influence the portions parents serve themselves and their children (which will in turn affect children's energy intake).^{44,134} One study found African American mothers served themselves and consumed larger portions than Hispanic mothers.¹⁰⁷ In turn, African American children were served 20% larger portions and consumed 13% larger portions than Hispanic children. It may be that certain cultures associated with one's ethnicity promotes consumption of larger portions through serving methods, types of food served, or use of common feeding practices,^{135,136} however very little research has been conducted exploring the relationship between ethnicity and portion size. Experimental evidence suggested mothers with lower education served larger portions to children than mothers with higher education (main effect $F(3, 495) = 5.47, P=0.004$). Children experiencing food insecurity served themselves 16.5% more energy than children not experiencing food insecurity.^{115,130} In observational studies parental socioeconomic status (measured as occupation and household income) was not associated with greater intake (kcal) and larger consumed portions (grams) of energy-dense foods in children aged two- to 18-years.^{61,127} However, parental income was associated with larger portions of meat¹⁰⁶ and greater daily vegetable intake,⁶² which may reflect the cost and availability of these foods. More research is needed to establish the potential association between socioeconomic status and child portion size.

Parents who are overweight may serve and consume larger portions themselves, which may indirectly influence the portions consumed by their children. However, studies

exploring this have found only weak¹²⁰ or no correlation¹⁰³ between maternal BMI and portion sizes served to or consumed by children. Although it is well established that having overweight parents is a significant predictor of children being overweight,^{14,15} more research is needed to understand whether portion size plays a role in this relationship.

2.6.3.8 Parental serving

Parents play an important role in shaping a child's food environment and influencing their food preferences and eating behaviours.⁴⁸ This includes influencing the portion sizes their children consume. Parental serving size (i.e. how much parents serve themselves) is suggested as a key factor associated with child portion size. Using digital photography, Johnson et al.,¹⁰⁷ measured parental and child serving sizes during mealtimes in participants' homes. Results showed parental serving size was strongly and positively associated with the amount parents served to their preschool child (Spearman's correlation = 0.51, $P < 0.001$) and the amount children were served was positively associated with amount consumed (Spearman's correlation = 0.88, $P < 0.001$). For snacks, Reale et al.,¹⁰⁸ showed caregivers' own snack portion size strongly predicted the snack portion size offered to their children, for both low and high energy dense snacks. This evidence suggests parents' own portion sizes may indirectly affect the amount their children consumes through the portion sizes subsequently served to their children.

This phenomenon may be underpinned by appropriateness, whereby children may perceive the amount served to them by parents as an appropriate amount to consume.¹³⁷ Parents may perceive a portion size to be appropriate for their child, however if these served portions are actually larger than appropriate for healthy growth, children may learn that these large portions are the appropriate amount to eat, rather than relying on internal satiety cues. This may also be exacerbated by certain parental feeding practices (discussed below), such as pressure to eat and encouraging plate-clearing.¹³⁸ However, because the portion size effect has a ceiling,¹⁰² it is likely that there is also a maximum amount that children will consume; a point at which fullness overrides appropriateness. This theory has been observed in adults, who were willing (without reluctance) to consume a portion size 40% larger than their ideal portion size,¹³⁹ but has not yet been explored in children. It is likely that parents (consciously or unconsciously) set

expectations around meal and snack times, with amount consumed being one of these expectations.

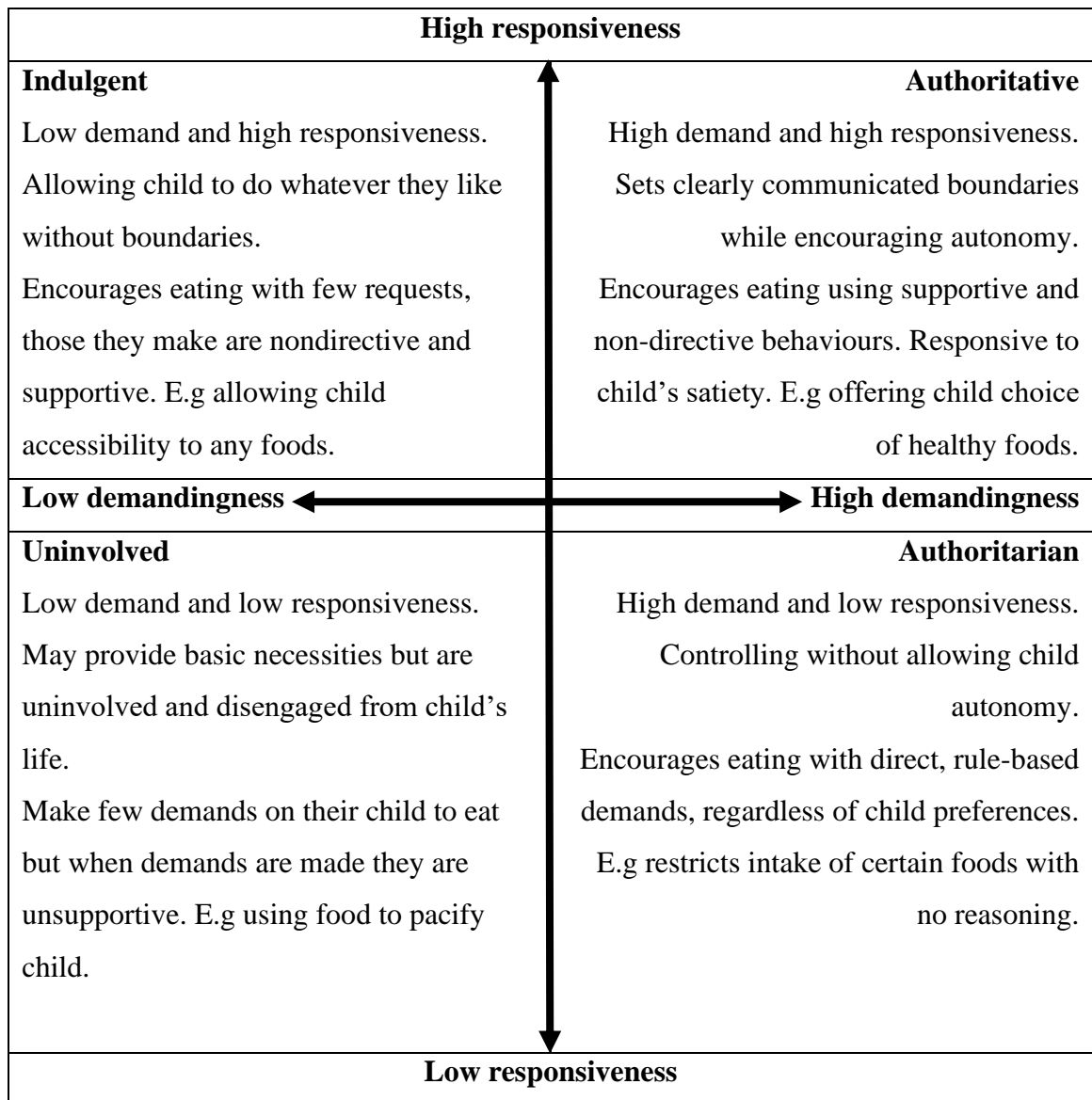
If parents routinely serve themselves large portions (which is possible due to the recent increases in adult portions of commercially available foods discussed in section 2.4) and are unaware of recommendations around child-appropriate portion sizes this may pose a problem for weight gain in children. Reale et al.,¹⁴⁰ found in a sample of 659, most parents selected portion sizes of common snack foods for their child in line with the UK portion size recommendations, however 16% selected smaller portions for low energy dense snacks and 28% selected larger portions for high energy dense snacks. A large proportion of the sample were highly educated. More research is needed to establish whether parents are aware of the portion size recommendations for both adults and children, whether portion sizes are in line with these recommendations and whether there are differences by socioeconomic status.

It may be better to allow children to self-serve, as evidence suggests children as young as five can serve portions in line with national recommendations¹⁰⁵ (although individual differences were observed). However, Savage et al.,¹⁰⁹ found macaroni cheese intake did not differ when three- to five-year-olds were served a large 400g portion (201.3±92.3g) versus when they were allowed to self-serve the 400g portion from a container onto their plate (193.2±92.3g) (in both conditions, a fixed portion of other meal items were also served). The amount children served themselves correlated with the amount they consumed (Pearson's correlation = 0.68, $P < 0.001$) and of the total meal (Pearson's correlation = 0.42, $P < 0.001$). This suggests children's own choice of serving size may be perceived as an appropriate amount to consume, regardless of whether the available portion is large. More research is needed to establish the best serving method to promote age-appropriate consumption for preschool children.

2.6.3.9 Parental feeding styles and practices

In the portion size literature, four parental feeding styles are used to describe the level of parental response to their children's demands to eat.^{141,142} These four parental feeding styles are authoritative, authoritarian, indulgent, and uninvolved. These parental feeding styles sit on two continuums of responsiveness and demandingness. Figure 2.3 illustrates and defines each feeding style.

Figure 2.3. Illustration and definitions of the four parental feeding styles



Parental feeding practices (different to parental feeding styles) refer to practices parents use to influence the development of children's attitudes, behaviours, and preferences towards food.¹⁴³ Definitions of various feeding practices vary, which makes reliably comparing study findings more difficult. However, a conceptual framework has been developed, which systematically reviewed and appraised the parental feeding practices literature to define each practice.¹⁴⁴ Broadly, parental feeding practices fall into one of three constructs: coercive control (controlling, restrictive practices), structure (practices that establish, rules, limits and routines but involve parent-child choices and interactions), and autonomy (practices that are child-led). Parental feeding styles and practices are often measured using parent-reported questionnaires. However, many versions of these questionnaires exist, varying in validity and reliability.^{145,146}

In relation to influences on portion size, it is suggested parental feeding styles and practice affect the portions parents serve and therefore the amount their children consume.^{44,48} Parental feeding practices may be linked with child appetite traits bi-directionally. Parents may use particular feeding practices if their child has a certain appetite trait (e.g. may limit food portions if child is food responsive). Other parental practices may exacerbate certain appetite traits (e.g. restriction may lead to eating in the absence of hunger). Few studies have explored the moderating role of parental feeding styles and practices on the portion size effect. One experimental study showed children of parents who reported to have indulgent or authoritarian feeding styles, served themselves approximately double of the main meal and consumed 64 to 162 kilocalories more from the total meal, than children of parents with uninvolved or authoritative feeding styles.¹³¹ Another study found parental use of the pressure to eat practice was associated with larger servings of energy dense snacks (OR=1.11, 95% CI 1.01, 1.21).¹⁴⁰ However, more research is needed to establish which parental feeding styles and practices are associated with consumption of large portions in preschool children, and the direction of association.

In the wider literature, parent feeding styles and practices are also associated with child eating behaviours and weight.¹⁴⁵⁻¹⁴⁷ Evidence from systematic reviews suggest food availability, food accessibility, praise, and modelling can increase child preference for and intake of healthy foods. However, restriction, pressure to eat, and instrumental feeding (e.g. rewards) could reduce preference for and intake of healthy foods.^{147,148} Systematic review evidence suggests an authoritative feeding style is beneficial for promoting healthy food intake and healthy weight status, whereas authoritarian, indulgent, and uninvolved styles may be detrimental (although evidence is less strong for these three styles).^{145,146} Systematic reviews suggest cross-sectional studies show parental restriction is positively associated with child BMI, and pressure to eat is negatively associated with child BMI, but with inconsistent evidence from prospective studies.¹⁴⁹ Cross-sectional studies cannot establish the direction of association and therefore, current evidence suggests the relationship between parental feeding practices and child BMI may be bi-directional. Some prospective evidence suggests the protective effect of parental monitoring of food intake on child BMI, however other studies observe no association.¹⁴⁹ Although autonomy and structure-related practices are hypothesised to positively influence child eating behaviours and weight status, these practices are understudied and no firm conclusions can be drawn.¹⁴⁹ Parents may use various feeding practices to

influence the portions consumed by their children. Understanding these practices is important to better understand children's susceptibility to the portion size effect and could help develop interventions to promote age-appropriate portion sizes in preschool children.

To summarise, previous research has identified several factors associated with portion size in children. Factors related to the children themselves, the parents, the food, and the environment may all help to explain the variability in the portion size effect and why children may consume large portions. However, only a few studies have reported the percentage of variance explained by certain factors.^{62,105,127} Research exploring factors associated with portion size using large dietary datasets is required, especially factors related to child characteristics and the eating environment, which are currently understudied. CHAPTER 5 aimed to explore the variation in portion size among preschool children and identify individual and environmental factors associated with larger portion sizes.

2.7 PARENTAL PORTIONING DECISIONS

Parents influence how much (the portion size) their preschool children eat through their portioning practices. Parental portioning practices refer to how parents decide the portion sizes of foods and drinks to serve to their children.⁴¹ Several studies have used qualitative methods to gain a deeper understanding of parental portioning practices and the factors that influence these practices. In this section I will discuss the current qualitative portioning practices literature.

Kairey et al.,⁴¹ conducted a systematic review exploring parental food and beverage portioning practices for children aged two- to 12-years and identified 14 quantitative and 14 qualitative studies. Ten qualitative studies were conducted in the USA, three in the UK and one in Switzerland. Parents of preschool children were interviewed in nine qualitative studies, parents of five- to 13-year-olds in three studies and a wider age range of two- to 12-year-olds in one study. Results from qualitative studies were analysed thematically and presented as three key themes; parent-related factors, child-related factors, and external factors.

2.7.1 Parent-related practices

The parent-related factors theme included seven sub-themes; balance precedes portion size, desire for a healthy child (of healthy weight), need to ensure their child is fed, learned portion sizes their child will eat, onus of control over portion size, desire to avoid waste of time and food (money), and knowledge of portion sizes.⁴¹ Results suggested parents are more concerned whether their children are eating enough food and have a healthy diet, to ensure children are healthy and of a (perceived) healthy weight. This aligns with Carnell et al.,¹⁵⁰ who found the underlying motivation for using parental feeding practices to promote or restrict intake among normal weight three-to-five-year-olds was predominantly to promote a healthy, nourishing, balanced and varied diet.

Kailey et al.,⁴¹ suggested parents learn what they believe to be appropriate portion sizes to serve to their children through past and ongoing experience of knowing how much their child eats on a meal-to-meal basis and over the course of a day. Parents served portions that reflected children's usual consumption, increasing or decreasing meal and snack portions to meet their ideal of their children's daily food intake.⁴¹ This has also been reported in more recent qualitative studies exploring parental portioning practices.^{140,151-153} Philippe et al.,¹⁵¹ suggested mothers in France used observations of previous feeding times and intuition to determine portion sizes for their preschool children.

Parents also reported deciding portions based on their experience of children's hunger, learning to recognise hunger through children's behaviours and vocalisations.¹⁵⁴ Several parents described serving larger portions if their child expressed hunger, to ensure their child was adequately fed.⁴¹ This links to the quantitative research discussed in section 2.6.3.4, where maternal perception of hunger was associated with the amount of food served to children.¹²⁰ When their child expressed hunger outside of mealtimes, some parents worried limiting or restricting snacks would restrict the food needed for optimum growth, whereas other parents set portion size limits for snacks without concern.^{140,155} Although parents rely on child hunger to determine portion sizes, they may sometimes have difficulty distinguishing between want and need. Parents may overfeed preschool children as a result of misjudging child hunger and fullness, which could lead to disinhibiting children's ability to self-regulate.³⁴ Johnson et al.,⁹⁶ found a six-week pre-test post-test intervention (not a randomised controlled trial), teaching preschool children

about their hunger and fullness through interactive activities improved their ability to recognise internal cues of satiety.

Experience in serving portion sizes likely develops over time and grows with more than one child,^{156,157} however it is unclear at what stage (or child age) parents develop enough experience to determine appropriate portions. Despite relying on experience, parents in the USA and UK reported not knowing the official recommended portion sizes for children of different ages and sometimes used adult portions to help decide their children's portions (e.g. halving adult portion),^{41,140} which links to the association between parental serving size and child serving size discussed in section 2.6.3.8.

Kailey et al.,⁴¹ presented mixed evidence on who had control over deciding portion sizes: some parents described allowing children to serve themselves and dictate whether they were finished eating or wanted more; Other parents served the food to their children, encouraging and negotiating with them to consume an amount they deemed appropriate. One reason was to avoid food waste (and money) and wasted time spent preparing the food. In another study, some parents thought controlling their children's portions was the best way to ensure appropriate consumption, whereas other parents thought as long as healthy food was served, children could choose how much to eat.¹⁵² This aligns with the parental feeding practices literature, which suggests parents use a variety of practices (including autonomy-promoting and controlling practices) to influence their children's eating behaviours and food intake.^{143,146,148} Parents that allowed their children autonomy over portion sizes believed their child would eat when hungry and stop eating when full (self-regulate satiety).⁴¹ This may be a preferential practice because in noncontrolling, noncoercive environments, children can regulate their appetite and energy intake⁹⁶ However, as the portion size effect literature shows, children may overconsume energy dense foods,³⁸ especially if they have food responsive appetite traits.⁴⁴ Another portioning practice described involved serving a small portion and then allowing children to ask for more (seconds),^{41,140,151} which allowed both parent and child some control over the portion sizes. Philippe et al.,¹⁵¹ suggested the level of autonomy given to preschool children to decide portions varied across parents, however parents always monitored and re-adjusted portions where necessary, never granting full autonomy.

2.7.2 Child-related practices

Kailey et al.,⁴¹ presented two sub-themes under the child-related theme; age and developmental stage, and body size and weight status. Parents believed portion sizes should generally increase with age, although appropriate amounts will differ between children (i.e. not a fixed portion size for all children of a certain age).¹⁵⁸ Parents, especially of preschool children, appear to be more concerned about children gaining enough rather than too much weight.^{154,155,159} These parents often encouraged the consumption of larger portions, even sometimes in the absence of hunger if they or other family members perceived children to be too thin, to ensure adequate growth. However, they would not necessarily restrict portions if perceived children to be overweight.^{154,155,159} Using perception of child weight or body size to determine portion sizes may be problematic, as parents may not identify their child as being overweight¹⁶⁰ or have an accurate idea of child-appropriate portion sizes.⁴¹

Other studies have identified child preference and picky eating as child-related factors determining portion sizes.^{140,151,158} Parents often serve larger portions of well-liked foods and smaller portions of less liked foods, often to avoid food waste. One study distinguished between practices used by parents of ‘good’ versus ‘picky’ eaters (aged two- to five-years).¹⁵⁸ Parents of ‘picky’ eaters were concerned about getting their child to eat something, so would often serve only well-liked foods and use prompts and rewards to encourage eating. In comparison, parents of ‘good’ eaters provided a variety of food and allowed child autonomy over how much to consume.

2.7.3 External practices

Kailey et al.,⁴¹ presented three sub-themes within the external practices theme: perceived healthfulness of food or beverages, portioning resources, and authoritative guidance. Many parents across studies described using external measures of portion size, such as child-specific dishware and pre-portioned packaged foods to determine portion sizes. Some parents relied on dishware and packaged foods to be appropriately portioned for children, whereas other parents described sub-dividing or sharing packaged foods they believed to be adult-sized or too large. These findings are also echoed in more recent qualitative studies, exploring parental portioning practices, especially the use of package size to determine snack portions.^{140,152,153} This highlights the need for food manufacturers

to include clear age-appropriate portion size recommendations on packaging. Some parents used hand and finger sizes as a quick way to determine portions but very few reported weighing or measuring foods.⁴¹

Perceived healthfulness was an important factor determining parental portioning practices. Parents often to ensure child health described not considering the served portion sizes of ‘healthy’ foods, therefore allowing children larger portions or even unlimited access, however restricting portions of ‘unhealthy’ food. Some parents used ‘unhealthy’ foods as rewards, providing incentive to encourage children to consume the healthier foods served to them at mealtimes. However, evidence from the feeding practices literature suggests practices such as restriction and using food to reward may be counterproductive and instead increase children’s preference and intake of unhealthy foods.^{148,161} Curtis et al.,¹⁶² found a lack of knowledge regarding nutritional value and content of foods among parents whether with overweight or normal weight children. If parents are more concerned about achieving a healthy balanced diet than the portion sizes served, it is important to ensure they are well-educated about the foods and beverages that make up a healthy diet.

In other qualitative studies, external factors such as time and the influence of family members was reported to sometimes determine portion sizes. Time as an external factor was reflected in mealtime routines (and the time of day established for these), which may determine the portion sizes served. For example, if snacks are served close to mealtimes, parents may serve smaller portions to avoid ruining appetite for meals. Whereas larger snacks may be served if children need to wait a while until the next meal, to satisfy hunger.^{140,151,163,164}

Relating to the influence of family members, parents, particularly mothers, reported partners (often fathers) and grandparents rarely considered the portion sizes served to their children. They were reported to use adult dishware to serve portions and serve too much ‘unhealthy’ foods too frequently.^{140,155,162,165,166} Marr et al.,¹⁶⁷ conducted a systematic review exploring the dietary provision, feeding practices, and feeding styles of grandparents caring for preschool children. The review identified three qualitative studies (one each in China, Canada and the USA) reporting the portion size of food served by grandparents to preschool children. Parents reported grandparents were serving large portions of energy dense foods, overfeeding, and encouraging eating in the absence of

hunger. In some cultures, this stemmed from the belief that being overweight was better for child growth. In addition, the review suggested grandparents served foods high in fat and sugar (regularly or occasionally); served snacks more regularly than parents; used positive feeding practices to provide structure and autonomy but also used negative practices such as restriction, food rewards and pressure to eat to control consumption. Grandparents had an indulgent feeding style, whereby preschool children were treated, spoiled, and indulged when in their care. Grandparents may be encouraging the consumption of larger than age-appropriate portion sizes and parents may feel undermined by grandparents not following the same portioning practices and feeding principles as them.

Several qualitative studies conducted in the USA, UK and Europe have asked parents whether they are aware of or use official portion size guidance to help determine portion sizes.^{140,151,152,155,156,159,162,168} Despite parents of preschool children expressing an interest in accessing information on appropriate portion sizes for children, many parents across studies reported not being provided with any official guidance or coming across any themselves.^{140,151,159,168} Parents of school-age children however dismissed the idea of accessing portion size guidance due to information overload.¹⁵⁶ This may be because parents of school-aged children feel they have received enough feeding advice over the years and can now rely on their own experience, confidence, and routines. Previous studies have only asked parents about their general knowledge of portion size guidance rather than awareness of specific resources, with the exception of Tang et al.,¹⁵³ who asked parents about their awareness of the Public Health England Change4Life ‘me-sized meals’ campaign. Only five of the 21 parents were aware of the campaign, but none reported using the campaign resources to help determine portion sizes, nor did they seem concerned about following them. This was echoed in other studies, where parents admitted having a lack of knowledge about child appropriate portion sizes but had not thought to look for guidance resources.^{159,162} It seems important to better understand the type of guidance parents would like to access to gain information on age-appropriate portion sizes and target guidance at parents with younger children, who may have less experience, confidence and exposure to feeding advice. In previous studies parents expressed the desire for clear, realistic, child-centred guidance from a trusted source, such as health professionals or friends with experience.^{140,152} However, more research is needed to learn about preferred format, structure, content, and use of guidance among

parents of preschool children. CHAPTER 4 aimed to better understand the opinions of parents regarding the desire for portion size guidance and how portion size guidance could be presented to appeal to parents.

In summary, parents use a variety and combination of portioning practices. Parents often use their experience of previous feeding times and perception of child hunger, alongside external portioning aids such as dishware and packaged foods. Parents describe a varying level of child autonomy over deciding portions. Parental portioning practices may be influenced by children's preference for the foods served and the desire to avoid food waste. Meal and snack time routines and the influence of other family members may also affect parental portioning practices. Parents express a lack of knowledge about child-appropriate portion sizes and have very little awareness of portion size guidance. Research should identify whether this lack of awareness is due to a lack of accessible guidance resources or a lack of desire to seek guidance, through systematically searching for portion size guidance resources. In addition, especially among parents with younger children who do express an interest in accessing guidance, future research should deepen the understanding of whether and how parents want to use guidance.

2.8 SUMMARY OF LITERATURE

In summary, portion sizes of commercially available energy dense food and drinks have increased over the last few decades, during which the prevalence of childhood obesity has also increased worldwide. Data from national surveys suggests portion sizes of some other commonly consumed foods may have increased among preschool children, however this evidence is limited by its cross-sectional nature and the dietary assessment methods used to estimate consumed portion sizes. Prospective evidence shows that portion size is positively associated with excessive weight gain in preschool children, suggesting portion size should be a key area of research, which could contribute to the wider research exploring and informing effective strategies to prevent and reduce childhood obesity.

Research has established preschool children consume greater energy when served larger portions of different foods. Therefore, serving larger than age-appropriate portion sizes to preschool children may override internal satiety signals and lead to excessive intake. Evidence suggests individual factors, such as child characteristics, appetite traits, hunger,

and food preference, and food-related factors, such as energy density and palatability may contribute to the variability in children's consumed portion sizes. Evidence suggests environmental factors, such as eating contexts and environmental cues, and parental factors, such as parental characteristics, parental serving, and parental feeding styles and practices may also contribute to the variability in children's consumed portion sizes. However, more research is needed to strengthen this evidence base, especially for child characteristics and the eating environment.

Parents influence the portion sizes served to and consumed by preschool children. Parents use a range of parental portioning practices to decide how much to serve their children, which are either parent-related, child-related or external practices. Many parents use previous experience to decide portion sizes but it is unknown at what stage parents feel they have enough experience to rely on, as previous qualitative studies have only recruited parents with children aged two and older. Whilst parents of preschool children do not usually know official portion size recommendations, they often express interest in accessing them. However, type, content, and format of portion size guidance for preschool children in the UK has not been synthesised. It is important to firstly identify existing portion size guidance before considering developing new guidance or other strategies to promote the consumption of age-appropriate portion sizes for healthy growth.

CHAPTER 3. WHAT GUIDANCE IS THERE ON PORTION SIZE FOR FEEDING PRESCHOOL AGED CHILDREN (ONE TO FIVE YEARS) IN THE UK AND IRELAND? A SYSTEMATIC GREY LITERATURE REVIEW

3.1 OVERVIEW

The work presented in the current chapter was published in Obesity Reviews.¹⁶⁹ Except for this overview, some minor edits to improve readability and reduce repetition, and a final section on the implications of this study for the thesis, this chapter is presented as per the article. I was responsible for the conceptualisation, article screening, data extraction, analysis and writing of the article. The fourth author was responsible for independently double screening and data extraction. The other three authors (supervisors) helped with conceptualisation, reviewed the manuscript and provided feedback prior to submission. This chapter explores the portion size guidance resources aimed at feeding one- to-five-year-olds in the UK and Ireland and answers research objective one of this thesis: ‘To identify existing guidance available on portion size aimed at feeding preschool children. To describe it’s content, presentation, intended audiences and how it is informed and to compare portion size recommendations across guidance resources.’ The findings of this study will provide a better understanding of how many portion size guidance resources exist, how consistent the guidance is and whether there is a need to improve existing or future guidance. The background, methods and discussion are presented below. The final section presents the implications of the study findings for this thesis.

3.2 BACKGROUND

Childhood obesity prevention is a current worldwide public health priority.¹⁷⁰ As previously stated in 1.1, the prevalence of childhood obesity in the UK and worldwide is of concern and larger portion sizes, are likely to contribute to childhood obesity.¹⁰⁶

Research suggests infants (up to one year) are able to self-regulate their energy intake.³⁴ However, this self-regulation mechanism seems to diminish with age,^{34,43} making young children increasingly susceptible to factors such as parent feeding practices or environmental cues, which may result in over-consumption. Experimental evidence has

shown serving young children (three-to-six-years) larger portions of palatable energy dense foods at a meal (e.g. macaroni cheese, cereal, chicken nuggets) results in a higher energy intake.^{97,171} Evidence shows young children consume larger amounts of the served foods, without a compensatory decrease in the intake of other foods, leading to greater energy intake during a single meal,³⁸ and over a whole day.⁴⁵ Other studies have shown increasing portion sizes of healthy foods such as milk and fruit alongside other foods results in increased consumption of the healthy foods, without increasing total energy intake (kcal) of the meal.^{121,172} However, this may not be the case for other foods; serving vegetables alongside a reduced portion of high energy dense food did not lead to increased vegetable consumption or reduced total meal energy intake.¹²² Therefore, to manage overall energy intake it is important to consider the combined effect of altering portion sizes of different foods because eating occasions typically represent a mixture of many foods rather than a single one. Longitudinal evidence has shown larger total meal sizes consumed at 21 months were associated with faster growth rate above the average, from two to five years, suggesting meal size (resulting from the combination of many foods) may be a critical driver of weight gain.⁵⁴

We know children require energy for growth and development and, as children age, they require more energy due to an increase in body size.³⁹ Increasing portion size as children age is an effective way of meeting these increasing energy intake demands. However, when portion sizes are consistently providing energy above requirements, this may lead to over-consumption and excess weight gain.³⁸ Thus, age specific portion size guidance may help to strike a healthy balance.

The School Food Trust, a former English charity that focused on the promotion of healthy eating in children, was commissioned by the Department for Education to review the current status of food and drink provision for early years (one-to-five-years) in 2010. They stated early years childcare providers and practitioners, local authorities and parents all expressed the need for clear and practical guidance about healthy food and drink for young children, including guidance on portion sizes.¹⁷³ As a result of this work, voluntary food and drink guidelines for early years childcare providers in England were created. Public Health England subsequently commissioned The Children's Food Trust (formerly the School Food Trust) to revise these guidelines in 2016 as part of the UK governments' Childhood Obesity strategy to support early years settings.¹⁷⁴ In addition, an earlier

published non-governmental childhood obesity strategy also proposed making more portion size guidance available to parents and health professionals, as well as early years settings.¹⁷⁵ Despite this, recent qualitative evidence suggests some parents in the UK are still unaware of any existing guidance, and do want guidance on appropriate portion sizes to help feed their preschool children.⁴¹

Evidence-based, accessible guidance that is useful for all (but especially those in greatest need in terms of inequalities and obesity risk) is required before implementation of any strategies can be carried out.¹⁷⁶ Portion size guidance could support those feeding preschool children in order to manage children's age-specific energy needs and ensure dietary and nutritional adequacy (e.g. vitamin sufficiency, avoiding excessive salt), which are vital for general health. Guidance can usefully indicate the balance and combination of foods which are known to promote good health and adequate energy intake in the early years. Therefore, the identification and scrutiny of current guidance aimed at those responsible for feeding preschool children should be conducted on a regular basis, to assess whether it is fit for purpose for the population they serve.

Previous research has reviewed food and drink guidelines and policies aimed at feeding preschool children in the UK¹⁷⁷ and Ireland.¹⁷⁸ These critical reviews identified and discussed voluntary and mandatory guidelines in the UK and Ireland, however did not use systematic search strategies to do so. Both reviews focussed only on guidance for childcare providers (e.g. preschools and nurseries) and did not include guidance for parents or others responsible for feeding preschool children. Both reviews discussed guidance published in or before 2015, some of which has since been updated. Therefore, a systematic review which attempts to identify all the current portion size guidance available in the UK and Ireland for feeding preschool children is warranted. We conducted a systematic grey literature review which aimed to identify, describe and compare portion size guidance for those responsible for feeding preschool children (one-to-five-years). The review focused on four research questions:

- 1) What resources exist in the UK and Ireland that provide portion size guidance for feeding preschool children, aimed at non-academic audiences?
- 2) Who is the target audience for the guidance?
- 3) How was the guidance informed?

- 4) How consistent are portion size recommendations across guidance resources?

3.3 METHODS

A systematic grey literature review was conducted. Grey literature can be defined as publicly available, open source information, which is not controlled by commercial publishers.¹⁷⁹ A protocol was developed in advance and registered on the international prospective register of systematic reviews (PROSPERO), with registration number: CRD42019127526. The review followed the PRISMA 2009 reporting guidelines¹⁸⁰ (Appendix 2). Four search strategies listed below were conducted to identify potentially relevant resources, which provided guidance about portion sizes for preschool children (one-to-five-years) in the UK and Ireland.

3.3.1 Search strategies

- 1) Internet search: The internet search engine Google (<https://www.google.com>) was used to search for relevant resources. Three Google searches were conducted. The first was an advanced search and included all of the keywords and phrases: ("portion size" OR "meal size" OR "serving size" OR portion* OR food OR diet OR dietary OR nutrition OR nutritional OR menu OR recipe OR meal) AND (preschool* OR pre-school OR "early years" OR "young children" OR "childcare" OR "1 to 5 years" OR "age 1 to 5" OR "1 to 4 years" OR "age 1 to 4") AND (guidance OR guidelines OR guide OR policy OR advice OR information) AND ("United Kingdom" OR UK OR England OR Wales OR Scotland OR Ireland). The second search (portion size, guidance, preschoolers, UK) and third search (nutrition, guidelines, 1 to 5 years, United Kingdom) were broader to ensure all possible resources could be identified. All Google results were screened and those judged to be potentially relevant were saved for full-text assessment. All results obtained were scanned for relevance based on the title, the contents page (if available) and the source of information (i.e. excluded non-UK websites and duplicate information) by two researchers (AP and AD). All potentially relevant resources were read in full by AP and AD to assess eligibility for inclusion and disagreements were resolved through discussion. Searches were conducted up to and including 28th February 2019.

- 2) Suggestions from experts and academics working in the field: Seven experts and academics were identified through personal contacts of the authors and contacted directly to suggest websites or resources they thought may be relevant to the literature search. This search strategy was chosen as it has been successful in identifying relevant grey literature in previous reviews.^{181,182} Experts included one Dietician and Senior Health Promotion Specialist, one Dietician/Public Health Nutritionist, one Senior Nutrition Scientist and one Nutrition Communications Manager. Experts and academics were contacted because they all had knowledge in early years nutrition or public health guidance. Data saturation was met after seven meetings with experts and academics, which occurred between December 2018 and February 2019.
- 3) Open Grey: Open Grey (<http://www.opengrey.eu/>) is an online system for identifying grey literature in Europe. The same keywords and phrases as the internet search were used to conduct the search. All results were scanned and those thought to be relevant were saved for follow-up. Searches were conducted by AP up to and including 25th February 2019.
- 4) References lists from relevant resources: After identified resources were read in full to assess eligibility, a search for additional resources was conducted by screening all reference lists from the included resources. Reference lists were first screened by title, contents page and source and those deemed relevant were read in full to assess eligibility for inclusion. Searches were conducted by AP and AD up to and including 15th March 2019.

3.3.2 Data Management

All resources eligible for inclusion were stored in an Excel file with Uniform Resource Locator (URL) and Portable Document Format (PDF) links. The number of resources identified, screened, assessed for eligibility, excluded, and included for review, duplicates and the dates these processes occurred were stored by both reviewers in an Excel file.

3.3.3 Eligibility criteria

After initial screening, resources saved for follow-up were read in full to decide those to be included for review. Resources were included if freely and publicly available and

excluded if aimed only at academic audiences. These criteria were set to ensure that only resources that were aimed at those who are involved in or advise on feeding preschool aged children (e.g. parents, childcare providers, healthcare professionals) were included. Childcare providers included but were not limited to nurseries, preschools, playgroups, childminders, nannies, toddler groups, creches and family centres. Healthcare professionals included but were not limited to health visitors, paediatricians, mid-wives, dieticians, nutritionists, public health teams, general practitioners (GPs), and community food workers.

Resources were included for review if they reported examples of weight or calorie-based portion size guidance. For example, if they presented recommended number of grams for food items. Resources were excluded if only generic advice on portion sizes was provided (e.g. a portion should be the size of a fist) or did not provide portion sizes for a range of foods that could be combined to make a meal. This was to enable quantifiable comparisons of portion sizes between the resources. Resources were included if aimed at preschool children (defined here as one-to-five-years) and excluded if aimed at children with disease or allergies. Inclusion was limited to resources published in the UK and Ireland to limit potential cultural differences in typical food consumption, which would make comparisons between resources difficult. Resources were excluded if they had directly duplicated information from another resource or website (e.g. a news article or blog site posting another organisations' information). There were no language or date restrictions.

3.3.4 Data extraction

Descriptive information for each of the included resources was extracted; name of resource, publisher (name of organisation), URL, funder, date of publication, the target country and audience, the age range of children, how the guidance were created and informed and whether portion size guidelines were for individual food/drinks or meals. All resources were checked for previous and updated editions and the most up-to-date resource was included in the review. All authors (or contacts from the organisations who published the resource) were contacted via email to provide more detailed information about how the resources were created and informed. Contacts were followed up by telephone or email up to three times if they didn't respond or if further information was required.

Portion sizes of all foods and drinks in each resource were extracted as well as their associated eating occasion (breakfast, main meal (lunch or dinner), snack, dessert, and none (i.e. general recommendation not specific to an eating occasion)). Snacks were defined according to the guidance resource and therefore could include both low and high energy density foods. The units used to present the portion sizes (e.g. grams, household measures) were also extracted. This data was used to summarise and compare portion sizes of individual foods/drinks and of eating occasions. Water was not extracted because not all resources provided this as an amount and therefore could not be compared across resources.

To aid comparability across resources, when portion sizes of foods/drinks were reported in household measures (e.g. spoons, cups, number of foods, slices), these were converted to grams or ml using the 'Food diary coding Exercise, Nutrition and Health Science (ENHS) DietPlan 6 manual' (Centre for ENHS, unpublished data, 2015), which was based on the 'Intermap UK' and 'ALSPAC' study food code books^{183,184} developed to aid coding of diet diaries in children and adults. When portion sizes couldn't be converted, these were coded as missing. Weights were rounded up to the nearest gram. Data extraction was conducted by the primary researcher (AP). The second reviewer independently extracted 10% of the data and this was compared between reviewers to minimise bias and inaccuracy. There was a 1.5% discrepancy between the two reviewers, which was resolved through discussion. Therefore, it was decided that no further duplicate data extraction was required. Data was stored in an Excel file.

3.3.5 Assessment of quality and risk of bias

A formal framework for assessing quality and risk of bias was not used, as one is not available for guidance resources. Various aspects such as publication date, publisher, funder and format of the resources were reported descriptively and information about the evidence and processes used to develop the resources were collected.

3.3.6 Analysis and reporting

A narrative review of the included resources is presented. Quantitative analyses were conducted to assess the number of food and drink items included and average portion sizes of food/drinks across food groups and meals across eating occasions. Two separate analyses were conducted; one for resources that recommended portion sizes for

individual food/drinks and one for resources that recommended portion sizes within meals, as these were distinct methods of presentation in the collated resources. Average portion sizes of meals across eating occasions were calculated to summarise the data and enable comparison between resources presenting with different formats, similar to previous research.⁵⁴

Graphical methods (histograms and Q-Q plots) were used to assess normality of the extracted data. Analyses were conducted in Stata 15. Results were presented as a median and interquartile range, owing to skewed distributions. To present a meaningful overview of the extracted data, food/drink items and portion sizes were analysed by broad food groups based on the Eatwell guide (dairy, fruit, vegetables, protein, starchy and foods high in fat and sugar).³⁰ Each food/drink item extracted was assigned a food group, in line with how it was grouped within the resource. Where food/drink items had not been assigned a food group within the resource, the National Diet and Nutrition Survey (NDNS) database¹⁸⁵, which uses the DINO dietary assessment system¹⁸⁶ was used to decide which food group to allocate to. Energy equivalents (in kcals) for each portion size were also calculated using the NDNS nutrient database¹⁸⁵ by assigning each extracted food/drink to a food code. This process was carried out independently by two authors (AP and CS) and any disagreements were resolved through discussion with a third author (LJ).

3.4 RESULTS

3.4.1 Search results

Figure 3.1 presents a study flow diagram, which was created by adapting the PRISMA 2009 Flowchart¹⁸⁰ and a previous grey literature review flow diagram.¹⁸² Figure 3.1 illustrates the number of results yielded from the four search strategies. Of the initial results obtained and screened from experts (n=30), Google (n=764) and Open Grey (n=26) searches, full-text assessment was conducted for 96 and 22 resources were included in the review. Resources were most frequently excluded at the full-text assessment stage due to not providing portion size information (n=38). For example, some resources only provided generic advice about feeding practices or types of food to feed preschool aged children, without providing portion sizes.

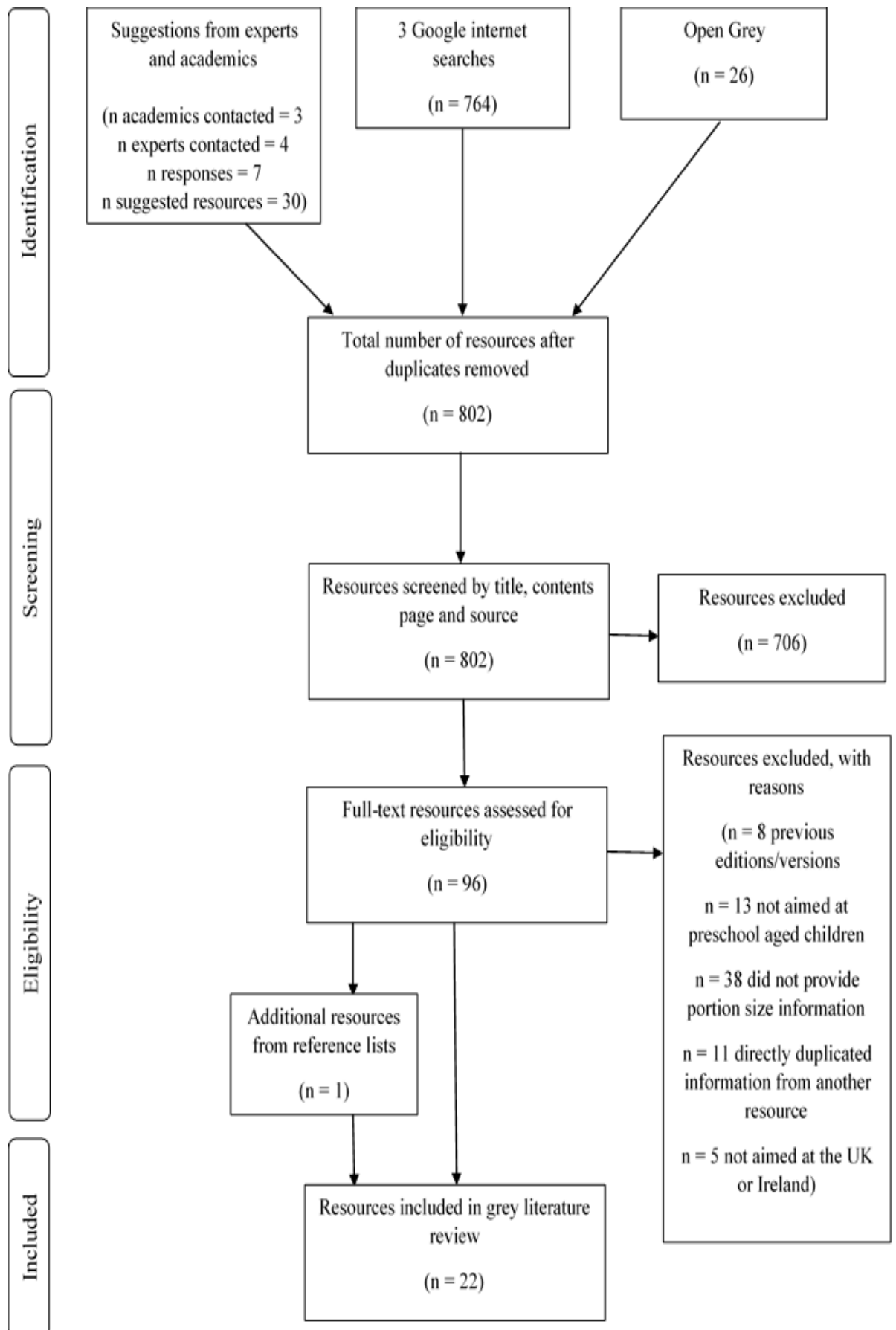
3.4.2 Descriptive information

Table 3.1 presents descriptive information about each of the 22 guidance resources. All resources were found online as a website page, document, or online leaflet. The oldest dated resource was published in 2004 by the Department of Health and Children in Ireland. Six resources were most recently published in 2018.

3.4.3 Who the guidance is aimed at

Table 3.1 presents information about who the guidance resources were aimed at. Ten resources (45%) were aimed at more than one target audience. Resources were most commonly aimed at childcare providers (13/22, 59%), which tended to present portion sizes within meals (9/13, 69%). Parents/carers were stated as the target audience in seven (31%) of the resources. However, only four (18%) were solely aimed at parents and these tended to present portion sizes of individual foods (3/4, 75%). One (5%) resource was aimed at preschool inspectors. For most resources, portion sizes were recommended for children aged one-to-four (12/22, 54%) or one-to-five (6/22, 27%) years. The Health Service Executive (HSE) resource presented a daily meal plan recommendation for a five-year-old boy. The Bradford Nutrition and Dietetics Service (NDS) presented separate portion sizes for one year, two-to-three-years and three-to-five-years. The Start4Life 'Recipes and meal ideas' website page specified that the portion sizes were recommended for children aged 12 months and older. Nine resources provided guidance for the UK (41%), six for England (27%), four for Ireland (18%), one for Northern Ireland (5%), one for Wales (5%) and one for Scotland (5%).

Figure 3.1. Study flow diagram



3.4.4 Presentation of portion size guidance

Table 3.1 reports how portion sizes were presented in each of the 22 guidance resources. Fifteen (68%) resources recommended portion sizes of individual food/drink items, all of which presented these within food groups, in line with the Eatwell Guide.³⁰ All resources included food/drinks from the starchy, protein, dairy and fruit and vegetables groups and five resources (33%) included foods high in fat and sugar. Eleven (50%) resources gave guidance for portion sizes of food/drinks within meals, 10 of which presented meals by eating occasion (breakfast, lunch, dinner, and snacks). The two IFT (Infant & Toddler Forum) resources presented breakfast, main meals and snacks and the Safefood resource presented 'composite meals'. Two of the First Steps Nutrition Trust (FSNT) resources were specific to only one eating occasion (snacks and packed lunches, respectively). One FSNT resource, included vegan meals only. Sixteen resources (73%) presented portion sizes as a mixture of weights and household measures (spoons, cups, number of foods (e.g. ½ apple), slices) and six (27%) presented portion sizes in weights (grams, ounces, millilitres) only.

Table 3.1. Descriptive information for the 22 included guidance resources

Publisher/Date	Type of organisation /funding	Country	Target audience	Age range (years)	Presented as portion sizes of individual food/drinks or meals		Presented as food groups or eating occasions					
							Food groups		Eating occasions			
					Individual food/drinks	Meals	St, FV, D, P	HFHS	B	L/D	S	
Action for Children (AfC)/2017	NGO	England	CP, HP	1-4	X	X	X	X	X	X	X	X
Bristol Early Years (BEY)/2018	GO	England	P	1-4	X		X					
British Nutrition Foundation (BNF)/2014	NGO*	Britain	P	1-3	X		X					
Bord Bia Irish Food Board (IFB)/2018	CO	Ireland	P	1-5	X		X					
Bradford Nutrition and Dietetics Service (NDS)/2013	CO	England	Not stated	1, 2-3 & 3-5	X		X	X				

Publisher/Date	Type of organisation /funding	Country	Target audience	Age range (years)	Presented as portion sizes of individual food/drinks or meals		Presented as food groups or eating occasions				
							Food groups		Eating occasions		
									Individual food/drinks	Meals	St, FV, D, P
Caroline Walker Trust (CWT)/2015	NGO	UK	CP, HP, Pa	1-4	X	X	X		X	X	X
Department of Health (DoH) East Midlands/2010	GO	England	CP	1-4	X		X				
Department of Health (DoH) Ireland/2004	GO	Ireland	CP, PI	1-5	X		X				
First Steps Nutrition Trist (FSNT)/2015	NGO	UK	CP, HP	1-4		X				X	
First Steps Nutrition Trist (FSNT)/2017	NGO	UK	CP, HP	1-4		X			X	X	X

Publisher/Date	Type of organisation /funding	Country	Target audience	Age range (years)	Presented as portion sizes of individual food/drinks or meals		Presented as food groups or eating occasions					
							Food groups		Eating occasions			
					Individual food/drinks	Meals	St, FV, D, P	HFHS	B	L/D	S	
First Steps Nutrition Trist (FSNT)/2018	NGO	UK	CP, HP	1-4		X						X
First Steps Nutrition Trist (FSNT)/2018	NGO	UK	CP, HP	1-4	X		X					
HSC Public Health (PH) Agency/2018	GO	Northern Ireland	CP	1-5	X		X					
Health Service Executive (HSE)/2016	GO	Ireland	General Public	5		X	X					
Infant & Toddler Forum (ITF)/2015	NGO*	UK	CP, HP	1-4	X	X	X	X	X	X	X	X
Infant & Toddler Forum (ITF)/2016	NGO*	UK	Pa, HP	1-4	X		X	X				

Publisher/Date	Type of organisation /funding	Country	Target audience	Age range (years)	Presented as portion sizes of individual food/drinks or meals		Presented as food groups or eating occasions				
							Food groups		Eating occasions		
					Individual food/drinks	Meals	St, FV, D, P	HFHS	B	L/D	S
Leicestershire Nutrition and Dietetics Service (NDS)/2017	CO	England	HP	1-5	X		X	X			
National Health Service (NHS) Health Scotland/2018	GO	Scotland	CP	1-5	X		X				
Public Health England (PHE)/2017	GO	England	CP	1-4		X			X	X	X
SafeFood/2013	GO	Ireland	CP, Pa	Not stated	X	X	X	X		X	

Publisher/Date	Type of organisation/funding	Country	Target audience	Age range (years)	Presented as portion sizes of individual food/drinks or meals		Presented as food groups or eating occasions				
							Food groups		Eating occasions		
					Individual food/drinks	Meals	St, FV, D, P	HFHS	B	L/D	S
Start4Life/unknown	GO	UK	Pa	12+ months		X			X	X	X
Welsh Government (Gov)/2018	GO	Wales	CP	1-4		X			X	X	X

Abbreviations: GO, government organisation; NGO, non-government organisation; CO-commercial organisation; CP, childcare providers; Pa, parents; HP, healthcare professionals; PM, preschool managers; PI, preschool inspectors; FPS, food/drink portion sizes; MPS, meal portion sizes; St, starchy foods; FV, fruit and vegetables; D, dairy; P, protein; HFHS, foods high in fat and sugar; B, breakfast; L/D, lunch/dinner/main meal; S, snacks.

*funded by an Educational grant from Danone Nutricia, Early Life Nutrition, however the resources remain independent of its commercial interests

3.4.5 How the guidance resources were informed

Information on how the portion size recommendations within each resource were informed was obtained to assess the evidence-base and quality of the resources (Table 3.2). This was requested from contacts for 17 (77%) of the resources, as the information was not supplied within the resources. This information was obtained from 16 contacts through two face-to-face meetings (one meeting with the author covered five resources), one phone call and nine email replies. One organisation did not respond. From the data collected, expert opinion was most commonly used (13/22, 59%) to inform the portion size information within the resources, with many drawing upon expertise from dietitians and nutritionists.

Government Dietary Reference Values (DRVs) were also commonly used (12/22, 55%) to inform the portion sizes. In nine of the 11 resources recommending meals, the DRVs for energy and nutrient requirements had been considered. For the Caroline Walker Trust (CWT), Public Health England (PHE), Welsh Government, Action for Children (AfC) and three FSNT resources, it was stated that portion sizes were based on meeting the requirements for those with the highest energy needs (three- to four-year-olds). In addition, the meals within these resources were aimed at childcare providers providing preschool aged children with 90% of their daily energy intake (20% breakfast, 10% morning snack, 30% lunch, 10% afternoon snack, 20% dinner). The ITF presented a range of portion sizes, with the lower range being suitable for a one-year-old and the higher range to a 4-year old and the HSE presented only portion sizes appropriate for a five-year-old. Eight resources (36%) stated that nutrient analysis was conducted on theoretical meals, to ensure nutrient requirements were being met across the meals each day for the whole age range.

Eight (36%) resources used portion size information from other existing resources. Appendix 3 presents a hierarchical model illustrating which resources informed others. Three resources integrated information from one or more existing resources as a starting point for their own guidance; (1) The British Nutrition Foundation (BNF) used portion size information from the ITF in combination with expert opinion, an expert working group and the DRVs; (2) PHE used existing meals from the FSNT and AfC resources as the basis for some of their menu planning; and (3) Safefood used portion sizes from DoH

Ireland and CWT along with meal pilot testing and an expert working group. Five resources used the exact portion sizes from other resources. For example, the Welsh Government used the same 3-week menu plans as PHE and Bradford NDS used a combination of portion sizes from the CWT, ITF and BNF resources.

Table 3.2. How the portion size recommendations were informed for each guidance resource

Publisher /Date	Review of academic evidence	DRVs	Existing guidance	Government guidelines or SACN	Survey data	Focus groups with consumers	Menu plans and/or nutrient analysis	Pilot testing of menus	Expert working group/ consultation	Expert opinion (D, N, CP, A)	No info available
AfC/2017		X			X	X	X	X	X	X (N, D, A, CP)	
BEY/2018			X (AfC)								
BNF/2014		X	X (ITF)						X	X (D, N, A)	
Bord Bia IFB/2019										X (N)	
Bradford NDS/2013			X (CWT, ITF, BNF)							X (D)	
CWT/2015		X					X	X	X	X (A, D)	
DoH East Midlands/2010			X (CWT)			X					

Publisher /Date	Review of academic evidence	DRVs	Existing guidance	Government guidelines or SACN	Survey data	Focus groups with consumers	Menu plans and/or nutrient analysis	Pilot testing of menus	Expert working group/ consultation	Expert opinion (D, N, CP, A)	No info available
DoH, Ireland/2004				X (Irish adult Food Pyramid)					X		
FSNT/2015		X				X	X			X (A, D, N)	
FSNT/2017		X				X	X			X (A, D, N)	
FSNT/2018		X				X	X			X (A, D, N)	
FSNT/2018		X				X	X			X (A, D, N)	
HSC PH Agency/2018				X						X (D)	

Publisher /Date	Review of academic evidence	DRVs	Existing guidance	Government guidelines or SACN	Survey data	Focus groups with consumers	Menu plans and/or nutrient analysis	Pilot testing of menus	Expert working group/ consultation	Expert opinion (Di, N, CP, A)	No info available
HSE/2016		X		X (Irish adult Food Pyramid)						X (N)	
ITF/2015	X	X								X (Di, N)	
ITF/2016	X	X								X (Di, N)	
Leicestershire NDS/2017			X (BNF, HENRY)*								
NHS Health Scotland/2018	X	X		X (SACN)			X		X		
PHE/2017		X	X (FSNT, CFT†/AfC)	X (SACN)		X	X		X		

Publisher /Date	Review of academic evidence	DRVs	Existing guidance	Government guidelines or SACN	Survey data	Focus groups with consumers	Menu plans and/or nutrient analysis	Pilot testing of menus	Expert working group/ consultation	Expert opinion (Di, N, CP, A)	No info available
SafeFood/2013			X (DoH Ireland, CWT)					X	X		
Start4Life/ Unknown											X
Welsh Government /2018			X (PHE)								

Abbreviations: D, dietician; N, nutritionist; CP, childcare provider staff; A, academic; SACN, Scientific Advisory Committee on Nutrition; CFT, Children's Food Trust

*The HENRY resource was not included in this review as it was not freely available to the public

†Children's Food Trust resource was later updated with the Action for Children resource

3.4.6 Quantitative data. Resources that recommend portions sizes for individual food/drinks

Across the 15 resources that presented portion sizes for individual food/drink items, a total of 197 unique items were included (food=190 (96%), drinks=7 (4%)). The only drinks included were milk and fruit juice. There was a large range in the number of items presented across resources; Bord Bia Irish Food Board (IFB) presented the lowest number of items (29) and FSNT presented the highest (111) (Appendix 4).

Table 3.3 presents the average portion size (grams/ml) and energy content (kcal) of a food/drink item within each food group, as well as the variability across resources (indicated by pooling inter-quartile ranges of each food group across resources). Overall, the dairy food group had the largest median portion size and energy content, regardless of whether food and drinks were analysed together and separately. While the recommended portion of dairy drinks was larger than foods, the energy content of a portion was the same owing to the lower energy density of liquids. Dairy also had the highest variability in food portion size (IQR=25-93g). However, the highest variability in energy content was observed for protein (IQR=44-106kcal). Median portion size (grams) was similar for fruits, vegetables, protein, and starchy food groups. The vegetables food group had the lowest average energy content for a recommended portion, despite having a similar weight in grams, as well as the lowest variability in portion size (IQR=30-40g) and energy content (IQR=5-15kcal). The foods high in fat and sugar had the smallest average portion size (grams) but had a similar energy content per portion to dairy, protein, and starchy groups. Although the variability in average portion size between resources for foods high in fat and sugar was only 17g (IQR=11-28g), this equated to a 52kcal variability in energy content (IQR=57-109kcal). Figure 3.2 presents the median portion sizes within each food group by resource (foods only). The figure shows that there was some variability in average portion size within resources for all food groups except for vegetables (shown by the error bars). The variability within resources was highest for dairy (57g) and lowest for vegetables (9g). When comparing individual resources, an 85g difference was observed between the resources that recommended the highest average dairy food portion size versus the lowest (ITF 2016 versus Bristol Early Years (BEY)) and a 55g difference for starchy food (Bord Bia IFB versus CWT). Average portion size

of fruit was much less variable between resources; however, one exception was the Bord Bia IFB resource, which recommended a much higher average portion size for fruit (125g (IQR=100-155)). The data shows that no specific resources consistently recommended higher portion sizes than others across food groups.

Table 3.3. Summary of the number of unique food and drink items, number of observations, average portion sizes and average energy content presented by food group for resources that present portion sizes for individual food/drinks

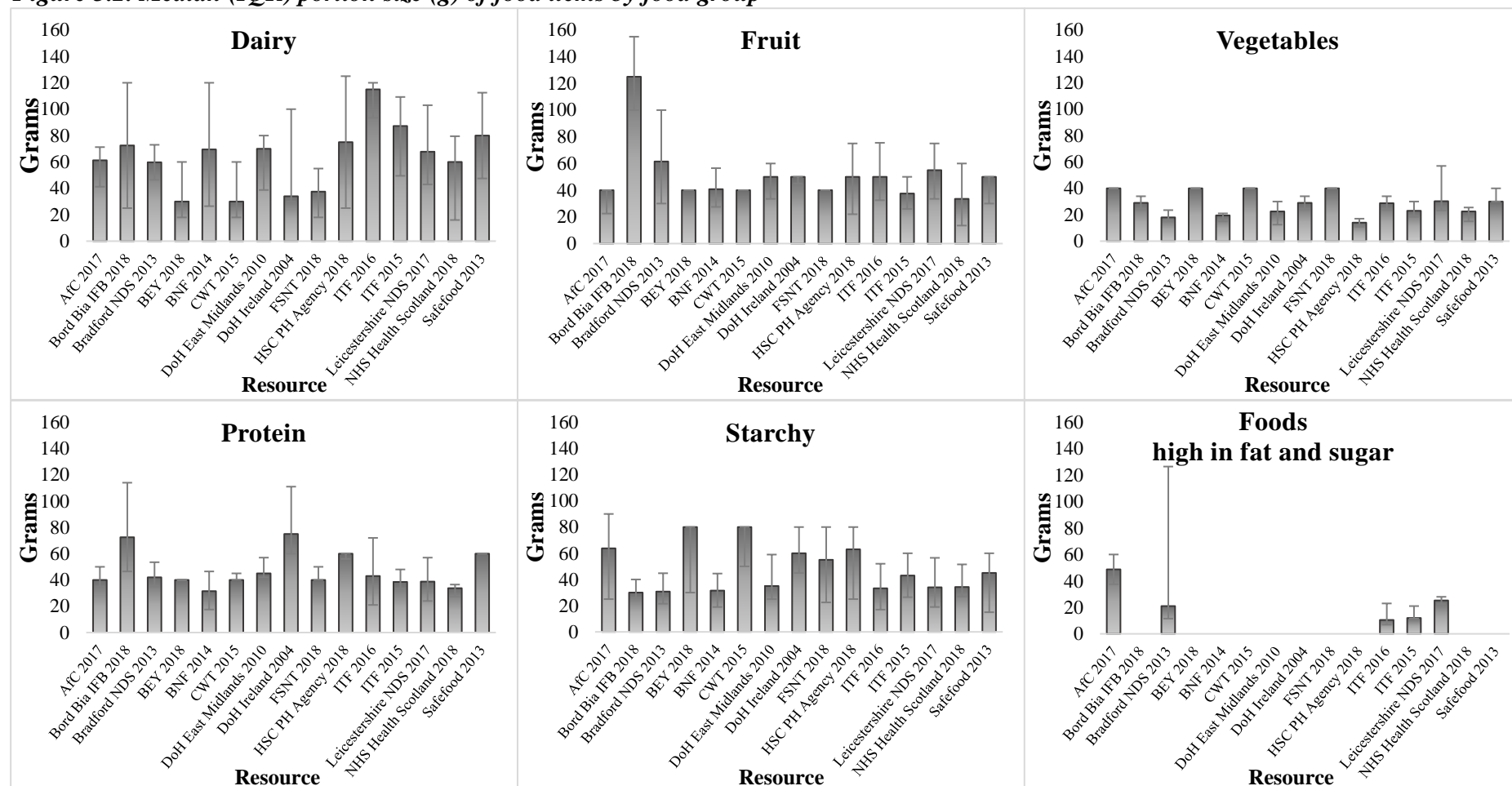
	Dairy	Fruit	Vegetables	Protein	Starchy	Foods high in fat and sugar
Median (IQR) number of unique food and drink items included within resources						
	5 (5-6)	15 (8-19)	12 (3-24)	10 (7-21)	11 (8-18)	4 (3-11)
N observations* (%)						
Food and drinks (g or ml)	84 (9)	195 (22)	179 (20)	186 (21)	190 (21)	30 (3)
Foods only (g)	66 (7)	186 (21)	179 (20)	186 (21)	190 (21)	29 (3)
Drinks only (ml)	18 (2)	9 (1)	-	-	-	1 (0.1)
Median (IQR) portion size (g or ml)						
Food and drinks (g or ml)	66 (31-118)	40 (40-57)	40 (26-40)	40 (39-57)	41 (25-80)	20 (11-28)
Foods only (g)	60 (25-93)	40 (40-50)	40 (30-40)	40 (39-57)	41 (25-80)	18 (11-28)

Median (IQR) portion size (ml)						
Drinks only (ml)	125 (110-125)	100 (100-113)	-	-	-	110 (110-110)
Median (IQR) energy content (kcal)†						
Food and drinks	74 (59-93)	21 (15-33)	9 (5-14)	72 (44-106)	71 (56-106)	69 (52-109)
Foods only	73 (59-93)	20 (15-32)	9 (5-14)	72 (44-106)	71 (56-106)	69 (57-109)
Drinks only	74 (34-84)	38 (38-43)				42 (42-42)

*N observations refers to the total number of observations in the raw dataset. Total N observations = 899.

†Calculated using energy values in NDNS database (not extracted from original guidance resources) and grams from guidance resources

Figure 3.2. Median (IQR) portion size (g) of food items by food group*



*Excludes drinks to aid comparability between resources in grams

3.4.7 Quantitative data. Resources that recommend portions sizes for food/drinks within meals

Across the 11 resources that presented portion sizes for food/drink items within meals, a total of 272 unique foods/drink items were included (food=269 (99%), drinks=3 (1%)). The only drinks included were milk and fruit juice. There was a large range in the number (and therefore variety) of foods included across the resources, from 10 (HSE) to 186 (PHE and Welsh Government) (Appendix 5).

Table 3.4 presents the average portion size and energy content of food/drinks within meals by food group. Compared with when guidance was given for individual food groups, we observed similar recommendations for food groups within meals for fruits, vegetables, and dairy groups. Whereas protein food portions were slightly larger and more variable (50g (IQR=45-94) vs. 40g (IQR=39-57)), starchy food portions were slightly smaller (30g vs. 41g) and portions of foods high in fat and sugar were larger (20g vs. 60g), although the energy content was within a similar range. Across the resources, starchy mixed dishes had the largest median portion size and energy content. Food/drink items in the fruit food group consistently had a median portion size of between 30 to 40g or ml across the resources, except for HSE, which had a higher portion size (100g or ml (IQR=50-150) (Appendix 6), which was partly driven by the inclusion of fruit juice. Similarly, food items in the vegetable food group consistently had a median portion size of 30 to 40g, except for HSE, which had a higher portion size (68g (IQR=68-68) and ITF, which had a lower portion size (19g (IQR=12-38) (Appendix 6). There was little variation in energy content for fruit (23kcal, IQR=20-38) and vegetables (28kcal, IQR=10-33) across resources. The interquartile ranges for the portion sizes and energy contents of mixed dishes (vegetable, protein or starchy) were relatively large (55g/97kcal, 66g/120kcal and 110g/195kcal, respectively), suggesting that resources do not consistently recommend similar sized portions for mixed dishes. The variability across resources for foods high in fat and sugar was 40g, which equated to 77kcal and variability between individual resources was large (Appendix 5).

Table 3.4. Summary of the number of unique food and drink items, number of observations, average portion sizes and average energy content presented by food group for resources that present portion sizes for food/drinks within meals

	Dairy	Fruit	Vegetables	Vegetable mixed dishes*	Protein	Protein mixed dishes†	Starchy	Starchy mixed dishes‡	Foods high in fat and sugar
Median (IQR) number of unique food and drink items included within resources									
	4 (3-7)	10 (5-20)	11 (6-19)	4 (1-15)	3 (2-6)	6 (1-13)	10 (8-24)	2 (2-4)	6 (4-18)
N observations§ (%)									
Food and drinks (g or ml)	71 (7)	196 (19)	158 (15)	118 (11)	50 (5)	119 (12)	169 (16)	30 (3)	111 (11)
Foods only (g)	54	191	158 (15)	118 (11)	50 (5)	119 (12)	169 (16)	30 (3)	111 (11)
Drinks only (ml)	17 (2)	5 (0.5)	-	-	-	-	-	-	-

Median (IQR) portion size (g or ml)									
Food and drinks (g or ml)	60 (20-100)	40 (36-40)	40 (30-40)	123 (90-145)	50 (45-95)	120 (90-156)	30 (20-53)	165 (80-190)	60 (35-75)
Foods only (g)	50 (18-60)	40 (30-40)	40 (30-40)	123 (90-145)	50 (45-95)	120 (90-156)	30 (20-53)	165 (80-190)	60 (35-75)
Drinks only (ml)	100 (100-100)	100 (100-100)	-	-	-	-	-	-	-
Median (IQR) energy content (kcal) 									
Food and drinks	62 (44-77)	20 (15-38)	10 (5-33)	98 (69-166)	85 (74-186)	165 (105-225)	76 (59-102)	210 (120-315)	78 (55-132)
Foods only	59 (44-80)	20 (15-38)	10 (5-33)	98 (69-166)	85 (74-186)	165 (105-225)	76 (59-102)	210 (120-315)	78 (55-132)
Drinks only	67 (67-67)	38 (38-38)							

*Includes vegetable, pulses and meat alternative mixed dishes,

†Includes meat, fish, and egg mixed dishes,

‡Includes cereal based mixed dishes (e.g. pasta, rice)

§N observations refers to the total number of observations in the raw dataset, not the number of unique foods. Total N observations = 1028.

|Calculated using energy values in NDNS database (not extracted from original guidance resources) and grams from guidance resources

Table 3.5 and Figure 3.3 present the median total portion size for each eating occasion by resource. Findings show that on average resources recommended lunch (with or without a dessert) as the largest eating occasion (250g plus 98g) and a snack as the smallest (150g). This was also true for energy content; lunch had the highest energy content (245kcal plus 124kcal, and snacks had the lowest (142kcal) (Table 3.6). The HSE resource recommended the largest median portion size and energy content for breakfast and main meals, but the smallest for snacks. The ITF recommended the smallest median portion size and energy content for breakfast, main meals, and dessert. Figure 3.3 demonstrates the variability between resources for breakfast, main meals and snacks and shows the portion size of a dessert tends to be more consistent across resources that include them. The largest difference was observed for the portion size of dinner; a 300g/344kcal difference between Start4Life (195g/175kcal) and HSE (475g/519kcal) (Table 3.5 and Table 3.6).

Table 3.5 shows that as a result of the variability in meal sizes between resources, variability in the average total daily grams and kilocalories of food and drink recommended was also observed. Based on all resources recommending breakfast, two main meals and two to three snacks (specified by resource), the ITF and Start4Life resources recommend much lower total daily amounts (587g/1002kcal and 727g/919kcal, respectively) than the other resources, in particular compared to the CWT and HSE resources (1354g/1293kcal and 1260g/1293kcal, respectively).

Figure 3.4 presents the median portion size of any given eating occasion by resource. The median portion size of an eating occasion across all resources was 235g (IQR=214-260). The energy content equivalent was 271kcal (IQR=238-292). Again, CWT and HSE recommended larger than average portion sizes for any given eating occasion (292g and 280g, respectively) and ITF and Start4Life recommended lower than average (90g and 169g, respectively). To compare to resources that recommended portion sizes for individual food/drinks, we combined the median portion sizes of one dairy, one fruit, one vegetable, one protein and one starchy food/drink item (in line with the Eatwell Guide³⁰) to calculate average portion size of an eating occasion. The median portion size of an eating occasion for resources that recommended portion sizes for individual food/drinks was 227g (IQR=161-352) and the energy content equivalent was 247kcal (IQR=179-

353). These were similar to resources that recommended portions sizes for food/drinks within meals.

Table 3.5. Average total meal sizes in grams by eating occasion and total energy content in kcal

Median (IQR) portion size (g or ml)											
Eating occasion	AfC 2017	CWT 2015	FSNT 2015	FSNT 2017	FSNT 2018	HSE 2016	ITF 2015	PHE 2017	Start4Life	Welsh Gov 2018	All
Breakfast	190 (174-194)	244 (194-255)	-	253 (235-263)	-	260 (260-260)	69 (37-117)	193 (165-205)	162 (119-178)	193 (165-205)	194 (165-219)
Main meal*	205 (175-215)	268 (223-290)	285 (260-350)	200 (185-260)	-	388 (388-388)	111 (106-119)	216 (193-230)	198 (198-211)	216 (193-230)	218 (193-248)
Dessert	80 (68-100)	100 (65-140)	-	80 (70-80)	-	-	58 (57-62)	81 (70-88)	-	81 (70-88)	80 (69-95)
Lunch	210 (200-240)	310 (290-320)	285 (260-350)	-	-	300 (300-300)	-	230 (220-255)	220 (206-223)	230 (220-255)	250 (220-285)
Dessert	100 (35-120)	100 (50-140)	-	-	-	-	-	95 (55-110)	-	95 (55-110)	98 (55-120)

Median (IQR) portion size (g or ml)											
Eating occasion	AfC 2017	CWT 2015	FSNT 2015	FSNT 2017	FSNT 2018	HSE 2016	ITF 2015	PHE 2017	Start4Life	Welsh Gov 2018	All
Dinner	190 (150-200)	240 (140-270)	-	-	-	475 (475-475)	-	183 (140-210)	175 (170-215)	183 (140-210)	185 (143-218)
Dessert	100 (40-100)	100 (70-120)	-	-	-	-	-	83 (40-100)	-	83 (40-100)	85 (40-100)
Snacks	80 (74-116)	180 (170-204)	-	180 (170-185)	100 (80-113)	75 (50-100)	90 (53-208)	155 (90-171)	85 (70-90)	155 (90-171)	150 (90-178)
Average eating occasion†	240 (163-295)	292 (228-358)	-	253 (217-267)	-	280 (214-344)	90 (80-130)	230 (184-281)	169 (143-186)	230 (184-281)	235 (214-260)

Total Grams‡	950 (747-1086)	1354 (1084-1513)	-	1173 (1085-1313)	-	1260 (1260-1260)	587 (469-895)	1094 (800-1195)	727 (635-796)	1094 (800-1195)	1094 (884-1195)
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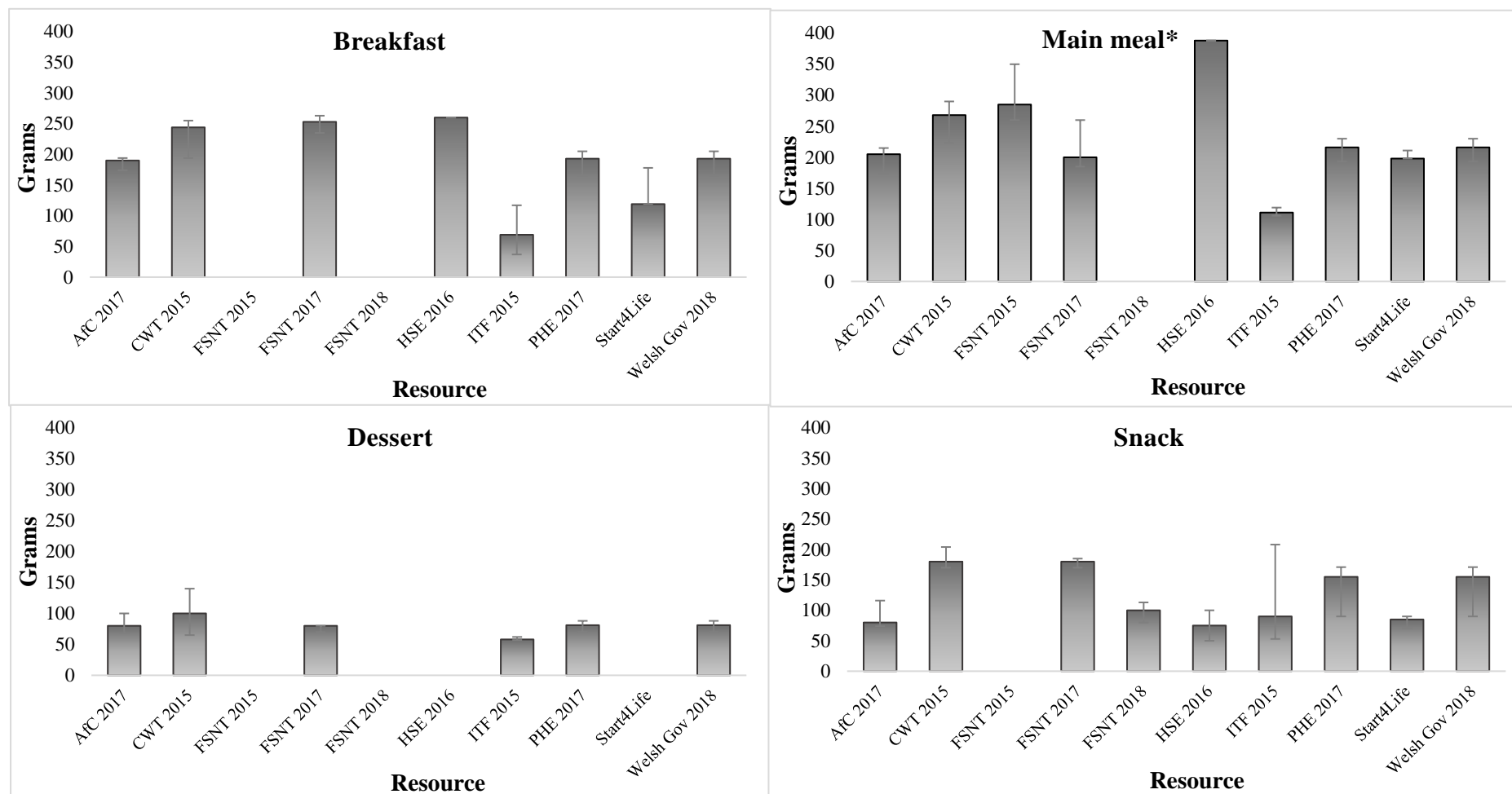
*Where resources present lunch and dinner, the average of the two meals were calculated and presented as 'Main meal' to aid comparability across resources

†Calculated as median of all eating occasions (either breakfast, main meal, snack or breakfast, lunch, dinner, snack)

‡Sum of breakfast, two main meals and two snacks, except for the HSE resource, which specified three snacks

§the percentage of total daily energy intake that the guidance resources aim to achieve are: AfC 90%; CWT 90%; FSNT 2017 90%, HSE 100%, ITF not stated, PHE 90%, Start4Life not stated, Welsh Gov 90%. Average daily energy requirements for one- to two-year-olds are 850kcal (girls) to 950kcal (boys) and for three- to four-year-olds 1250kcal (girls) to 1350kcal (boys)¹⁸⁷

Figure 3.3. Average total meal sizes by eating occasion



*Where resources present lunch and dinner, the average of the two meals were calculated and presented as 'Main meal' to aid comparability across resources

Table 3.6. Average energy content (kcal) of meals by eating occasions

Median (IQR) energy content (kcal)											
Eating occasion	AfC 2017	CWT 2015	FSNT 2015	FSNT 2017	FSNT 2018	HSE 2016	ITF 2015	PHE 2017	Start4Life	Welsh Gov 2018	All
Breakfast	247 (233-254)	227 (165-259)		250 (226-273)	-	362 (362-362)	113 (85-135)	263 (242-295)	192 (153-208)	263 (242-295)	249 (208-284)
Main meal*	297 (242-309)	254 (198-296)	333 (267-413)	224 (171-254)	-	421 (421-421)	127 (103-165)	239 (206-297)	245 (171-265)	239 (206-297)	242 (184-297)
Dessert	130 (72-131)	137 (98-151)	-	119 (109-159)	-	-	75 (65-171)	84 (67-130)	-	84 (67-130)	102 (69-135)
Lunch	249 (207-367)	269 (212-396)	333 (267-413)	-	-	323 (323-323)	-	221 (184-287)	297 (251-340)	221 (184-287)	245 (203-340)
Dessert	124 (82-237)	120 (79-173)	-	-	-	-	-	124 (67-183)	-	124 (67-183)	124 (67-181)

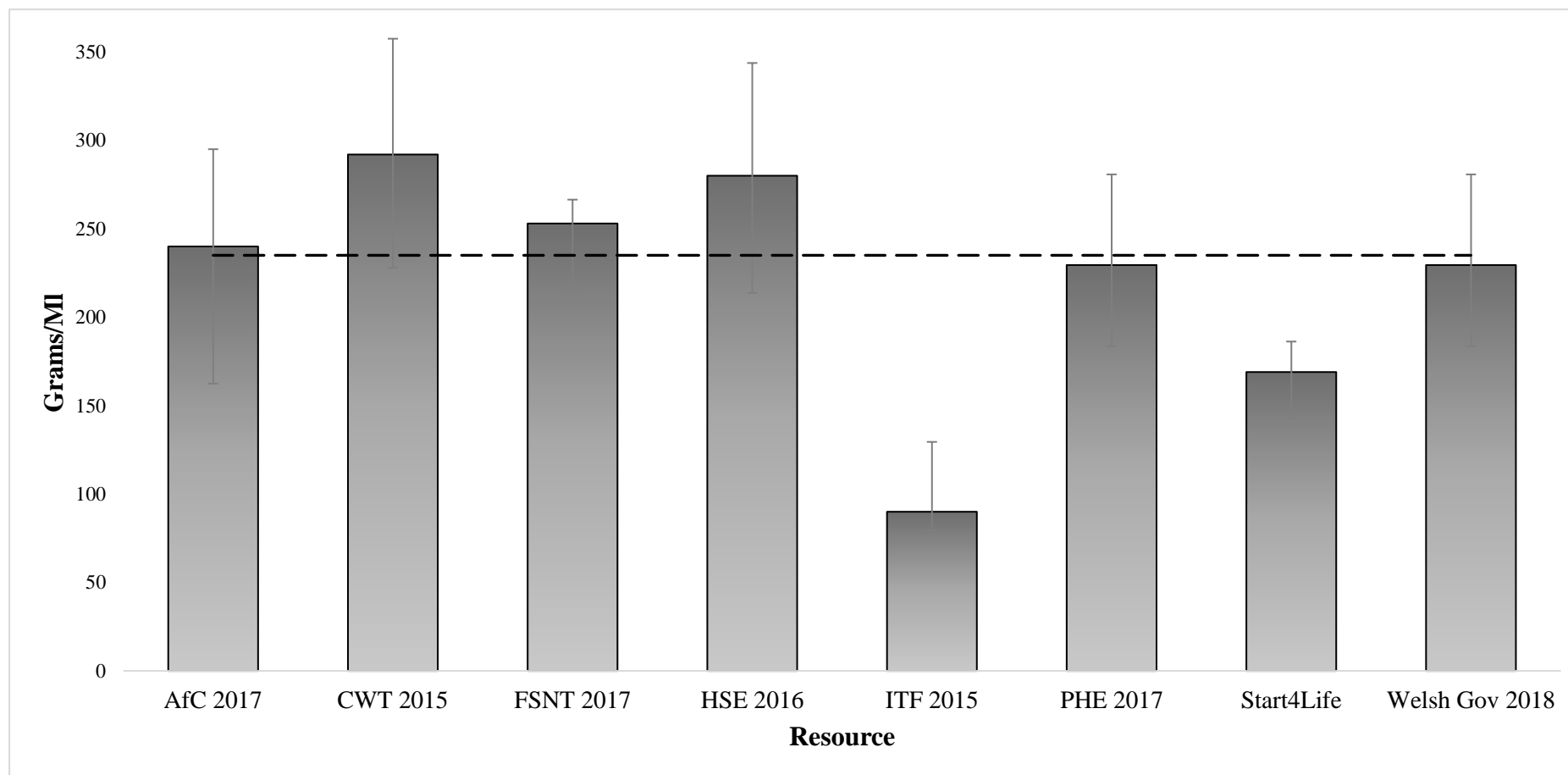
Median (IQR) energy content (kcal)											
Dinner	251 (234- 387)	201 (134- 265)	-	-	-	519 (519- 519)	-	253 (159- 342)	175 (135- 258)	253 (159- 342)	241 (157- 328)
Dessert	61 (22- 137)	98 (75- 167)	-	-	-	-	-	67 (22-92)	-	67 (22- 92)	67 (22- 100)
Snacks	120 (100- 142)	167 (144- 196)	-	154 (130- 193)	109 (91- 141)	39 (30- 47)	232 (120- 249)	150 (89- 181)	138 (131- 150)	150 (89- 181)	142 (99- 181)
Total energy content (kcal)†	1301 (1209- 1479)	1293 (1141- 1520)	-	1329 (1237- 1561)	-	1293 (1293- 1293)	1002 (942- 1139)	1258 (1119- 1476)	919 (804- 986)	1258 (1119- 1476)	1276 (1180- 1295)

*Where resources present lunch and dinner, the average of the two meals were calculated and presented as 'Main meal' to aid comparability across resources

†The percentage of total daily energy intake that the guidance resources aim to achieve are: AfC 90%; CWT 90%; FSNT 2017 90%, HSE 100%, ITF not stated, PHE 90%, Start4Life not stated, Welsh Gov 90%

Average daily energy requirements for one- to two-year-olds are 850kcal (girls) to 950kcal (boys) and for three- to four-year-olds 1250kcal (girls) to 1350kcal (boys)¹⁸⁷

Figure 3.4. Average portion size of an eating occasion by resource



Dotted line represents the average meal size of an eating occasion across all eight resources. Excludes FSNT 2015 and FSNT 2018 resources because they only present one type of eating occasion

3.5 DISCUSSION

This is the first systematic grey literature review to identify and collate the existing portion size guidance resources for feeding preschool aged children (one-to-five-years) in the UK and Ireland. The review aimed to describe the target audiences, how resources were informed and the consistency of the portion sizes between resources. Our results showed there are 22 resources available that target specific audiences (childcare providers, parents/carers, health professionals). Some similarities can be drawn between the resources, such as the focus on an age range (one-to-four or one-to-five-years) rather than a specific age and the use of food groups to present the recommended portion sizes of foods and drinks. However, several differences were also observed, such as how resources were informed, the recommended portion sizes and energy content of some food groups and eating occasions and whether portion sizes were presented as individual foods or as meals.

There are two main reasons why guidance on the feeding of children and portion size is important for this age group and therefore why reviewing the current guidance is paramount. The first being to ensure optimal growth and development (physical and cognitive) and avoid deficiencies. A healthy diet (which guidance resources often promote) can help to achieve this through providing sufficient energy and nutrients.¹⁸⁸ In addition, if a healthy diet is promoted at a young age, this is more likely to track into adolescence and adulthood.^{189,190} The second reason is to prevent excessive weight gain, which could lead to obesity^{6,191} and increased risk of comorbidities.¹⁹² A study by Syrad et al.,⁵⁴ found in a UK twin birth cohort, a small (10kcal) increase in meal size at 21 months was associated with a 4% faster growth rate above the average, demonstrating that increasing meal size was associated with more rapid weight gain.

Experiments show young children are susceptible to consuming more when served larger portion sizes.¹⁰¹ However, parents tend to be more concerned about feeding young children enough and a variety of food rather than too much.¹⁵⁶ Following appropriate portion size guidance for meals may be particularly important for parents because there is evidence that parents often decide how much to serve their child based on instinct, previous experience and how much they serve themselves.¹⁰⁷ The guidance we have

identified could form the basis for advice to caregivers to help maintain a healthy weight status in preschool aged children.

Twenty-one of the included resources recommended portion sizes for an age range (one-to-three, one-to-four or one-to-five-years). Of these, 13 resources presented one portion size for each food or drink item. While this portrays a simple message, it suggests to caregivers that the portion sizes do not vary with age (i.e. that a one-year-old needs as much energy as a five-year-old). In contrast, in order to meet the energy needs for healthy growth, daily energy intake should increase from 850/950kcal/day at age one-to-two-years to 1250/1350kcal/day at age four-to-five-years in girls and boys respectively.^{187,193} It may be more appropriate to recommend a portion size range (as eight resources did), emphasising that the lower end is more appropriate for younger children as this may help prevent unintentional over-feeding of younger children.

Portion sizes in the resources were presented as either individual food or drink items or as combinations of foods within meals. A meal-based approach tended to be aimed at childcare providers and included weekly menus. This may be more practical for childcare providers to use as they could replicate the weekly menus included in the guidance and serve the recommended portion sizes. Where resources were targeted at parents, individual food portion sizes tended to be presented rather than meals. This may be more practical for parents as they can flexibly construct a meal from a range of food items and learn the recommended portion size for each. However, using this type of guidance may be more difficult to implement when serving composite meals (e.g. lasagne) for a whole family. In addition, knowledge about how to combine different food groups to make appropriately sized and balanced meals is required when translating individual food-based guidance into practice, which may be a source of error in implementation for users of the guidance. Therefore, it is important for resources to also give guidance on how portion sizes of foods and drinks can be combined to serve appropriately sized meals to make guidance easier to translate into practice.

We showed that the portion size of an average eating occasion was similar for meal-based vs. individual food-based guidance, but the variability in total meal size was much wider for guidance given on individual foods (235g (IQR=214-260) and 227g (IQR=161-352), respectively). Both meal-based and food-based estimates for total meal size were similar to the median intake of food of an eating occasion in the NDNS at 232g (Appendix 7).

We did however observe variation between resources that provided meal-based guidance. The difference between the largest average main meal (388g/421kcal) and the smallest average main meal (169g/202kcal) was large (difference=219g/219kcal). We also observed similar variation in average total daily intake; the difference in grams between the resources that recommended the lowest and highest total daily intake was 767g (410kcal). Evidence suggests that a small daily positive energy balance of 70 to 160kcal above the total energy required for adequate growth could lead to gradual excessive weight gain in children.⁸⁸ The variation in recommended meal sizes across different resources could, if followed, lead to different energy intake and subsequent weight outcomes over time (assuming physical activity remains constant). Although, we estimate that all meal-based guidance resources recommended total daily energy contents (kcal) within the World Health Organization daily energy requirement recommendations for four- to five-year-olds¹⁹³, some resources would need to be used flexibly to not exceed the requirements for younger children.

We observed the greatest variability in portion size across resources in the dairy food group (IQR=68g), however this only equated to 34kcal. This may in theory influence the risk of obesity, as dairy foods tend to be calorie rich, however a recent systematic review suggests that dairy intake is not a determinant of obesity in children.¹⁹⁴ In contrast, variability in portion size within the protein food group was relatively small (IQR=18g), however this equated to a 62kcal variability across resources. This variability in energy content may be due to the inclusion of both animal and vegetable protein foods. As higher animal protein intake may be associated with later obesity risk in children¹⁹⁵, guidance may need to carefully consider appropriate portion sizes for animal versus vegetable protein sources. On the other hand, fruit and vegetable portion size recommendations and energy equivalents were much less variable (IQR=10g/17kcal and 10g/9kcal, respectively). Fruit and vegetable recommendations may be more consistent across resources because of the long-standing public health message that five portions (of 80g for adults) of fruit and vegetables should be consumed each day.¹⁹⁶ Guidance has tended to half this portion size for preschool aged children (median recommended portion size was 40g for both fruit and vegetables). However the UK five-a-day campaign states that a child's portion will vary with age and body size.¹⁹⁷ Therefore, the portion size guidance we identified may be over-simplifying this recommendation, which may need to be more age-specific.

The portion size and energy content variation we observed in some food groups between resources may partly be explained by the variety of recommended foods, as the same list of foods was not included in every resource. However, it may also suggest that recommended portion sizes of the same foods are not consistent across resources. This is in line with research conducted comparing recommended portion sizes for adults, from UK schemes, which also observed significant discrepancies for several foods in the starchy and protein food groups but consistency for fruit and vegetables.¹⁹⁸ A lack in consistency, which creates confusion, may be an important reason why some parents do not use existing guidance.¹⁵⁶

Only 11 of the 22 resources included guidance on foods high in fat and sugar. The World Health Organization recommends energy-dense, nutrient-poor foods should be avoided¹⁹⁹, therefore, the absence of guidance on foods high in fat and sugar is designed to discourage caregivers offering these foods at all. However, in an obesogenic environment with high availability of foods high in fat and sugar,²⁰⁰ which are frequent favourites of many children²⁰¹, guidance for caregivers on appropriate limits for foods high in fat and sugar could be beneficial. More & Emmett²⁰² created a daily food plan to meet the UK DRV's for one- to four-year-olds and estimated cake and biscuits/cookies could only be eaten once per day and confectionary, savoury snacks and sweet drinks once per week. Complete restriction of palatable energy-dense foods by parents has been associated with increased preference for these foods, increased eating in the absence of hunger and higher weight status in young children.²⁰³ In addition, our results suggested that a small variability in portion size of foods high in fat and sugar (IQR=17g), equated to a larger variability in energy content (IQR=52kcal), suggesting that a small increase in portion size has important implications for energy intake. Therefore, guidance recommending appropriate limits for the portion size and frequency of foods high in fat and sugar may help parents and caregivers strike a healthy balance.

According to the information we obtained, the resources were commonly informed by expert opinion, DRVs, nutrient analysis or existing resources, with 18 resources using more than one method. Studies have shown that one to four-year olds do not currently meet the recommended nutrient requirements in the UK²⁰⁴ and Ireland.²⁰⁵ However, the overall effect on weight of meeting multiple DRVs on health has not been explored in a longitudinal cohort study or trial. It is therefore unknown whether following DRV-based

portion size guidance would lead to optimal weight gain. Moreover, the Scientific Advisory Committee on Nutrition lowered DRVs for nutritional requirements in children up to 10 years in 2011²⁰⁶ and the limit on free sugar intake for children over two years in 2015.²⁰⁷ Resources published before 2015 may not meet current requirements, emphasising the need for regular updates.

3.5.1 Future research and policy implications

Previous research suggests parents are unaware of existing portion size guidance.⁴¹ This review can help identify suitable portion size guidance for different target audiences, as well as explore improvements to ensure resources support caregivers in translating advice into practice, to avoid excessive weight gain and nutritional insufficiency in children.

This review adds to the current Infant & Toddler campaign in the UK,²⁰⁸ in raising awareness of portion size guidance to support parents in serving appropriate portion sizes to their children. The extracted quantitative data could be used in future analyses to assess whether children adhere to recommendations, by comparing portion sizes within the resources with national survey data.

Raising awareness and developing portion size guidance may be particularly important in other countries, where ‘super-sizing’ of food and drinks is common, such as in the USA.²⁰⁹ Downsizing policies are required to help tackle the portion size effect and its consequences for childhood obesity in many countries²¹⁰ and evidence-based guidance is required to underpin successful interventions. The methods within this review could be replicated for other countries where childhood obesity rates are a concern, to assess guidance adequacy. Where more guidance is required, this review has identified UK resources that could be adapted to suit cultural norms around types of food and meal patterns in other settings.

3.5.2 Strengths and limitations

This is the first time that a review has systematically identified all available portion size guidance resources for preschool aged children in the UK and Ireland. The focus on grey literature allowed us to identify guidance resources potentially available to childcare providers, which would not have been identified in academic journals (typically unavailable to the general public) and the use of experts to identify possible resources

strengthened the search strategy. The use of the NDNS food coding system allowed comparison of resources in a systematic and consistent way. We did not report on the quality of each resource because there is currently no framework to assess the quality of portion size guidance. Our review highlights the need for a framework to be developed to ensure evidence-based and effective guidance is being created. The use of the food code book to convert weights from household measures to grams or ml and use of the NDNS database to calculate energy densities may have led to an under or over estimation of some portion sizes and energy densities but we do not believe this caused a systematic difference across foods or resources. The search strategy mainly focused on online resources and so we may have missed physical resources that are not published online. We aimed to ensure that all the most up-to-date resources were included at the time of searching but it is possible that new or updated resources have since been published.

3.5.3 Conclusions

This review identified 22 guidance resources that caregivers could follow to provide appropriate portion sizes for preschool children. Key variations in portion size guidance were observed that raise questions for future research: Should guidance be food-based or meal-based for certain target audiences? Should guidance be age-specific to ensure healthy weight gain? Should guidance include foods high in fat and sugar? What guidance format is most accessible for use by parents/carers? Our review provides the basis for improvements to ensure foods are combined to make appropriately sized meals for optimal growth and that guidance is appealing to users and easy to implement.

3.6 IMPLICATIONS FOR THE THESIS

The results of this chapter show there is an abundance of portion size guidance resources aimed at feeding preschool children, available online for free. However, resources differ in their presentation, format, content, and portion size recommendations. As there are a range of resources currently available to parents and childcare providers, rather than creating new guidance, it is more appropriate to conduct further research into whether the existing guidance is appropriate. A key research question arising from this study is whether the intended target audiences access and use the guidance resources. Chapter 4 was informed by the results of this study and explores parental awareness of and opinions on a selection of the identified portion size guidance resources.

CHAPTER 4. DO FIRST-TIME PARENTS OF ONE-TO TWO-YEAR-OLDS IN THE UK USE PORTION SIZE GUIDANCE? QUALITATIVE EXPLORATION OF PORTIONING PRACTICES AND AWARENESS OF PORTION SIZE GUIDANCE

4.1 OVERVIEW

This chapter presents the findings from a qualitative study interviewing first-time parents of one-to two-year-olds and aims to answer objective two of this thesis: ‘To understand the portioning practices used by first-time parents of one-to-two-year-olds and the influences affecting these practices. Informed by objective one, to explore first-time parents’ awareness of and opinions on existing portion size guidance resources.’ The findings of this chapter will provide an understanding of how first-time parents serve portions to their one- to two-year-olds and what influences their practices. Using six of the portion size guidance resources identified in CHAPTER 3, this chapter will provide understanding of parental awareness and use of portion size guidance. The final study objective and topic guide were informed by the findings from CHAPTER 3. The background, methods, results, discussion and implications for this thesis are presented below.

4.2 BACKGROUND

As previously stated in section 1.2, the prevalence of childhood obesity is at a concerning level^{1,3} and the need for early prevention is paramount. Early childhood is a critical period where there is rapid development in feeding from exclusive breast- or bottle-feeding for the first four to six months followed by a modified adult diet by the age of two years.^{211,212} During this time, parents have the greatest influence over their children’s food consumption with regard to whether, when, what, where, and how much their child eats.²¹² Parents influence the development of their children’s eating behaviours and preferences, firstly through gene inheritance²¹¹ and also the use of feeding styles and practices, which in turn can affect the growth and weight status of children.³⁵

Research suggests children under one year have the ability to self-regulate their appetite.^{34,94} However, from a young age, children's ability to respond to internal cues of hunger and fullness can be overridden by external cues⁹³, such as how they are fed by their parents.^{39,45} Feeding young children portion sizes that are consistently larger than age-appropriate can lead to increased energy intake during the mealtime and across several days.⁵⁴ In addition, prospective evidence suggests consuming larger portions can lead to excessive weight gain in preschool children.⁵⁴ It is therefore important to understand how parents make decisions about portions for their young children, to help ensure adequate but not excessive food and energy intake.

Previous studies^{41,140,153} exploring parental portioning practices report parents use their instinct and previous experience, to decide portion sizes for their children. Other portioning practices reported by parents include using child-specific dishware⁴¹ and being responsive to their child during mealtimes.^{41,165} Child appetite, child characteristics, adult portion sizes, time and proximity to the next meal were also reported to influence decisions on portion size.⁴¹

Previous studies have recruited parents with children aged two years and older, with many parents within the studies having more than one child.^{41,140,153} However, little is known about the portioning practices and influences of *first-time* parents of young children, who have less or no previous experience to rely on. In addition, several studies have explored parental feeding practices such as restriction, monitoring and pressure to eat in relation to eating behaviours in children²¹³ and weight outcomes¹⁴⁹ but little is known about how feeding practices influence portion sizes specifically.

Previous studies show parents have little knowledge of official recommendations on age-appropriate portion sizes.^{140,152,153,155,156,159,162} Mothers in one study reported confusion around portion size recommendations and suggested guidance was not accessible or well-advertised.¹⁴⁰ Parents of preschool children show interest in knowing the recommendations and welcome the use of guidance,^{140,152,168} whereas parents of school aged children do not want more guidance on parenting and feeding.¹⁵⁶ First-time parents often seek information about feeding,^{214,215} and may be a receptive audience to receiving and following portion size recommendations for their child.

My recent systematic grey literature review (CHAPTER 3) identified an abundance of online portion size guidance resources in the UK, mainly aimed at childcare providers but also a number aimed at parents.¹⁶⁹ The resources vary in their structure, length and inclusion of foods but provide portion size recommendations that could be followed by parents. However, there appears to be a translational gap between the development of these guidance resources and dissemination to the target audiences, which has not been explored in the research. It would be beneficial to know whether first-time parents of one- to two-year-olds in the UK are aware of existing guidance resources and if not, whether they would find them useful and be willing to follow the recommendations.

The objectives of this study were:

- 1) to understand the portioning practices of first-time parents of one- to two-year-olds;
- 2) to identify the influences on parental portion size decisions;
- 3) explore parents' awareness and opinions on six portion size guidance resources aimed at parents feeding one- to five-year-olds in the UK (Appendix 8), including specific aspects relating to the content and structure that vary between resources.

4.3 METHODS

4.3.1 Recruitment and participants

First-time parents of one- to two-year-olds (12 to 24 months) were recruited via a study advert posted in UK-wide parent and ethnic minority Facebook groups and online parent forums. The advert briefly described the study and inclusion criteria and gave contact details to take part. Participants could reside anywhere within the UK. First-time parents of children with chronic conditions or special feeding requirements were excluded. Participants ideally needed access to a computer, laptop, or tablet and the internet but phone interviews could be scheduled where access was not available. Those who expressed an interest in the study were sent an information sheet with detailed information about the study, their participation, and data handling. If they agreed to take part, a suitable time for the interview was arranged. Participants were sent a video about the interview process, the consent form, and instructions on how to download software and join the interview. Interviews took place between October 2020 and January 2021.

Ethical approval for this study was obtained from the Faculty of Health Sciences Research Ethics Committee, University of Bristol, UK.

4.3.2 Study procedure

Due to COVID-19 restrictions, face-to-face research was not permitted. One-to-one semi-structured interviews were conducted via Skype for Business (video conferencing software). The interviewer (AP) was available for technical support if required.

Interviews lasted between 40-90 minutes (mean = 58 minutes) and were audio-recorded using an encrypted device. Verbal consent was gained at the start of the interview (audio-recorded) and demographic questions asked at the end (not audio-recorded). Participants received a £20 shopping voucher as a thank-you. The Standards for Reporting Qualitative Research²¹⁶ were followed and presented in Appendix 9.

4.3.3 Study materials

Patient and public involvement (PPI) was sought from three groups of parents of preschool children prior to the study commencing, to help inform the topic guide (Appendix 10) and refine the study advert (Appendix 11), participant information sheet (Appendix 12) and consent form (Appendix 13). Parents were recruited through People in Health West of England (an initiative promoting effective public involvement). Suggestions made by PPI participants included changing the image used in the study advertisement to improve visual appeal, making the study incentive stand out, and numbering the guidance resources to make referencing them easier during interviews. The topic guide (Appendix 10) was also informed by previous literature.^{41,140,152,153} The first part of the topic guide focused on portioning practices and influences on portion size decisions among a novel sample of first-time parents of one- to two-year-olds. The second section of the topic guide asked questions about portion size guidance resources aimed at feeding one- to five-year-olds. This involved showing participants a PowerPoint presentation of six resources via the “share screen” function in Skype for Business (Figure 4.1). The six resources presented were those aimed at parents in the UK as identified in the grey literature review (CHAPTER 3). Table 4.1 presents the characteristics of each resource.

During the interview a set of slides were presented to the parent. The first slide showed the front covers of all six resources and parents were asked about their awareness of these existing resources (which were aimed at parents as the target audience). The remaining slides presented their content and were used to explore the opinions of the participant on different aspects of the resources (e.g. portion sizes presentation as individual foods or meals, length and structure, age-specificity, and inclusion of foods high in fat and sugar). Resources were numbered for ease during transcription and analysis.

Study information materials stated the interview would be about feeding children but did not mention portion size or guidance resources, to reduce social desirability bias (the tendency of participants to respond to questions in a way that will be viewed as favourable by the interviewer).⁶⁰ I listened back to each interview and completed a reflexive diary, to assess interviewing technique and revise the topic guide if new relevant topics emerged. Demographic questions were asked to describe the study sample. Participants had the opportunity to add other relevant information and ask questions. Participants were sent links to the resources after the interview if requested.

Figure 4.1. Images used to assist topic guide when discussing awareness of and opinions on six UK portion size guidance resources



Table 4.1. Characteristics of portion size guidance resources shown to parents

Resource number	Resource name	Organisation	Meals or individual foods	Age range	Includes foods high in fat and sugar
1	Eating well: Packed lunches for 1-4 year olds	First Steps Nutrition Trust	Meals	One portion size for 1-4-year-olds	No
2	Portion sizes for toddlers	Infant & Toddler Forum	Individual foods	A portion size range for 1-4-year-olds	Yes
3	Every Baby Matters	NHS Bradford	Individual foods	Separate portion sizes for 1 year olds, 2-3-year-olds and 3-5-year-olds	Yes
4	5532 a-day	British Nutrition Foundation	Individual food	A portion size range for 1-4-year-olds	No
5	Recipe and meal ideas	Start4Life	Meals	One portion size for 12 months+	No
6	Food Portion Book for 1-4 year olds	Bristol City Council	Individual foods	One portion for 1-4-year-olds	No

4.3.4 Qualitative data analysis

Interviews were transcribed verbatim by Bristol Transcription Services, and I anonymised transcripts. Initial coding was done on paper. Later coding and theme generation was conducted using NVivo 11. Reflexive thematic analysis²¹⁷ was conducted, which is a revised version of thematic analysis. The method is summarised in Appendix 14. Briefly, reflexive thematic analysis is a flexible and iterative process which involves familiarisation with the data, coding, generating initial themes, reviewing themes, defining and naming themes, and writing up. Data was analysed both inductively and deductively, using both semantic and latent coding. Initial coding was conducted independently by three researchers (AP, LT and RK). I (AP) initially coded four transcripts, whilst RK and LT each coded two different transcripts. Separate meetings between AP and LT and RK were scheduled to discuss initial codes. These meetings informed the development of the coding framework, which was then applied to the remaining transcripts by AP, using NVivo. The coding framework was frequently updated and discussed with the whole study team. Themes and sub-themes were then developed, discussed, reviewed, refined, and named. In line with reflexive thematic analysis, coding with more than one researcher was to provide additional expertise and alternative perspectives, rather than to find agreement on codes.

4.3.5 Reflexivity

I am White, female and in my late twenties, without children. Qualified to a Masters level and having worked in child diet and physical activity research for three years. Currently completing my PhD and a novice in conducting reflexive thematic analysis (having some previous experience using framework analysis). I presented myself to participants as a researcher at the University of Bristol with an interest in child diet and health. I did not state whether I had children or that I was doing a PhD, unless participants asked. The data was analysed more as a researcher (or outsider) perspective rather than an insider perspective.²¹⁸ Although most participants were female (an element of insiderness)²¹⁸ and I could show understanding of parenting, I am not a parent myself. I approached the analysis with a constructionist epistemology and experiential orientation.²¹⁹ Appendix 14 provides further description of my reflexivity.

4.4 RESULTS

Twenty-seven parents were recruited: 25 mothers and two fathers. Table 4.2 summarises participant demographics. The majority of parents were White (67%) and aged between 31 and 35 years (63%). Most parents had a first degree or higher (89%) and were married (70%). Fifty-two percent of parents heard about the study through a friend, 44% via Facebook and 4% via online parent forums. The mean age of the children was 18 months (range: 13-24 months).

The results are presented by study objectives. Section 4.4.1 addresses objective one – to understand the **portioning practices** of first-time parents of one- to two-year-olds. It focuses first on how parents decide what portion size to serve and goes on to discuss parental feeding practices used to encourage and control portions consumed.

Section 4.4.2 addresses the second objective of this study – to understand the **influences** on portion size decisions. This is presented as child-related influences, parental influences, and external influences.

Finally, section 4.4.3 addressed the third objective – exploring parents' **awareness** of existing portion size guidance resources aimed at feeding one- to five-year-olds and their **opinions** on the content, structure and accessibility of six resources.

4.4.1 Objective 1: Portion sizes served by parents and portion sizes consumed by one- to two-year-olds

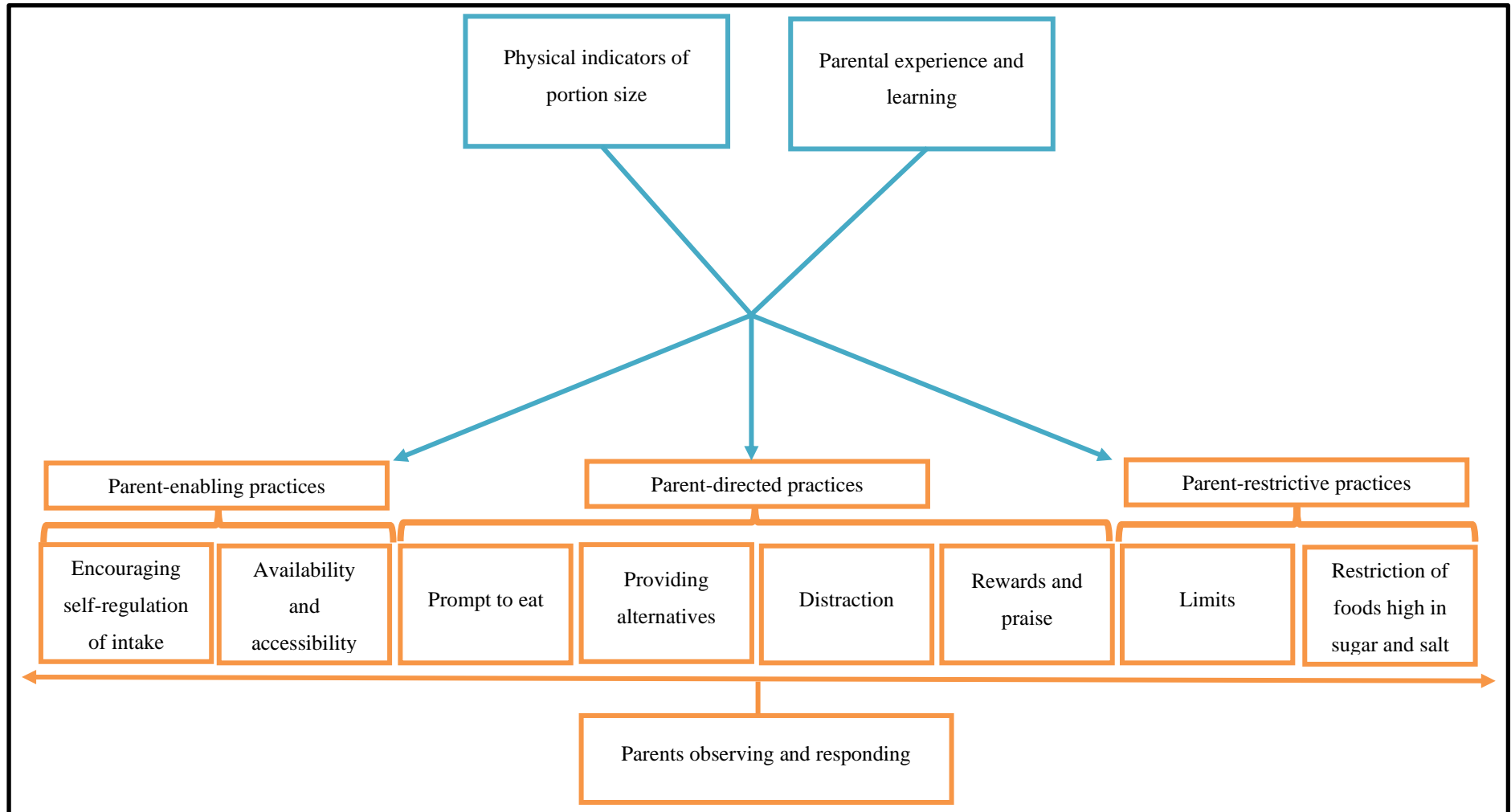
Here I describe two themes to explain the practices parents used to *serve* portions to their child (4.4.1.1) and practices parents use to encourage or control the portion their child *consumes* (4.4.1.2). The first theme (portion sizes *served*) includes two sub-themes: physical indicators of portion size, and parental experience and learning. The second theme (portion sizes *consumed*) describes practices on a spectrum including: parent-enabling practices, (encouraging self-regulation of intake, availability and accessibility); parent-directed practices (prompting to eat, providing alternatives, distracting, and offering rewards and praise); and parent-restrictive practices, (limiting and restricting foods high in sugar or salt). Underpinning this spectrum, is the fourth sub-theme of “parents observing and responding”. Figure 4.2 presents an illustration of these practices on the spectrum.

Table 4.2. Demographic characteristics of parents (N=27)

Sample Characteristics		N	%
Age	25-30	4	15
	31-35	17	63
	36-40	4	15
	41-45	1	4
Gender	Female	25	93
	Male	2	7
Ethnicity	White British	18	67
	Bangladeshi	4	15
	Pakistani	1	4
	Black Caribbean	1	4
	Chinese	1	4
	White Other	1	4
	Mixed	1	4
Region of UK	London	2	7
	East of England	2	7
	West Midlands	2	7
	Yorkshire and Humber	1	4
	North West	3	11
	South West	15	56
	South East	1	4
	Wales	1	4
Education	A levels/NVQ/GNVQ	3	11
	First degree or equivalent	18	67
	Higher degree or equivalent	6	22
Employment Status	Full time	10	37
	Part time	12	44
	Stay at home parent	3	11
	Unemployed	1	4
Marital status	Married	19	70
	Living with partner	7	26
	Single	1	4
How participants found out about study	Facebook	12	44
	Through a friend or relative	14	52
	Online parent forum	1	4
		Mean (SD)	Range
Age of child (months)		18 (3)	13-24

Abbreviations: NVQs, National Vocational Qualification; GNVQs, General National Vocational Qualification

Figure 4.2. Illustration of objective 1 (Portions served by parents (blue) and portions consumed by one- to two-year-olds (orange))



4.4.1.1 Portion sizes served by parents

4.4.1.1.1 Physical indicators

Parents used physical indicators to determine portion sizes. Parents were often guided by the size of children's dishware, believing the amount that fits in a child-specific bowl, plate or Tupperware was a child-appropriate portion size. Similarly with packaged foods specifically marketed for young children (such as *Organix*, *Ella's Kitchen* and *Kiddylicious*), parents served the whole packet because they felt this was an age-appropriate portion size. Plates and bowls were often used to serve meal portions in the home, whereas packaged food and Tupperware were often used for snacks and when on-the-go.

"I think because I've got his little kiddie bowl and the plate, I just put it in that and then I kind of know obviously if it's a bowl for a kid then I suppose that should be the right portion size." (Parent of 19-24-month-old/P08)

"If it's in a packet, I'll give him the whole packet, pretty much. I feel like it's packaged that way because it was manufactured to be, 'this is a portion', whether that be for a kid or an adult." (Parent of 12-18-month-old/P24)

Some parents used their own judgement alongside these physical indicators and did not always fill the plate or serve the whole packet. Parents suggested this was dependent on the food type. For example, a whole packet would not be served if the food was perceived to be unhealthy and similarly a full bowl of a single food was not served as perceived to be too much (a few parents mentioned yoghurt). A few parents suggested their child became overwhelmed when presented with a large, full plate of food. In this instance, parents served less on the plate to start, followed by a second serving.

"I suppose I've just got my idea about what [her] size portion would be for all different types of food. So, with yoghurt it would probably only be about half full." (Parent of 19-24-month-old/P02)

“Giving her a little bit to look at, think about, sort of process and then eat – that is the best way to do it rather than pile the whole portion in front of her... I think it’s just about, just not being overwhelmed by a big mass of food in front of her” (Parent of 12-18-month-old/P07)

A few parents used their own portion sizes to help determine the portion size for their child and whether to offer additional servings. A portion that was “*smaller than*” or “*less than half*” of their adult portion was deemed appropriate.

“With porridge, she has quite a big bowl in the morning... I won’t give her more because if she has any more, it’s bordering on an adult’s portion” (Parent of 19-24-month-old/P12)

4.4.1.1.2 Parental experience and learning

When first asked, many parents referred to using their “*instinct*” or just “*winging it*” when serving portions to their child. However, when parents expanded on this, they described learning over time from observing the amount their child ate (and wasted) on a meal-to-meal basis, and using this as a reference when serving portions at the next meal. Parents suggested they had gained confidence over time from past feeding experiences, which they now used to decide portions through “*eyeballing*” and guessing approximate amounts. This contrasted with experiences during weaning, where parents tended to measure foods more frequently. Although parents did not know the official portion size recommendations for one- to two-year-olds, parents now felt confident to serve their child appropriate portions across a range of meals and foods and to allow their child autonomy to dictate how much they ate (within limits – see section 4.4.1.2.3). A few parents felt using their instinct and experience was the best practice.

“I know how much he’ll eat from past meals ... I know roughly how much he’ll want, and I always make it a little bit more of everything just in case he wants a little bit more” (Parent of 12-18-month-old/P18)

“You listen to all the advice and then you realise that actually your own instincts are better.” (Parent of 19-24-month-old/P18)

4.4.1.2 Portion sizes *consumed* by one- to two-year-olds

In this section I discuss the practices parents use to encourage their child to eat (an acceptable amount of) the portion served and practices used to limit the consumption of portions perceived to be inappropriate for their child. These practices are presented as four sub-themes (parent-enabling, parent-directed, parent-restrictive, and parents observing and responding), with each practice sitting on a spectrum; at one end, allowing their child autonomy over how much is consumed through self-regulation of intake, to the other end, enforcing complete restriction of foods. Parents observing and responding runs along the spectrum and influences which practice is used (Figure 4.2).

4.4.1.2.1 *Parent-enabling practices*

Encouraging self-regulation of intake

Many parents believed how much their child ate should be led by the child's hunger and fullness rather than being a set portion size. These parents tried to support their child in self-regulating their own intake by allowing their child to eat as little or as much of the served portion as they wanted. When their child expressed hunger (verbally or non-verbally), parents responded by serving larger (or second) portions. When their child expressed they were no longer hungry, parents stopped serving more food or stopped encouraging them to eat because they felt it was important not to pressure their child to "*finish [their] plate*". Some parents also stated they avoided giving praise for finishing a meal (but see section 4.4.1.2.2). Several parents felt encouraging self-regulation was particularly important because they served larger portions than they would expect their child to eat to ensure their child would not go hungry. Encouraging self-regulation was frequently used during meals, (especially the evening meal) and sometimes for snacks. However, rarely used for 'unhealthy' foods (see section 4.4.1.2.3).

"We kind of let him guide us as well. Like I say, if he's still hungry we will offer him more. If he doesn't want to eat, we don't force him too. He will eat if he wants to eat." (Parent of 19-24-month-old/P13)

"I might give her too much and I know she'll never eat it, but I won't sit there and say, 'eat it all' because I'll know that she's got a big portion. I

probably give her bigger portions than I know she'll manage rather than giving her less" (Parent of 19-124-month-old/P12)

Parents picked up on certain verbal and non-verbal cues for hunger and being full and responded accordingly. Cues for hunger included crying, whinging, and screaming, saying “*more*” (verbal), and pointing (non-verbal). Cues for being full included saying “*no*” and “*finish*” (verbal), getting distracted, dropping food on the floor, boredom, and contentment (non-verbal).

“If he finishes his food and then he’s quiet and sitting there, I think you must be quite happy then so I’ll let him finish... if his little legs are going, I think he must be happy.” (Parent of 19-24-month-old/P08)

Availability and accessibility

The availability of and accessibility to food for one- to two-year-olds is controlled by their parents who purchase, prepare, and serve the food. However, several parents mentioned the foods they regularly bought and prepared were influenced by their child’s preferences. Parents sometimes specifically bought more of a food their child had enjoyed or requested. Including favoured foods in a meal ensured their child would eat (at least some of) the meal, especially when parents had concerns about their child not eating enough (generally or that day).

“I bought a punnet of blueberries Saturday and I’ve had to buy another two since... if he’s eating it, I’m just like, ‘Well he’s eating it. At least he’s eating something.’ I’d much rather him eat a load of fruit than nothing else.” (Parent of 12-18-month-old/P17)

Some parents described leaving left-over food accessible to their child after they had stopped eating to allow their child to go back and eat it later. This practice was used to ensure their child was fed throughout the day, especially if their child had eaten little of the meal. Several parents expressed they would not mind how much their child ate of certain healthy foods (often fruit and vegetables) because these provide nutrition, without ruining their appetite at mealtimes. Other parents explained that their child did not “*have free access to help [themselves] to anything*” because they wanted to control and set appropriate limits on portions (see section 4.4.1.2.3).

“I might just let him graze all day, because he seems to just enjoy picking at things as and when. For example... I’ve served him up a lunch and he’s not interested at the time, I’ll then just put his lunch on a chair and we’ll play in the same room... So he can just wander over, help himself, and then wander back away again.” (Parent of 12-18-month-old/P16)

“I don’t mind how much she has of that because you know, you can’t ever really get too full of fruit and veg.” (Parent of 19-24-month-old/P22)

4.4.1.2.2 Parent-directed practices

Prompt to eat

Some parents described encouraging and prompting their child to eat more of the served portion (usually of the main meal or vegetables) without forcing, to ensure their child was fed. This usually involved verbal encouragement, making food fun or repeated exposure.

“I do gentle persuasion by making him try again and then if by the third attempt, if he doesn’t want to then yes, I’ll take it away.” (Parent of 19–24-month-old/P27)

“Sometimes you have to encourage him to have a little bit more and so you do stupid things. Like at the minute he’s really into dinosaurs so you will say where’s that dinosaur and then he opens his mouth and then you just keep feeding him.” (Parent of 19-24-month-old/P04)

Providing alternatives

To encourage their child to eat more and ensure their child was fed, some parents provided an alternative meal if their child had eaten none or very little of their meal. For most parents, this only happened occasionally, often when left-over meals had been reheated and served but were no longer “appetising”. However, for one parent, providing alternative meals was a regular practice. Other parents were not willing to cook and serve alternative foods.

“So, it’s become like a norm these days. I need to try two/three things before she eats, so it’s wasting a lot of food to be honest, but that’s how

it's been for the last few days, so hopefully it's just like a phase.” (Parent of 19-24-month-old/P26)

*“If he doesn't eat what's put in front of him, he's going to go hungry.”
(Parent of 19-24-month-old/P09)*

Distraction

Some parents explained if they felt their child had not eaten enough of the served portion (usually at mealtimes), they would use distraction techniques such as letting the child watch TV, play with toys, or the parent reading a book to the child whilst the child was eating (or being fed). However, one parent thought watching TV whilst eating actually led their child to eat less because they were too distracted by the TV.

“Reading some books while eating. Sometimes switching on the television, YouTube, whatever it takes, to be honest, but we try to avoid switching on the TV or YouTube, that's the last resort, but she usually reads some books while eating so she forgets that she's eating.” (Parent of 19-24-month-old/P26)

“Sometimes I'm tempted to let her watch TV while eating breakfast. I don't think that's very good because it takes up so much of her attention, she forgets to actually eat.” (Parent of 19-24-month-old/P02)

Rewards and praise

A minority of parents used rewards and praise to encourage eating and their child was praised or rewarded after finishing their meal. Rewards included offering pudding after the main meal or non-food rewards such as being able to watch TV. A few of these parents suggested their child needed to eat at least some of their food before getting pudding.

“When she eats all her food, we're all happy... It's sort of like well done and she can go and watch her favourite show and maybe have a chocolate bar after, you know. So yes, she does know when she's done well” (Parent of 19-24-month-old/P22)

“If you say to him well there’s nothing else and he wants to have a pudding, he knows that he has to have some of his food first.” (Parent of 19-24-month-old/P04)

4.4.1.2.3 Parent-restrictive practices

Limits

Some parents had rules and limits to control the portions consumed by their child. These parents felt the portions served were enough and their child did not need any more. Limits were usually only applied to certain foods or at certain times. For example, portion size limits were often set for treats (often foods high in sugar or salt), where a small portion would be served and no more was allowed. Sharing snacks and treats (e.g. a packet of crisps) with their child was a practice a few parents used to limit the portion their child consumed. Some parents also limited portions of healthier foods, such as fruit and vegetables as snacks, when served close to a mealtime, believing this might ruin their appetite for a later meal. This was also the case for limiting milk between meals for some parents. Fewer parents limited the portions at mealtimes, though some suggested getting the balance of food groups in a meal was important. In these instances, parents tried to not allow their child to just eat one food or would refuse more of a certain food before their child ate some of the other foods on their plate too.

“I tend to eat them at the same time so I know she doesn’t have the whole bag, because I know she shouldn’t eat a whole bag of crisps.” (Parent of 12-18-month-old/P11).

“He really loves cucumber and hummus so I limit that after he’s eaten that bit... otherwise I don’t think he would eat his main meal because he would just snack constantly.” (Parent of 19-24-month-old/P04)

“Sometimes we try to remove milk as well a bit, cause she drinks, I think, more than she supposed to for her age group. Sometimes it reduces her hunger, so she doesn’t eat the solid food because she drinks too much.” (Parent of 19-24-month-old/P26)

Restriction of foods high in sugar or salt

All parents described restricting in some way their child's intake of foods high in sugar or salt, such as chocolate, sweets, juice, crisps, and cake. Noticeably they did not refer to restricting foods because of their fat content (although examples of restricted foods were often also high in fat). Many parents believed these foods were bad for their child's health and teeth and did not promote healthy eating habits. They therefore wanted to restrict these whilst their child was young and unable to access these foods themselves.

"I think for sugar it's just that he's going to be able to have sugar and so much of it when he's older and can make those decisions for himself and so I'd rather give him as much time as possible without any sugar in his diet... it's a health thing with the salt" (Parent of 12-18-month-old/P20)

"She'd probably want to eat a lot more crap than she does now. She'll be influenced by other children, what she sees on the telly... Probably next year, to be honest, it will start [and] well, I'm going to have to start explaining to her what a meal should look like, and that some food is treaty food." (Parent of 19-24-month-old/P06)

Parents described restricting foods high in sugar or salt to varying degrees, from complete restriction to allowing them occasionally, e.g. once per week or once per day. Some parents felt strongly about not serving these foods at this age because their child did not know they existed. Rather they wanted to promote the consumption of healthier foods (such as fruit). On the other hand, parents who served these foods as occasional treats expressed it would be difficult or unfair to completely restrict these foods, especially when their child was under the care of other people. For example, difficulty occurred with childcare providers or grandparents who provided these foods and also when parents themselves ate these foods in front of their child or when their child specifically requested these foods. Some parents suggested offering these foods occasionally could be part of a balanced diet and complete restriction may be counterproductive when their child was older.

"She loves fruit. That's why I don't think there's any need to give her a chocolate because she gets the sweetness and the taste through natural fruit." (Parent of 12-18-month-old/P01)

“She likes chocolate, and she asks for it now. My family are always buying her chocolate buttons and things, so we’ve always got loads in the cupboard. I do like to give it her as a treat.” (Parent of 19-24-month-old/P02)

A common practice used to restrict food was hiding it; either giving their child some of the restricted food and then hiding the rest away so their child thought the food was all gone or hiding completely restricted food so their child did not know it was available. One parent also described swapping out the restricted food for a healthier child-specific version without their child noticing.

“I won’t give her a whole chocolate bar, or a whole bag of milky buttons. I’d give her three or four with something else, or just three or four, then I’ll have to put the packet away, because she will just help herself, or point at them until I give her a few more.” (Parent of 12-18-month-old/P11)

“I will give him one crisp and then I will sneak his crisps in my packet. (Parent of 12-18-month-old/P17)

4.4.1.2.4 Parents observing and responding

Parents observing and responding to their child was a practice that underpinned the spectrum of practices in encouraging, or limiting consumed portions. Parents observed how much their child was eating and used different practices from the spectrum accordingly, which involved considering the type of food, as well as child, parental, and external factors (see section 4.4.2).

Parents described observing their child’s intake over the course of the day or several days, noticing how much they had consumed at each eating occasion. These observations then informed the portions served and practices used to limit portions or encourage eating more. For example, when parents observed their child eating less than usual at a meal, parents would often respond by serving a larger portion of a meal or snack at the next eating occasion, with the aim of compensating for the earlier lack of intake. This was particularly apparent during the evening meal when parents want their child well fed to ensure a good night’s sleep, without waking due to hunger. Here, parents observed whether their child had eaten their usual portion or still seemed hungry and responded by

offering additional food (such as pudding or seconds of the meal). Some parents used milk (bottle or breast) habitually before bedtime or occasionally before bed if their child ate less than usual, to ensure fullness and adequate intake of nutrients.

“I’m worried that if she doesn’t eat anything, she’ll be up in the night crying and hungry. So [at] dinner... if she won’t eat food, I’m like okay why don’t we try some yoghurt, let’s try some fruit, let’s try like the little fruit pouches. Which yes, I’m trying just to give her food and if she doesn’t eat it, that’s her choice.” (Parent of 12-18-month-old/P21)

“She does breastfeed quite a lot when I’m with her. So, because of that I’m not really worried about her not eating much at nursery.” (Parent of 19-24-month-old/P02)

Some parents expressed anxiety after observing their child had eaten less than usual (or not at all) during a meal. Others stated because their child consistently consumed large portions at breakfast, they tended to be less worried about their child not eating as much at later mealtimes. This linked to parents learning to look at their child’s intake over the course of the whole day or over several days. Parents *“stopped stressing so much if she doesn’t eat”* during one meal because their intake over *“the whole day should hopefully even out”*.

“It’s so different every day... if it was, say, three days in a row and he had not eaten very much, I would probably be really anxious about it. But if it’s like the odd day that he has really just not eaten very much at all, I try not to get too stressed about it” (Parent of 12-18-month-old/P19)

Parents observing and responding most frequently involved serving more food, however some parents observed that their child had eaten enough (at that meal or that day) and did not need to serve seconds. This was usually based on observing their child had not finished the served portion but seemed full, or because the finished served portion was perceived to be large enough to ensure fullness.

“I’ll get him a little bit more of a healthy snack out of the fridge. He likes sweetcorn for example, so I can just top him up with some bits of sweetcorn or just something little that he can pick up so it registers slowly

that his tummy might actually be full, he doesn't know it yet.” (Parent of 19-24-month-old/P08)

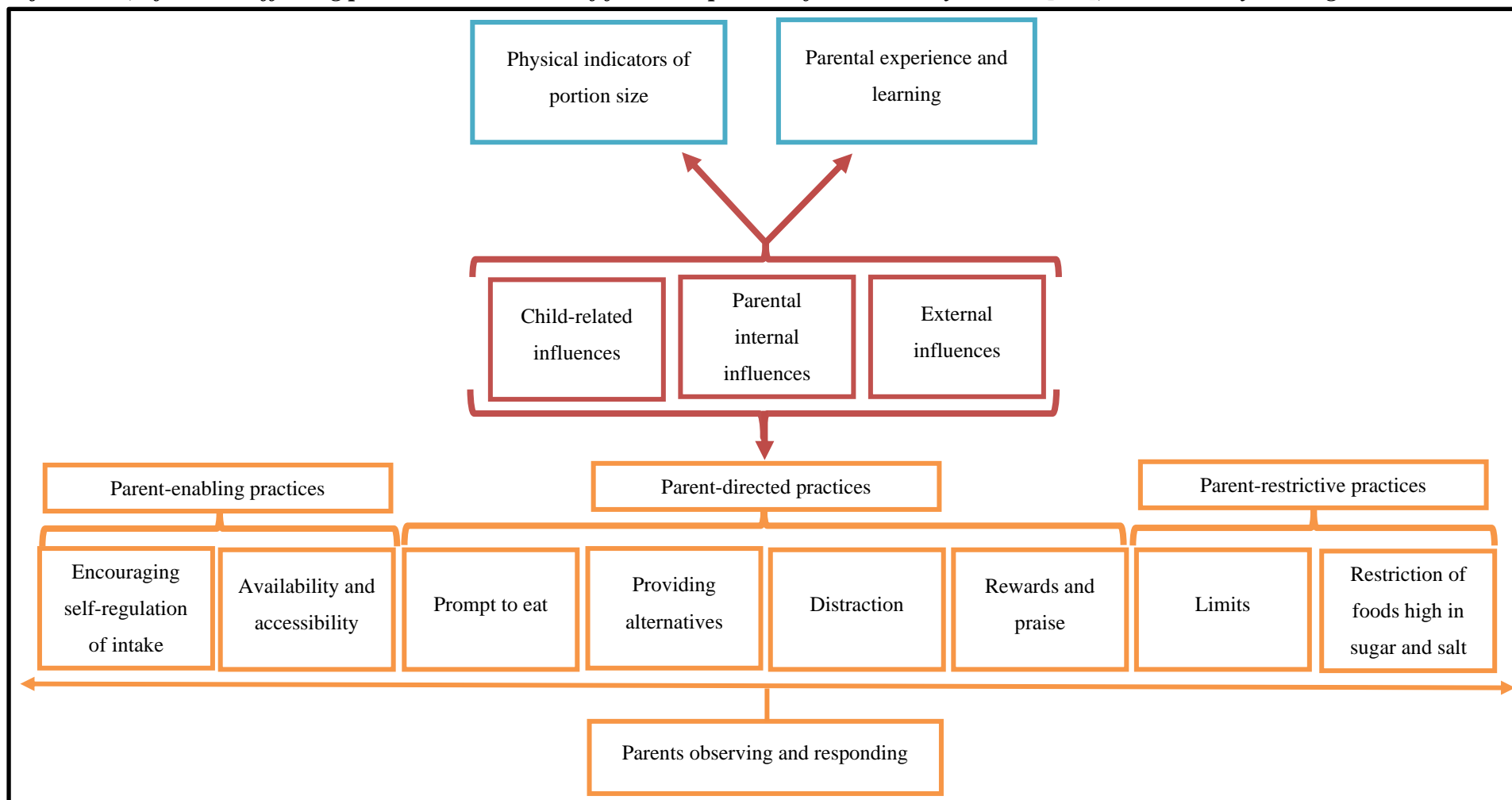
“So, I might give her some more fruit or something but I wouldn't keep feeding her if she's had a big portion.” (Parent of 19-24-month-old/P12)

To summarise, section 4.4.1 has addressed objective one of this study, which was to understand the portioning practices of first-time parents of one- to two-year-olds. I found parents used physical indicators, such as child-specific dishware and food packaging, as well as their own experience gained over time to serve portions. Once portions are served, parents use a spectrum of parent-enabling, parent-directed, and parent-restrictive practices to encourage eating or limit intake.

4.4.2 Objective 2: Influences affecting portion size decisions of first-time parents of one- to two-year-olds

In this section, I focus on objective two, which was to identify the influences on parental portion size decisions among first-time parents of one- to two-year-olds. The influences are presented as three sub-themes: child-related influences, such as child appetite; parental influences, such as parental concerns about child's portion sizes; and external influences, such as sources of external advice. The child-related influences are presented first as these appeared to have the greatest influence on parents' decisions regarding portions. Figure 4.3 illustrates the sub-themes' connection to the portions served by parents and the portions consumed by one- to two-year-olds themes.

Figure 4.3. Illustration of objective 1 (Portions served by parents [blue] and portions consumed by one- to two-year-olds [orange]) and objective 2 (Influences affecting portion size decisions of first-time parents of one- to two-year-olds [red]) and how they link together



4.4.2.1 Child-related influences affecting portion size decisions

4.4.2.1.1 Appetite

The most important child-related influence on the portions consumed by one- to two-year-olds was their appetite. Descriptions of children's appetite ranged between "great", "variable" and "poor". Some parents also described their child as a "good eater" and put this down to "luck". Compared to parents whose children were not reported to be 'good eaters', parents with 'good eaters' were less concerned about their child eating enough and less likely to need to use parent-directed practices to encourage eating. Parents of children with poor or variable appetites were conscious of not wanting to force their child to finish their food to allow self-regulation of intake but found this difficult at times because they were worried their child had not eaten enough. These parents were more concerned about getting their child to eat a good portion of something they liked than providing a balanced meal.

"He does have days when he completely refuses one meal, but I guess because he is a good eater, I don't really worry about it. If he doesn't want to eat something, that's fine, we'll just wait for the next meal."
(Parent of 12-18-month-old/P14)

"We're still trying to get him to eat... if he's really hungry he'll eat anything but if he's not he'll just throw it on the floor or just sit there kind of crying... I think I've gotten better at it now I'm very much like well if you don't eat you don't eat there's not much I can do about it but it is stressful, like the whole of yesterday he pretty much didn't eat anything."
(Parent of 19-24-month-old/P18)

Several parents linked their child's appetite to phasic factors such as growth, illness, teething and tiredness but could not always pinpoint which of these factors were affecting the portions consumed. Parents suggested their child's appetite, and therefore consumed portions, was reduced when their child was tired, ill, or teething and may be greater than usual when going through a growth spurt. One parent stated their child was eating much less of their meal than usual due to being ill so they had allowed their child more of the foods that were usually limited or restricted.

“If he didn’t have lunch and he didn’t have his dinner, then I would question it, think okay, there’s something wrong, he’s probably got a stomach-ache or he’s going to have a temperature or he’s teething, and I’ll try something else.” (Parent of 19-24-month-old/P27)

“Thinking about it, the last two weeks he’s just been eating non-stop, but before then there was definitely a bit of variation. So maybe at the moment he’s just quite hungry or having a bit of a growth spurt” (Parent of 12-18-month-old/P22)

4.4.2.1.2 Child appetite traits

Several parents associated how much their child ate to their child’s appetite traits. Some parents suggested their child didn’t eat all the served portion because they were “fussy”. Parents with a fussy child sometimes served foods they knew their child liked to ensure the whole portion would be consumed. Other parents with a child who “enjoys food” or would “eat anything” felt more confident their child would always consume the whole served portion. A few parents who struggled with their child’s food fussiness and food refusal at home mentioned their child ate much better in their childcare setting, which was reassuring but also frustrating for parents.

“She’s a bit of a fussy eater. We need to really push her to eat... It’s very strange... she came home from nursery, and she was saying that she wants pizza... and she’s really enjoying eating it, but after that, like I’d offer her [pizza] today, yesterday she wouldn’t eat at all.” (Parent of 19-24-month-old/P26)

Some children seemed to be responsive to the sight of food, regardless of being full (food responsive); these children were described as “greedy” or having “food envy” (wanting the food eaten by others). Parents with a food responsive child avoided eating different foods to their child at mealtimes and would not necessarily offer more food once their child had finished. These parents were also particularly careful to limit and hide foods high in sugar and salt. Other parents trusted their child would stop eating when full (satiety responsive). Parents who perceived their child to be satiety responsive encouraged self-regulation of intake and were less likely to limit the portions of meals

and snacks (although limits and restriction did often still apply to foods high in sugar or salt).

“If I didn’t stop giving him food to eat, if I gave him larger portions, he would just keep shovelling it in.” (Parent of 19-24-month-old/P08)

“I know that I give her too much, but I know that she will stop when she’s full. I know that she will never go past full and carry on.” (Parent of 12-18-month-old/P11)

“I’d say that I trust her to regulate her own, to decide for herself how much would be too much of something except when it’s cheesy oatcakes.” (Parent of 19-24-month-old/P02)

4.4.2.1.3 Size and activity level

Parents believed their child being “a good weight” or “not overweight” was a good indication the portion sizes they were serving and the amount their child was consuming was adequate for healthy growth. Parents judged their child’s size from their current weight (actual or perceived), birth weight or clothes size. Parents who thought their child was smaller than average sometimes felt their child should eat larger portions to promote growth. Parents did not associate large portions with gaining excessive weight.

“Because he is quite on the shorter side, so I want to bulk him up, so any sort of carbs, I’m happy to give him.” (Parent of 19-24-month-old/P27)

“He’s got a big belly on him, but he’s just little so I never worry about portion sizes with him really.” (Parent of 12-18-month-old/P15)

Some parents justified the portions served and consumed by their child in relation to how active their child was. Parents were not worried about portions being too large if their child was generally active or more active that day because they would be hungrier and need the extra calories.

“She’s very active so I just assume her appetite will grow and that’s why I add a little bit extra just in case” (Parent of 19-24-month-old/P24)

4.4.2.2 Parental influences affecting portion size decisions

4.4.2.2.1 Concern about child's diet

In general, parents were not overly concerned about their child's portion sizes. Instead, parents were more concerned about ensuring their child had a healthy balanced diet. Parents wanted their child to eat adequate portions of fruit, vegetables, carbohydrates, dairy, and protein throughout the day. Some parents described their own diet (and therefore the food they prepared, cooked, and served to the family) as healthy. Because the meals served to their child were healthy and balanced (described as "*protein, the carbs, mainly veg*" and "*some sort of dairy*"), parents did not worry about their child's portions, as there was value and nutrition in everything their child was eating.

"I've never really taken into account what an actual portion size should be, and I think that's because I'm feeding her what I would think of healthy food, so I think if she eats a whole bowl full of rice, that's not you know chips or McDonalds or chocolate. I wouldn't be too worried about it and obviously I always give her more vegetables than anything else and I think there's like value in everything she eats." (Parent of 12-18-month-old/P21)

Parents were concerned whether their child had eaten enough over the course of the day. A few parents felt internal pressure to get their child to eat, which resulted in mealtimes being "*stressful*" and "*hectic*". Parents suggested they were "*anxious*" or "*worried*" if their child consistently ate very little. They wanted their child fed well to ensure adequate growth and health and in these instances it led to parents using practices to encourage eating. Parents with 'good eaters' appreciated they did not need to worry about this. A few of these parents thought their child might be eating too much but did not seem overly concerned by this. Parents suggested they had become more relaxed and less concerned about how much their child consumed after their child had finished weaning because their child was then eating more, and meal and snack times had become more structured. Parents deemed their child's general happiness to be more important than how much they were eating.

"I've always been more concerned about her not eating enough than too much." (Parent of 12-18-month-old/P11)

“I don’t have any concerns at the moment, other than potentially her eating too much and when that needs to get reined in” (Parent of 12-18-month-old/P05)

“I just give him whatever he wants. As long as he’s healthy and happy, that’s all that matters to me.” (Parent of 12-18-month-old/P17)

4.4.2.2.2 Parents’ own diet

Many parents referred to their own diets and eating habits when discussing their child’s. Some parents thought the portion sizes their child ate related to the portion sizes they ate. For example, a few parents described themselves or their partners (other parent) as a “grazer” (eating smaller portions more frequently) and thought their child ate similarly, which sometimes made judging portion sizes more difficult. One parent justified their child eating large portions because they and their partner were both “greedy” and so their child had been “born this way”. A few parents admitted they or their partner might be “fussy” or an “overeater” but hoped this would not “rub off” on their child.

“She is a bit of a grazer, but her dad’s the same... I eat quite good portions, because I only eat three meals, whereas she kind of nibbles in between, so I probably put too much on her plate.” (Parent of 19-24-month-old/P11)

Several parents talked about their own eating during childhood and how their parents had fed them in relation to the practices they now used to feed their child, in particular the use of restriction. A few parents described themselves as an “emotional eater” and ate ‘unhealthy’ foods as a comfort. Often, they related this to unhealthy foods being completely restricted when they were a child or because food was used to “celebrate and commiserate” feelings. Another parent described having “free reign” over unhealthy foods when younger, which had had a negative impact on their own eating habits as an adult. As a result of this, parents had different views on restriction and had chosen to restrict foods high in sugar or salt in different ways, so their child did not develop the same unhealthy eating habits as them. When parents acknowledged their own ‘bad’ eating habits, they wanted to use practices to ensure their child did not develop those same habits.

“My parents really restricted me when I was younger and I would say my relationship around chocolate, I’m very much a comfort eater and a stress eater, but I’m conscious that I don’t want her to be like that. I don’t want to limit massively what she’s eating because, for me, it was always restricted and never allowed so then I’d be almost like a secret eater growing up and I don’t want that for her.” (Parent of 19-24-month-old/P06)

“I feel like I am an emotional eater... I wanted him to eat most things, but I also didn’t want that kind of emotional eating, so I’ve been really conscious of not giving him any processed foods, so he hasn’t had anything.” (Parent of 19-24-month-old)

A few parents described themselves as “food-focused” and “foodies”, which they described as enjoying food and having a good relationship with food (associating food as “part of a routine” and not with “diet mentality” or “emotional eating”). These parents wanted the same for their child. They seemed particularly confident in using their own instinct and experience to decide portion sizes and trusted their child to self-regulate their own intake.

“A focal point of our lives is how much we eat and where we eat and what we eat in a good healthy way... In terms of weighing things out and having that sort of stuff, I’m not a huge fan of that just because of diet mentality which I try and avoid as much of as possible and that kind of limiting mentality.” (Parent of 12-18-month-old/P03)

“I am a foodie, and I am food focussed... I very much like trust that babies know, to some degree, how to survive in the world and you know that’s my sort of parenting technique, is that she knows what she needs, and we’ve just got to provide that. So that’s what we just tend to do.” (Parents of 12-18-month-old)

4.4.2.2.3 Concern about food waste

Some parents were concerned about food waste and modified the amount served to their child to minimise waste. In contrast, certain foods such as pasta were served in larger

portions as parents felt there was unlikely to be waste. Parents appeared to have learnt appropriate portions for a range of foods over time by observing the amount their child wasted, either by leaving it, tipping it, or throwing it on the floor.

“It’s just about risk of waste. Then there’s certain things where it’s quite low risk like with say pasta or rice... we think she’s going to eat it definitely then we’ll fill her bowl with it.” (Parent of 19-24-month-old/P02)

“I’m trying not to stress about the fact that he’s wasting food, or he’s not going to eat something because he will eat if he’s hungry. Yes. But it’s easier said than done when you’ve scraped every meal off the floor that day.” (Parent of 12-18-month-old/P19)

4.4.2.3 External influences affecting portion size decisions

External influences were people who influenced parental portioning practices or places where parents had less or no control over the portions served (e.g. restaurants and childcare). Though parents discussed many external influences when talking about weaning and feeding in general, I have restricted my analysis here to only those external influences which relate to child portion sizes.

4.4.2.3.1 Friends and family

Friends who were also parents were a key source of advice for first-time parents because they could share experiences. Many parents discussed their child’s eating habits, and sometimes portion sizes with friends (in-person and via WhatsApp). A couple of parents followed the practice of observing their child’s consumption over the whole day rather than just one meal because a friend had given that advice. Discussing how much their child ate with friends provided a form of comparison and (potential) reassurance. Parents were reassured if their child was eating a similar amount to other children, and/or if other parents were going through the same struggles. However, sometimes comparison caused anxiety if their child was not eating as much as other children. Some parents felt conflicted about comparing their child to others because parents felt that *“every child is different”*.

“Nearly all of us, at least once a week, will have a ‘why won’t they eat? Ahhh!’ We’re always all panicking about it.” (Parent of 12-18-month-old/P19)

“I know it’s not good to compare but you just get an idea of how much they eat and so you think, okay she’s doing alright.” (Parent of 19-24-month-old/P22)

Some parents noted that feeding was discussed less after the breastfeeding and weaning stages, especially with family. For most parents, portions were not discussed with family. However, some parents suggested grandparents were a negative influence because of what (rather than how much) they offered. Grandparents tended to offer restricted foods (e.g. foods high in sugar) when in their care and although parents usually allowed this to happen, they felt the need to compensate for this at home.

“You talk so much about how their kind of feeding’s going when they’re breastfeeding that you don’t really talk about it when they start eating solids in the same way.” (Parent of 12-18-month-old/P20)

“If his grandmother gives him ice cream, he can have ice cream but 90 per cent of the time he’s with us so... once in a while is fine.” (Parent of 19-24-month-old/P13)

Some parents mentioned their culture could negatively influence how much they served their child because their culture valued over-feeding. These parents tried not to follow these practices and avoided advice from older family members. In contrast, a few parents from an Asian background mentioned their family was a good influence. One parent of a 19-24-month-old said, *“I found my family and people around me much more helpful than maybe somebody from the health care sector” (P22)*. One parent mentioned their partner (child’s father) had said they were serving their child portions that were too large and shouldn’t be forcing their child to eat, which was then taken on board.

“People will push the children so much, to eat, they will shove down food to the child’s throat if they can. It’s a very pushy culture in terms of feeding and the elderly people they all like judge your level of your parenthood, based on how healthy your child is and that sort of thing... To

some of them, heavy is a sign of good healthy and stuff, so, social media is full of friends and family from [Asian country], so I try not to follow that or use their influence.” (Parent of 19-24-month-old/P26)

4.4.2.3.2 Location

Where a child ate, such as at restaurants and childcare facilities sometimes influenced the portions served and consumed. Some parents had eaten at restaurants with their child, although the opportunity to do this had been limited due to the COVID-19 pandemic: only half the sample discussed eating out with their child. When eating out, some parents brought pre-portioned food from home or allowed their child to have a small portion of their meal because they didn’t think their child would manage a whole portion. However, some parents did order a separate child’s meal. These parents described these as “*huge*” but still felt appropriate for their child. They were allowed to eat as much as they wanted of these meals because it was a “*kids portion*” or a “*treat*”.

Several parents sent their child to nursery or a childminder for part of the week. These parents liked to know how much their child had eaten at childcare to ensure they had eaten enough and to know whether their child needed more food at home. Because childcare usually served larger portions at lunchtime and smaller portions of “*snacky*” food at dinnertime, some parents worried about their child getting hungry in the evening and so served additional food. Parents said that childcare would communicate (via apps, paper slips or in-person) whether their child had eaten “*none, some, most or all*” of their meals. However, the actual portion sizes were rarely known. Only one parent mentioned knowing the portion sizes served by their childminder. Several parents said their child would have seconds at nursery and often had a second breakfast after having breakfast at home. However, this was not a concern for parents; parents assumed if their child was eating seconds, the portions served at nursery were probably smaller than those served at home.

“They would let me know if he’d had double portions or whatever, ‘oh he had two lots of breakfast today’, ‘yeah, standard’. I’m not surprised, obviously I don’t see him eat at nursery, so I don’t know what their portion sizes look like.” (Parent of 19-24-month-old/P12)

“They obviously swap the meal times round and that they eat their big meal at lunch and they do a snacky meal in the afternoon which isn’t what we do at home so I’m always a bit aware of him maybe being hungry when he gets home because he will have only had maybe a sandwich or something smaller and then it might be offering him, again, a breadstick, rice cake, sort of, snack.” (Parent of 12-18-month-old/P10)

To summarise, section 4.4.2 addressed objective two of this study, which was to identify the influences affecting portion size decisions of first-time parents of one- to two-year-olds. I identified three key influences: child, parent, and external. Child-related influences included child appetite, which appeared to be the most important influence, as well as child size and activity level. Parental related influences included concerns about providing a balanced diet and avoiding food waste, and parent’s own dietary habits. External related influences included friends with children as they were a key source of feeding advice and comparison, restaurants as portion sizes were perceived to be large and childcare as portion sizes were often unknown to parents.

4.4.3 Objective 3: Portion size guidance

In this section, I address objective three of the study, which was to explore parent’s awareness of, and the acceptability of six portion size guidance resources aimed at parents feeding one- to five-year-olds in the UK. This included discussing the content of the resources and specific aspects that varied between the resources, such as whether individual foods or whole meals were presented, the length and format of the resources, how portion sizes are recommended by age, and whether the resources include portion size recommendations for foods high in fat and sugar. Figure 4.1 presents screenshots of each guidance resource and Table 4.1 presents a description of each guidance resource in relation to the questions asked during interviews.

4.4.3.1 Awareness of existing portion size guidance

Only four of the 27 parents could name or had used any portion-size guidance resources. Three of these parents had found this guidance useful, however one parent said, *“I’ve read it, but I didn’t really tend to take much notice of it” (P21)*. Other resources were mentioned as sources of general child feeding advice, but these had tended to be used during the weaning stage, to get information about what a baby can and cannot eat, rather

than resources they now used for feeding their one- to two-year-olds. Resources mentioned included “the NHS website”, “Ella’s kitchen website”, “nutritional weaning guide” by the “Nutritional Society or maybe NHS Trust”, “Start4Life”, “Change4Life” and “Healthy Start”; however, parents were not always sure of the organisation’s names. Of these, the NHS website seemed to be a particularly trustworthy source of information for child feeding.

“I always used to look at the NHS website, the one that I knew; I’d trust that one more than any of them.” (Parent of 19-24-month-old/P12)

Most parents had not looked for portion size guidance for feeding one- to two-year-olds and had not sought child feeding information or advice after the weaning stage. This was because parents had gained experience and confidence in feeding their child the right amount, had an established feeding routine and were happy being led by their child rather than guidance. In addition, a few parents mentioned time was a barrier due to going back to work, so they no longer had time to look for resources online. If parents were to look for a resource, this tended to be for meal inspiration or for a specific concern, rather than for general feeding information. One parent felt online resources were not appropriate for their culture because the recommended meals included were often Westernised and not meals they would cook.

*“I’ve sort of got into a routine with it now and got more confident and I guess being back at work I’ve not had as much time to be looking.”
(Parent of 19-24-month-old/P12)*

“Quick meal ideas, that’s all I ever want really. How to get your five a day in. How to get your fruit and veg in, hidden veg meals, is your job really now.” (Parent of 19-24-month-old/P06)

“I find a lot of the meals that are there on-line sort of Westernised if that makes sense. There’s not much for sort of people in our ethnic minority with the sort of ingredients we have in our cupboards. We can’t sort of incorporate that in the meals that are on-line so a lot of it I just have to think it up or like ask my mum or somebody. There’s a gap in there, I do feel there’s a big gap in that.” (Parent of 12-18-month-old/P22)

Parents were shown six portion size guidance resources and asked whether they recognised any. Many parents recognised none. Resource five (Start4Life) was the most recognised resource, recognised by seven parents. However, parents referred to this resource as a source of information for weaning rather than something they used now. Resource one (First Steps Nutrition Trust) was recognised by two parents, Resource three (NHS Bradford) by two, Resource four (British Nutrition Foundation) by one and Resource six (Bristol City Council) by two. No parents recognised Resource two (Infant & Toddler Forum). Some parents thought the resources looked familiar but similar to weaning resources they had previously read.

4.4.3.2 Content, structure, and accessibility of the portion size guidance resources

4.4.3.2.1 Individual food versus meal-based resources

Resources two, three, four and six presented portion sizes for individual foods, while resources one and five presented portions of foods within meals. Parents did not express a strong preference either way (individual foods versus foods within meals) with most stating that both looked equally useful. Some parents felt the individual food-based resources were useful for learning about appropriate portion sizes for individual foods and food groups, and how these could be combined into a balanced diet. One parent thought the individual-food based resources, in particular Resource four, would have been more useful when their child was younger (when they measured food more often) and could act as a reference to look back to occasionally.

“When he was a little bit younger it would have been really useful to have Resource four. Just because sometimes I did struggle with that kind of how many teaspoons or how many tablespoons... that would be something I would go back to now I know it exists... Because I think you can get into bad habits, can’t you, quite quickly or not realise that your child is eating too much or too little. And so I think in a way, to have a bit of a kind of evaluation point where you say like, okay we’re doing this, but is this right, would be really useful.” (Parent of 12-18-month-old/P20)

When discussing the individual food-based resources, some parents liked Resource three because portion size recommendations were presented by age group (one year, two-three-years and four-five-years). This gave parents an idea of the exact portion sizes their child

should be consuming at a specific age and how portion sizes might increase with age. However, other parents preferred resources that presented a portion size range (e.g three to six tablespoons for one- to four-year-olds) because this offered more flexibility.

Other parents stated they wouldn't use individual food-based resources. One parent felt the resources did not provide enough information about how to combine the foods into balanced meals. A few parents felt it was unnecessary to provide recommended portion sizes for vegetables because their child could not overeat vegetables. Another felt that some of the recommended portions were impractical because they would not cook such small portions of foods (for example *"one tablespoon of porridge"*).

"Do I really need to look at her portion size of parsnip? Like, it's not gonna kill her if she eats too much parsnip." (Parent of 12-18-month-old/P21)

Only a few parents referred to the meal-based resources as being specifically useful to gauge appropriate portion sizes for their child. Instead, these resources were seen as a source of inspiration and therefore whether parents were interested in these resources depended on whether they liked to search for new meal ideas and recipes. Some parents felt confident in their ability to adapt their cooking and did not need new recipes, whereas other parents were often searching for child-friendly recipes (either child-specific meals or meals that could be adapted for the whole family). Some parents thought meal-based resources were more useful than individual food-based resources now their child was eating foods in combination (i.e. in a meal).

"I kind of looked at it and I went, 'I know how to cook all of these things.' The recipe isn't different for being a child." (Parent of 12-18-month-old/P03)

"I think in the beginning resource four [presented individual portion sizes] might have been useful when you really didn't have a clue as to how much they'd eat and when and now it's much more resource five for meal ideas. (Parent of 19-24-month-old/P06)

4.4.3.2.2 Accessible format

Parents discussed the format of the resources, in terms of accessibility, length and visual appeal. Parents preferred resources that were short (therefore not too time consuming to read), concise and visual. This reflected parents' experience and confidence and therefore lesser need for guidance. Several parents explained they had done a lot of reading during the weaning stage and so needed less information now. However, for some parents, seeing the resources acted as a "reminder" to continue seeking information. These parents were interested in reading the resources in more detail following the interview. They felt resources could act as a "guide" or "reference" to aid decision making and "give you an idea of what's appropriate" but was not something that needed to be rigorously followed. Although for some parents, the resources were deemed unnecessary because they trusted their own knowledge, experience, and child to guide their portion sizes.

"I definitely used to look at things much more though around that weaning age... It's probably not a bad idea to just go and have a little look at typical portion sizes, and just try and keep up to date with her age group a little bit, so maybe I'll do that." (Parent of 12-18-month-old/P16)

"It was the first year where I was really concerned and really worried and I wanted to do it according to the guidance but now, you say after one year maybe, you will get knowledge. You get experience [of] how much he wants to [eat]" (Parent of 12-18-month-old/P25)

Most parents referred to Resource six (which included many examples of recommended portion sizes for individual foods) as being "long winded" and "too much" and preferred the simple concise table of recommended portion sizes by food group and age in Resource three. Parents described skim reading resources for essential information or saving to read later in more detail when (or if) they had time. Therefore, resources which were concise and could be screenshotted or downloaded were deemed more accessible.

Parents described a range of ways they would like to access the resources. Apps, books, childcare, community child groups, emails, friends and WhatsApp, health visitors, the internet, physical or downloadable copies, and social media were all mentioned as accessible formats to find or receive portion size information. Although, the internet was

mentioned most frequently, there did not seem to be one unanimous preferred way to access guidance resources. Therefore, as one parent suggested, *“Having a range of formats is probably best.”* (Parent of 19-24-month-old/P13)

Many parents found the resources with food and meal images and bold colours more visually appealing and were more drawn to these resources after seeing them for the first time. Parents were drawn to the imagery on Resources two and five. In contrast, Resource three did not seem to be visually appealing, with one parent saying: *“I don’t know if I get any sort of impression from that.”* (Parent of 12-18-month-old/P14).

Parents suggested the front cover of a resource was important to spark initial interest. If the imagery or title looked interesting, they would be more likely to read further. For example, those parents interested in meal and recipe ideas were most interested in Resource five and those interested in food groups were most interested in Resources two and four because the front covers clearly portrayed what the resource was about. In addition, a few parents suggested the images would help to gauge how big the portion sizes were, without having to measure food out. Some parents thought these resources looked *“interesting”* and *“important”*, however others found them uninspiring, too *“busy”* and *“not simple”*.

“I think that’s really good to have visually, to kind of work out [portion size], actually, yes, otherwise I think it would be really easy to just give them what you give yourself.” (Parent of 12-18-month-old/P10)

4.4.3.2.3 Inclusion of foods high in fat and sugar

Resources two and three presented recommended portion size limits for foods high in fat and sugar. It should be noted, when parents discussed restriction of ‘unhealthy’ foods, they referred to foods high in sugar or salt (but not fat). Whereas resources presented portion size limits for foods high in fat and sugar (but not salt). Most parents thought it was appropriate and useful to include these recommended portion size limits because it would remind parents which foods should be restricted and how much their child should be allowed. Although many parents were currently restricting these foods from their child’s diet, they acknowledged these foods would probably *“creep into their lives at some point”* and so having guidance to follow was helpful. One parent suggested including foods high in fat and sugar was only appropriate for individual food-based

resources because meal-based resources would not want to include these foods when recommending healthy meals for children.

“It’s useful to know how much of it they have or what you should be aiming for and when they’re reaching for their fifth biscuit, perhaps half a biscuit is enough, so yeah, I like resource two.” (Parent of 19-24-month-old/P06)

“It is one of the foods that exist, so not mentioning it at all, maybe, isn’t sensible. I think you might as well include them, like they have in Resource two. But I can see why they haven’t in Resource one because they are giving suggested packed lunches, so they don’t want to suggest that somebody has a biscuit as part of their packed lunch.” (Parent of 12-18-month-old/P16)

However, a minority of parents felt resources should not include foods high in fat and sugar because this might “*signal that it’s okay to give them*” and instead resources should provide healthier treat options. One parent felt strongly about this:

“I don’t understand why they would need to include that. I think they could just put butter, couldn’t they, as the fat, and cheese? I think you know if they’re one and you’re giving them a biscuit then, well, I don’t understand why you would include it.” (Parent of 19-24-month-old/P09)

4.4.3.2.4 Portions served and consumed compared to the recommended portions

During the interview, many parents compared the portions they served their child or the portions their child consumed to the recommended portions in the resources. Several parents did not think the comparison would influence their portion size decisions and did not seem concerned if they were serving or their child was consuming more than resources recommended. This was because they wanted to be led by their child and respond to their child’s needs over the course of the day. Only a few parents stated they might “*cut down on certain foods*” (especially ‘unhealthy’ foods) if their child was consuming more than recommended because they did not want to encourage their child “*to be a fat child and grow up to eat a lot*”.

“If he was having over that, no it wouldn’t bother me. I’d just know that he’s just hungry, he likes that particular thing.” (Parent of 12-18-month-old/P17)

“I’m sure sometimes she has eaten more than a tablespoon of rice or a tablespoon of mashed potato in one sitting. I wouldn’t be worried about that because sometimes like in a day, some of her meals and snacks, she’ll hardly eat anything and she’ll just pick at and then one or two of those meals, or snacks, she’ll seem to eat absolutely tons and I’m sure it’s just making up for the fact that she’s not really eaten anything all day.” (Parent of 19-24-month-old/P02)

For some parents, the comparison reassured them their child was eating enough (rather than too much). Other parents felt the comparison would cause anxiety or guilt because their child may not be consuming as much as the guidance recommends. The reason for this anxiety and why some parents felt following the guidance was not appropriate seemed to relate to the notion *“every child is different”*. Some parents felt guidance resources did not reflect this and therefore favoured their own experience. One parent suggested guidance resources should reflect that all children eat differently and should inform parents about the contexts in which portion sizes should be of concern.

“That little resource thing, I think if I had that in my arsenal, I’d be like, ‘It’s all right! I’m doing all right!’ ...It actually makes me feel better, so if he ever does not eat it all, then I’m like, ‘Well, he’s having more than he should have anyway, so it’s fine.’” (Parent of 12-18-month-old/P17).

“I think following something like that probably wouldn’t be ideal because not every child would stick to something like that and it’d just end up making me more anxious so I think probably I wouldn’t use that.” (Parent of 19-24-month-old/P22)

To summarise, section 4.4.3 addressed objective three of this study, which was to explore parents’ awareness of and opinions on six portion size guidance resources aimed at parents feeding one- to five-year-olds in the UK. The resources were not widely recognised or used by first-time parents. First-time parents frequently sought feeding advice (including online resources) during the weaning stage, with the NHS being a key

trusted online source. However, now their children were one- to two-years-old, most parents felt confident without guidance. Most parents liked the individual food-based resources for achieving balance across food groups and the meal-based resources for gaining meal and recipe ideas. Parents thought portion size guidance resources should: be short and concise, include bold colours and food images that provide visual representation of portion sizes, have a front cover that clearly shows what the resource includes, be available in a range of easily accessible formats (e.g. downloadable), and include portion size limits for foods high in fat and sugar. Parents would only use portion size resources as a guide rather than strict guidance and often preferred to be led by their child.

4.5 DISCUSSION

This study was the first to explore parental portioning practices among a sample of first-time parents of one- to two-year-olds in the UK. It is also the first to use existing portion size guidance resources to facilitate discussions with parents about their awareness of and opinions on portion size guidance resources. A key finding was parents were mostly unaware of and did not use any of the six portion size guidance resources aimed at parents feeding one- to five-year-olds in the UK. Previous qualitative studies in the UK, USA and France have explored parents' general knowledge of portion size recommendations and guidance and similarly found parents did not know of any.^{41,140,151,152} Tang et al., asked parents about their awareness of the UK Change4Life 'me-sized meals' campaign and found only 24% were aware of it.¹⁵³ In addition, those who were aware had not considering using it to help decide portion sizes.¹⁵³ By asking parents about their awareness of and opinions on six UK portion size guidance resources, this study has strengthened the evidence suggesting parents have a lack of knowledge of portion size recommendations for preschool children, and suggests existing portion size guidance resources in the UK have poor reach and impact among first-time parents.

Although parents of preschool children in this and other studies^{41,140,151} have expressed interest in accessing portion size guidance, this study suggests parents are unlikely to engage with the existing UK portion size guidance. In addition, other studies found that when parents were asked to discuss ways to overcome barriers to serving age-appropriate portion sizes, use of guidance was not mentioned.^{152,159} Rather than knowing the portion size recommendations, parents instead use their own experience, alongside physical

indicators of portion size (child dishware, package size, own adult portions) to decide the portions to serve their child, which is also highlighted in previous studies.^{41,140,152,153} I found first-time parents of one- to two-year-olds had gained enough experience to serve what they perceived to be appropriate portions for their child. Through ‘eyeballing’, estimation and observing how much their child eats and wastes on a meal-to-meal and day-to-day basis, parents serve portions similar to the amount last consumed by their child.

Generally, parents do not want to use prescriptive guidance (which does not consider the individuality of their child) because parents want to be child-led, constantly observe their child’s intake over time and respond to their child by using different feeding practices to encourage, limit and restrict children’s consumed portions. Portion decisions are also influenced by child-related, parent-related, and external factors that are variable, such as child appetite, activity level, and eating location. This study identified a spectrum of parent-enabling, parent-directed, and parent-restrictive feeding practices, from encouraging self-regulation of intake to restriction of foods high in sugar and salt. Previous qualitative parental portioning studies^{41,140,151-153} and wider literature on parental feeding practices¹⁴⁴ identified similar practices. Parents describe allowing children to decide how much of a served portion to consume, providing access to more food in response to child hunger and not putting pressure on children to ‘plate-clean’. However, parents do use methods to encourage consumption of served portions when children have a poor appetite, and when parents have concerns about their child not eating enough (in general or that day) or not having a balanced diet. Although parents do not appear to be encouraging ‘plate-cleaning’, which is beneficial for sustaining children’s ability to self-regulate intake,¹³⁸ some parents do encourage children to consume more food, especially at mealtimes.^{41,151} As a result of this, children may eat past satiation which could lead to excess energy intake.⁴⁴ I, and others^{41,140,152,153} found parents limit portions of foods high in sugar and salt to encourage a healthy diet. Most parents in this study agreed guidance should include limits for unhealthy foods. However, as parents do not currently follow portion size recommendations, it is unknown whether parents restrict these foods appropriately to meet the recommendations.²²⁰ In addition, there may be a mismatch between the foods parents restrict versus the foods guidance suggests restricting. For example, I found parents were concerned about sugar and salt intake, whereas portion size guidance suggests limiting foods high in fat and sugar (not salt).

Some of the existing guidance may not align with parental concerns. This study and others^{41,150} show parents worry about their child being fed enough and having a balanced diet for healthy growth, but generally do not worry about portions being too large or leading to weight gain (although parents do limit and restrict foods high in sugar and salt because they feel this is important for oral and general health). This may represent a tension between the goals of public health and paediatric health professionals versus parents. Prospective evidence suggests large meal size is a critical driver of excess weight gain from two to five years. Therefore, whilst public health research, policies, and guidance aim to reduce energy-dense portions, this may not be the goal of parents.

4.5.1 Future research and policy implications

Table 4.3 presents implications for policy, practice and future research for different target audiences, informed by the results of this study. This study found parents often seek information and guidance during weaning but after this stage (by age one), parents no longer look for guidance resources online (where an abundance aimed at feeding one- to five-year-olds can be readily found (CHAPTER 3)). Therefore, to engage parents and increase knowledge of age-appropriate portion sizes throughout the preschool years, it may be more effective to provide this information early (e.g. during the weaning stage) when parents are most receptive to following advice and recommendations. In addition, parents could be provided guidance again at a later stage (around one-to-two-years) as a reminder, as suggested by parents in this study. This study shows if parents are to engage with guidance resources, they need to be: simple, concise, visually appealing, include portion size images, be available in a variety of accessible formats (e.g downloadable), from a trusted source (e.g the NHS), and have a front cover which clearly portrays its content. Key questions remain as to whether parents would be receptive to receiving portion size guidance at the weaning stage, who is best to provide this guidance and whether parents would follow the guidance.

Some parents in this study suggested health visitors could provide portion size guidance, which was also suggested in a study among parents of two- to four-year-olds.¹⁴⁰ However, this study suggests friends with similar aged children may be a more important source of feeding advice post-weaning, as friends acted as a guide and comparison to influence parental portioning decisions. In other studies, learning from friends with prior experience was also suggested as a strategy to learn about age-appropriate portion

sizes.^{152,159} In addition, peers (i.e. other parents) are suggested as a key influence on maternal decisions around breast-feeding and weaning.^{215,221} Peer-led interventions have been effective in increasing exclusive breastfeeding, improving children's diet, and reducing underweight among children in low-middle income countries.^{222,223} Although previous peer-led interventions to increase exclusive breastfeeding or infant feeding practices in the UK have had limited success,²²⁴⁻²²⁸ the feasibility of delivering one in community maternity services, involving theory-based motivational interviewing appears promising.²²⁹ The use of peer-led interventions to promote age-appropriate portion sizes and healthy weight has not been explored in the UK. Research should explore the feasibility of peers (parents with similar aged children) disseminating portion size resources and teaching parents about age-appropriate portion sizes (and possibly wider diet-related behaviours). However, this would need to involve careful planning (including co-production with parents, researchers, and health professionals), theoretical underpinning, and evaluation to assess impact and potential harms (as this could lead to spread of misinformation).

I found parents used child-specific dishware and packaged food to decide portions, which were often assumed to be appropriately portioned for one- to two-year-olds. In addition, a few parents mentioned ordering kids' meals at restaurants. Environmental strategies, such as reducing large package and tableware sizes^{133,230} and reducing the size of meals in eateries,²³¹ to promote age-appropriate portions should be considered. An evaluation (not peer reviewed) of the Change4Life 100 calorie snack campaign suggested parents found the campaign informative but it had not influenced their snack purchasing or preparation.²³² Although parents may seem interested in portion size information when prompted to discuss it, as was found in this and other studies,^{41,140} guidance and campaigns alone are unlikely to have a large impact on the serving and consumption of age-appropriate portion sizes. Action on Sugar recently showed 37% of child-targeted sweet snacks in the UK are high in sugars (55% medium in sugars) but 88% do not list free sugars in the ingredients list on their packaging (as they are not legally required to do so).²³³ Kiddylicious and Oragnix brands (mentioned by parents in this study as frequently purchased pre-packaged snacks) contained among the highest amounts of sugar. A study modelling the effectiveness of capping package size in Australia found a package size cap on sugar-sweetened beverages had potential for long term public health benefits, in terms of reduced mean body weight and increased health adjusted life years.²³⁴ Food companies

manufacturing child-targeted foods need to take responsibility for producing appropriately sized snacks with reduced sugar contents, which should be enforced by the UK government. Future research should explore the impact of introducing portion size and/or sugar content caps on child packaged food, and meals in eateries. In addition, eateries could introduce a range of portion sizes to cater for different aged children.

4.5.2 Strengths and limitations

A strength of this study was the pragmatic method of showing parents current portion size guidance resources to facilitate in depth discussions about their usefulness. First-time parents of one- to two-year-olds were recruited to better understand the portioning practices of parents with younger children without the influence of established practices gained from feeding older children. Due to COVID-19 restrictions, planned face-to-face interviews were conducted online instead. Though there were some distractions during the interviews (responding to their child or dealing with technical issues), online interviews were largely advantageous because both participants and I could do the interview in the comfort of our own homes, travel time to/from interviews was eliminated, and there was greater flexibility on the time interviews could be conducted. In addition, I sent participants an informational video before the interview, which helped build familiarity.

The sample in this qualitative study is limited to mostly White, highly educated mothers (only two fathers participated) and therefore awareness of and opinions on the guidance resources may not reflect those of the wider population. It is possible parents with lower levels of education may be less likely to have looked for and accessed the resources, therefore awareness in the general population is unlikely to have been higher than identified in this study.²¹⁵ The limited number of parents from ethnic minority backgrounds in our sample (N=9) is important to address, as food culture and the meals cooked or served may be different among ethnic minority groups^{135,136,235} This was expressed by one participant and another raised the issue of existing guidance being too ‘Westernised’ and therefore less accessible. Data was not collected on parent or child BMI and therefore it is unknown whether portioning practices differed among overweight parents or children. I am not a parent myself, which may have reduced the level of rapport with participants due to having less common ground. Interviews may have been

subject to social desirability bias⁶⁰ and parents provided post-hoc descriptions and explanations of their behaviours, which may not fully reflect their real-life behaviours.

Table 4.3. Implications for policy, practice and future research for different target audiences

Target audience	Implication for policy, practice and future research
Policy makers who develop portion size resources	Online guidance resources are not currently being used by parents. Policy makers who want to promote age-appropriate portion sizes for preschool children should consider other approaches to engage parents, such as social media and online or in-person parent community groups. If guidance is necessary, resources should be co-produced ²³⁶ with parents, health professionals and public health researchers.
Public Health teams	Public Health teams should consider new strategies to engage parents and disseminate portion size guidance, such as through peer-led education. Public health researchers should evaluate the feasibility and effectiveness of any new strategies. Public health teams should consider the stage at which dissemination is most effective, such as during the weaning stage (when parents are most receptive to following recommendations).
Paediatric health professionals, including health visitors	Health visitors could be commissioned and trained to provide portion size information to parents at mandatory checks. Health visitors could provide child sized plates or packaged food during visits or key

	birthdays to indicate appropriate portion sizes. Public health researchers should pilot and evaluate novel commissioning services.
Target audience	Implication for policy, practice and future research
Food and child-dishware industry/manufacturers	Food manufacturers should work alongside researchers and public health teams to ensure dishware and packaged foods are appropriately sized and labelled for child consumption. The sugar content of child-targeted snacks should be reduced. ²³³
Eateries	Eateries should use appropriate child-sized plates, reduce child portions and provide age-appropriate portion sizes.
Parents and childcare	Parents and childcare should where possible follow portion size recommendations, especially for foods high in fat, sugar, and salt. ²²⁰ Food provision guidelines should be made mandatory in childcare settings. Food provision guidelines for childcare do currently include portion size recommendations ¹⁶⁹ and should be followed appropriately. Childcare staff could receive training to improve the food environment, including information on age-appropriate portion sizes, which should be evaluated by researchers. ²³⁷

4.5.3 Conclusion

The majority of first-time parents of one-to two-year-olds were unaware of the existing portion size guidance resources for one- to five-year-olds. After the weaning stage, first-time parents were typically not seeking advice or guidance resources online. Some parents expressed interest in using resources if they were accessible and engaging. However, parents used their own experience and physical indicators of portion size to serve (perceived) appropriate portions to their children. Parents used a range of feeding practices along a spectrum to encourage eating and/or limit portions, which were led by observing and responding to their child. More research is needed to develop and evaluate the best way to promote the consumption of age-appropriate portions among preschool children, which will require the combined efforts of researchers, policy makers, public health teams, paediatric health professionals, food manufacturers, parents and childcare.

4.6 IMPLICATIONS FOR THESIS

This chapter shows first-time parents do not currently engage with the existing portion size guidance resources, identified in CHAPTER 3. The portion size guidance resources are therefore unlikely to be informing and shaping portion sizes. Novel strategies to disseminate, engage and promote child-appropriate portion size recommendations to parents, which consider current parental portioning practices (such as using child dishware, serving packaged foods, and being responsive to their children) are necessary. But so too, are other policy responses to facilitate appropriate portion size servings, which do not depend on awareness and use of portion size guidance.

CHAPTER 5. WHERE AND WHEN ARE PORTION SIZES LARGER IN PRESCHOOL CHILDREN? AN ANALYSIS OF EATING OCCASION SIZE AMONG 1.5-5-YEAR-OLDS IN THE UK NATIONAL DIET AND NUTRITION SURVEY (2008-17)

5.1 OVERVIEW

The work presented in this current chapter is published in Public Health Nutrition.²³⁸ Except for this overview, some minor edits to improve readability and reduce repetition and a final section on the implications of this study for the thesis, this chapter is presented as per the article. I was responsible for the conceptualisation of the study, analysis and writing of the article. The other authors helped with the conceptualisation of the study, discussion of results, reviewed the manuscript and provided feedback prior to submission. This chapter explores the variation in eating occasion size among preschool children and potential individual-level and environmental-level factors associated with the consumption of larger eating occasions. This chapter addressed research objective three of this thesis: ‘To explore the within and between variation in consumed portion size among preschool children, to better understand the contribution of individual versus environmental-level factors that may lead to the consumption of larger portions. To explore whether certain individual characteristics and eating contexts are associated with larger portion sizes.’ The findings of this study will add to the evidence base identifying factors, which may increase children’s susceptibility to consuming larger portion sizes. The findings from CHAPTER 3 and CHAPTER 4 were considered when selecting variables to include in the analysis in this study. The background, methods and discussion are presented below. The final section presents the implications of the study findings for this thesis.

5.2 BACKGROUND

As stated in section 1.2, childhood obesity is a worldwide public health problem¹ and large portion sizes are suggested to contribute to childhood obesity.³⁹ Experimental evidence has established a link between serving large portions and greater energy intake in preschool children, defined as the ‘portion size effect’.^{43,171} The effect has been

observed for meals and snacks, and across consecutive days,⁴⁵ however may vary depending on the individual, food or environment.^{48,117} To better understand this variability, we need to explore which factors are associated with the consumption of large portions in children. Several factors such as genetic susceptibility, responsiveness to food, parent feeding styles, and the home food environment have been proposed to increase a child's behavioural susceptibility to consuming large portions⁴⁸ and increase weight.^{239,240} Existing research has focused on individual factors and less is known about within-person factors such as eating environments.

Observational studies add to the experimental literature by exploring portion sizes in free-living settings and in larger, more diverse samples. The National Diet and Nutrition Survey (NDNS) is a nationally representative cross-sectional survey, which collects dietary data from children and adults in the UK.²⁴¹ Although data on served portions is not collected, the data provide estimates of portions consumed. This data can be used to explore potential factors associated with the intake of larger portions, a more proximal factor on the proposed causal pathway from larger servings to excessive consumption and subsequent weight gain.

Previous studies using NDNS data have observed associations with the consumption of individual foods, in children and adolescents.^{61-63,127} Consuming larger portions (grams) of energy dense foods such as chocolate, confectionary, savoury snacks, and biscuits was associated with eating out of the home and watching TV, being older, male, and having lower household income. Eating out of home and with friends was also associated with greater non-core energy intake (kcal) (e.g soft drinks, savoury snacks, chocolate) in adolescents.¹²⁷ Larger consumed portions of vegetables (grams) were observed during the weekend and the evening meal, whilst eating at home and among older children.⁶² Not watching TV and sitting at a table were also associated with greater vegetable consumption (grams).⁶³ These studies provide insight into which eating contexts and individual characteristics may lead to the consumption of larger portion of individual foods. Consuming larger portions of low energy dense foods, such as fruit and vegetables can be beneficial for children's health.⁸¹ In a meal, increasing the portion of fruit or vegetables will increase the volume (grams) of the portion but, owing to their low energy density, may decrease the total energy consumed (kcal) from that meal.⁹⁹ Overall meal size (kcal) (regardless of food type) has been prospectively associated with excessive

weight gain in preschool children.⁵⁴ Therefore, it is important to explore associations in relation to the overall energy content of eating occasions (referred to hereafter as eating occasion size), where foods and beverages are consumed in combination.

We also need to understand the relative importance of eating environments versus individual characteristics. In previous studies, 89% of variability in non-core food intake¹²⁷ and 82% of variability in consumed vegetable portions⁶² were attributed to differences between eating occasions. This suggests targeting high risk environments could be more effective if prioritised over specific person-level characteristics. Understanding whether variability in eating occasion size is attributable to differences between eating occasions or between preschool children, and the eating contexts and individual characteristics associated with larger eating occasions could help us to understand when, where, and for who the risk of consuming larger portions is higher.

Preschool children eat in distinct environments, with typically less control over their food choices than older children, and may have increased susceptibility to the portion size effect.³⁸ Although many portion size guidance resources aimed at feeding preschool children (referred to as one-to-five-years) are available in the UK, many are not informed by the portion size research.¹⁶⁹ Therefore, exploring factors associated with portion size could help contribute to the call for improvement of nutrition guidelines that are research driven, contextually specific and based on causal mechanisms.²⁴²

This study aimed to describe preschool children's eating occasions and to explore the relative contributions of *within*-children (between eating occasions) and *between*-children variation in eating occasion size. I aimed to identify possible eating contexts and individual characteristics associated with larger eating occasion size (kcal) in preschool children (one-to-five-years).

5.3 METHODS

5.3.1 Study sample

Secondary data analysis was conducted on dietary data from n=1962 preschool children aged 1.5-5 years in the UK National Diet and Nutrition Survey (NDNS) Years 1 to 9 (2008/09-2017) rolling programme. The survey design has been described elsewhere²⁴³

and I provide an overview of the survey in Appendix 1. NDNS data were downloaded from the UK Data Archive.²⁴⁴

5.3.2 Dietary data

Dietary data were collected via four-day estimated food diaries, completed by parents of the participating children. Parents were asked to record all foods and beverages consumed, including the day and exact time. Parents estimated portion sizes using household measures (e.g. tablespoons), grams from packaging and example pictures provided.⁵⁷ Diaries were coded by a trained NDNS research team. Where grams were not reported, portion sizes were determined by coders using household measures in the Diet In Nutrients Out system¹⁸⁶ or available packaging. Portion sizes were converted into energy by the NDNS research team using the food composition data from the Department of Health NDNS nutrient databank.

5.3.3 Definition of eating occasions

The outcome of interest was eating occasion size, measured in kilocalories (kcal). Eating occasions defined as an occasion in which energy containing foods or beverages were consumed within the same 15-minute period, as defined in previous eating patterns research in children.^{61,80,245,246} If two or more items were consumed within 15 minutes, these were considered a single eating occasion, if >15 minutes separated reported items, these were considered separate eating occasions. Appendix 15 details my preliminary work to define eating occasions and provides justification for the chosen definition.

5.3.4 Eating occasion variables

Parents of participants completed a face-to-face computer assisted personal interview and questionnaires. Parents were asked to record where and with whom (eating companion) each food and beverage was consumed. The original ‘where’ and ‘with whom’ variables were recoded into six and five categories, respectively, similar to previous research²⁴⁷ (Appendix 16 and Appendix 17). Parents were asked to record whether each food and beverage was eaten sat at the table or watching TV. Where watching TV responses were not specified, we classified these as “not watching TV” (17% of occasions).

5.3.5 Individual variables

Individual characteristics such as child's gender, age (years), ethnicity and total daily energy intake were available in the NDNS data. Height and weight data were measured by the interviewer and used to derive BMI z-scores using the BMI WHO cut-offs for two- to three-year-olds²⁴⁸ and UK90 for four- to five-year-olds.^{249,250} Parental socioeconomic status (SES) was indicated by parental occupation using the National Statistics Socio-Economic Classification (NS-SEC)²⁵¹ (Appendix 18). Misreporting of energy intake was assessed using the individualised method for children,^{252,253} which involved calculating the ratio of reported energy intake to estimated energy requirements, accounting for growth. Plausible reporting of energy intake was identified using cut-offs of 0.79 and 1.21. 17% of the total sample were categorised as under-reporters and 20% as over-reporters.

5.3.6 Statistical analysis

5.3.6.1 Descriptive analysis

All analyses were conducted in Stata 15. Exposure variables included four eating occasion characteristics (eating contexts); location, eating companion, watching TV, and sitting at a table, and four individual characteristics; age, gender, ethnicity, and parental SES. Descriptive statistics on characteristics of eating occasions were reported at the survey level (across all preschool children). Number and frequency of eating occasions and median (and interquartile range (IQR)) eating occasion size were reported for each eating context variable. Descriptive statistics on individual characteristics were reported. Number (%) of children was reported for categorical variables and mean and standard deviation (SD) for continuous variables. Mean eating occasion frequency and median eating occasion size were reported for categorical variables. For continuous variables, simple regression analyses were conducted, and beta coefficients (B) and 95% confidence intervals (CI) were reported. The number of preschool children who reported to consume an eating occasion in each of the eating contexts was presented across all children and by individual characteristics, to understand how these variables were inter-related.

Energy density of eating occasions (as defined in section 5.3.3) was calculated (kilocalories of eating occasion divided by grams of eating occasion) and median (IQR) was reported. Simple analysis of food groups associated with larger eating occasions was

conducted. The food groups classified within the NDNS were collapsed further according to the UK Eatwell Guide³⁰ food groups (starchy, protein, fruit and vegetables, dairy, oils and spreads, foods high in fat and sugar, and drinks).¹⁶⁹ The percentage of all eating occasions in which preschool children consumed a given food group was reported. Spearman's correlations were conducted to explore correlations between percentage of total energy consumed in an eating occasion from a food group and overall eating occasion size.

5.3.6.2 Multilevel modelling

Hierarchical multilevel modelling²⁵⁴ was used to explore the relationship of eating occasion size with eating contexts and individual characteristics as potential exposure variables. Eating occasions (level 1 variation) are nested within children (level 2 variation). Therefore, multilevel modelling allowed us to explore whether eating occasion size varied within and between children, as well as the potential exposures that explained this variability. Eating occasion size (kcal) was not normally distributed and was logged transformed to approximate the normal distribution. Individual level survey weights from each survey wave were combined according to NDNS instructions²⁴¹ and used in analyses to account for selection and non-response biases.

Several models were run: Model 1 was the variance component (null intercept) model, which did not include any exposure variables. This model assessed how much variability in eating occasion size was attributable to within-children-between-eating occasions and between-children variance. Models 1.1 to 1.8 explored the unadjusted associations between each of the eight exposures of interest and eating occasion size in their own model. In Models 2.1 to 2.8 a set of confounders unique to each of the eight exposures of interest were added to each model to explore if the evidence and size of associations were robust to adjustment for potential confounding. Appendix 19 provides a description of each model, including the potential confounders added for each exposure at each stage. Models 2.1 to 2.8 were adjusted for misreporting of energy intake as a potential confounder because misreporting has previously been shown to affect diet-health relationships.^{51,59,255} Individual-level models (2.5-2.8) were adjusted for total daily energy intake.²⁵⁶

For each model, the intraclass correlation and ‘percentage variance explained’ were calculated. These indicated the percentage of variation in eating occasion size attributed to differences at our two levels of variation and how much variance could be explained by our exposure variables compared to the null-intercept model, respectively. Model fit was assessed using likelihood ratio tests. Estimates were converted to kilocalories by multiplying the adjusted ratios by the model intercept, to provide meaningful public health units.

The STROBE flowchart²⁵⁷ (Appendix 20) illustrates the amount of missing data in the sample. I reported the sample size of each model and used the likelihood ratio test to assess whether missing data could bias our results. Appendix 21 presents the STROBE checklist for this study.

5.3.6.3 Mediation analysis

To aid interpretation of the results from Models 2.1 to 2.8 and attempt to explain more variation in eating occasion size, mediation analysis was conducted. Eating occasion type (whether an eating occasion was defined as a meal or snack) and eating frequency (average number of daily eating occasions) were added as potential mediators to the eating occasion-level and child-level models, respectively, to explore whether potential associations observed were due to children consuming specific eating occasion types or eating more frequently. Each eating occasion was defined as a meal or snack using a time-of-day, plus energy criterion method based on our data, similar to previous research.²⁵⁸⁻²⁶⁰ Appendix 15 details my preliminary work to create an eating occasion type variable and provides justification for my choice. The percentage energy from each eating occasion (of total daily energy intake) was plotted in 30-minute intervals over a 24-hour period, across all participants. The resulting graph (Supplementary Figure 5 in Appendix 15) displayed three peaks in energy across the day, which were used to label eating occasions as meals or snacks. I defined meals as eating occasions with the largest percent energy between 05:30-10:00, 11:00-14:00 and 16:00-19:00. All other smaller eating occasions within these mealtimes and all eating occasions outside of these mealtimes were defined as snacks. In the descriptive results, eating occasion size and frequency were additionally reported for meals and snacks because meals and snacks are systematically different in size. In the multilevel models, potential mediators were added to Models 2.1 to 2.8 if an exposure-outcome association was observed. Estimates from

the mediation models were compared to the final adjusted estimates to explore potential mediation. Models 3.1 to 3.8 present the mediation models and are presented as the final models because including eating occasion type and eating frequency provided the most meaningful interpretation of results within the context of the study.

5.4 RESULTS

5.4.1 Descriptive results

5.4.1.1 Characteristics of eating occasions

The median eating occasion size across all preschool children (n=1962) and all eating occasions (n=48,219) was 157kcal (IQR 85, 267). The median size for meals was 251kcal (IQR 170, 360) and for snacks was 96kcal (IQR 50, 153). On average preschool children consumed 6.7 (SD 1.8) eating occasions per day, of which 3.0 (SD 0.3) were meals and 3.7 (SD 1.9) were snacks.

Table 5.1 displays the number (%) of eating occasions across the different eating contexts. Nearly three quarters of eating occasions occurred at home, with 11% in childcare and just 2% in eateries. Meals made up 47% and snacks 53% of eating occasions overall, whereas 63% of occasions in eateries were meals and 77% of eating ‘on the go’ was a snack. Parents and/or other family members ate with preschool children in 85% of eating occasions, with just 5% eaten alone. A third of occasions were while watching TV and nearly half were while sitting at a table. Figure 5.1 illustrates the median (IQR) eating occasion, meal, and snack sizes across the different eating contexts.

Table 5.2 suggests larger eating occasions were more energy dense than smaller eating occasions (1.1kcal/g vs 0.4kcal/g) and contained more food groups (the percentage of all eating occasions in which preschool children consumed a given food group was greater across all food groups for larger vs smaller eating occasions). Table 5.3 suggests percentage energy from all food groups (but not drinks) were correlated with overall eating occasion size.

Table 5.1. Characteristics of eating occasions in absolute frequencies and percentages, among preschool children (n 1962), in the UK National Diet and Nutrition Survey 2008-17

	Total eating occasions N (%)		
	Total	Meal	Snack
Overall	48419 (100)	22836 (47)	25583 (53)
Location			
Home	35294 (73)	17290 (76)	18004 (70)
Friend's/relative's house	3070 (6)	1450 (6)	1620 (6)
Childcare	5333 (11)	2451 (11)	2882 (11)
Eateries	974 (2)	620 (3)	354 (1)
On the go	2191 (5)	504 (2)	1687 (7)
Activities and other places	1557 (3)	521 (2)	1036 (4)
Eating companion			
Parents/carers	15337 (36)	7267 (35)	8070 (38)
Alone	2202 (5)	673 (3)	1529 (7)
Parents & siblings	10065 (24)	5627 (27)	4438 (21)
Family and friends	10250 (25)	5307 (25)	4943 (23)
Friends	4365 (10)	2002 (10)	2363 (11)
Watching TV			
No	31960 (66)	15301 (67)	16659 (65)
Yes	16459 (34)	7535 (33)	8924 (35)
Sitting at table			
No	16432 (34)	4564 (20)	11868 (46)
Not Specified	9209 (19)	3112 (14)	6097 (24)
Yes	22778 (47)	15160 (66)	7618 (30)
Time of day			
06:00-09:00	7868 (16)	5595 (25)	2273 (9)
09:00-12:00	8940 (18)	2960 (13)	5980 (23)
12:00-14:00	8127 (17)	6267 (27)	1860 (7)
14:00-17:00	8920 (18)	1577 (7)	7343 (29)
17:00-20:00	11289 (23)	6429 (28)	4860 (19)
20:00-22:00	2789 (6)	0 (0)	2789 (11)
22:00-06:00	486 (1)	8 (0.04)	478 (2)
Day of the week			
Weekday	33550 (69)	15850 (69)	17700 (69)
Weekend	14869 (31)	6986 (31)	7883 (31)

Figure 5.1. Median (IQR) size of eating occasions and eating occasions defined as meals and snacks across eating contexts (location, eating companion, watching TV and sitting at a table) among preschool children (n 1962), in the UK National Diet and Nutrition Survey 2008-17

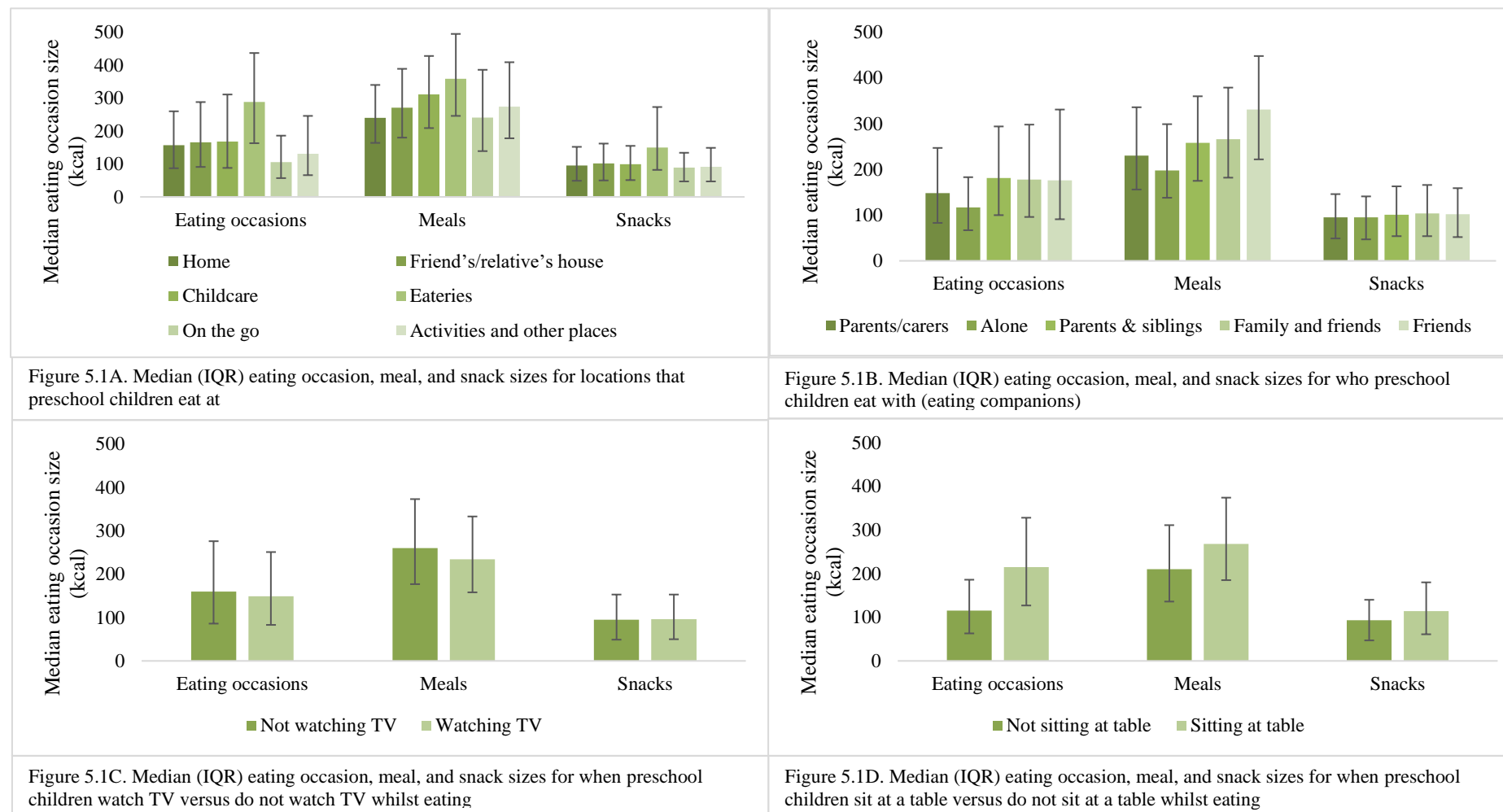


Table 5.2. Percentage of all eating occasions in which preschool children consumed a given food group and the median energy density of an eating occasion for an average, small, and large sized eating occasions

Percentage of all eating occasions in which young children consumed a given food group, for all, small, and large sized eating occasion			
	All eating occasions	Small eating occasions (lower tertile)	Large eating occasions (upper tertile)
Food group within eating occasions	% of all eating occasions in which preschool children consumed a given food group	% of all eating occasions in which preschool children consumed a given food group	% of all eating occasions in which preschool children consumed a given food group
Dairy	15	6	26
Starchy	45	10	80
Fruit & Veg	35	29	47
Proteins	23	3	51
Oils & Spreads	18	3	35
High fat, high sugar	31	19	41
Drinks	54	41	61
Median energy density of an eating occasion, for an average, small, and large sized eating occasions			
Energy density (kcal/g)	Median (IQR)	Median (IQR)	Median (IQR)
Energy density of eating occasions	0.5 (0.8, 1.3)	0.4 (0.1, 0.8)	1.1 (0.8, 1.5)

Table 5.3. Spearman's correlations between eating occasion size (kcal) and the percentage energy from food groups within an eating occasion

	Eating occasion size	
	Spearman's correlation	p value
Percentage energy from food groups		
Dairy (% energy)	0.2373	p<0.001
Starchy (% energy)	0.5063	p<0.001
Fruit & Veg (% energy)	0.0872	p<0.001
Proteins (% energy)	0.4736	p<0.001
Oils & Spreads (% energy)	0.3417	p<0.001
High fat, high sugar (% energy)	0.1535	p<0.001
Drinks (% energy)	-0.0013	0.7749

5.4.1.2 Characteristics of preschool children

Table 5.4 describes the sample of preschool children (n=1962). The sample consisted of 53% boys, 86% White ethnicity, 39% low SES, with a mean child age of 3 years (SD 1.3). Figure 5.2 presents the median (IQR) eating occasion, meal, and snack sizes across the individual characteristics. The overall frequency of eating occasions was similar among boys and girls, and SES groups but varied by ethnicity; 7.1 times/day among Asian/Asian British children versus 5.6 times/day among Black/Black British children. A lower eating occasion frequency and greater eating occasion size was associated with being older (0.3 eating occasions less per day and 22kcal more per occasion, per year of age). A higher eating frequency was associated with smaller eating occasions (-16kcal per occasion for each extra time eating occurred). A higher total EI was associated with larger eating occasions (124kcal per occasion for each 1000kcal of total energy consumed) (Appendix 22).

5.4.1.3 Characteristics of preschool children within eating contexts

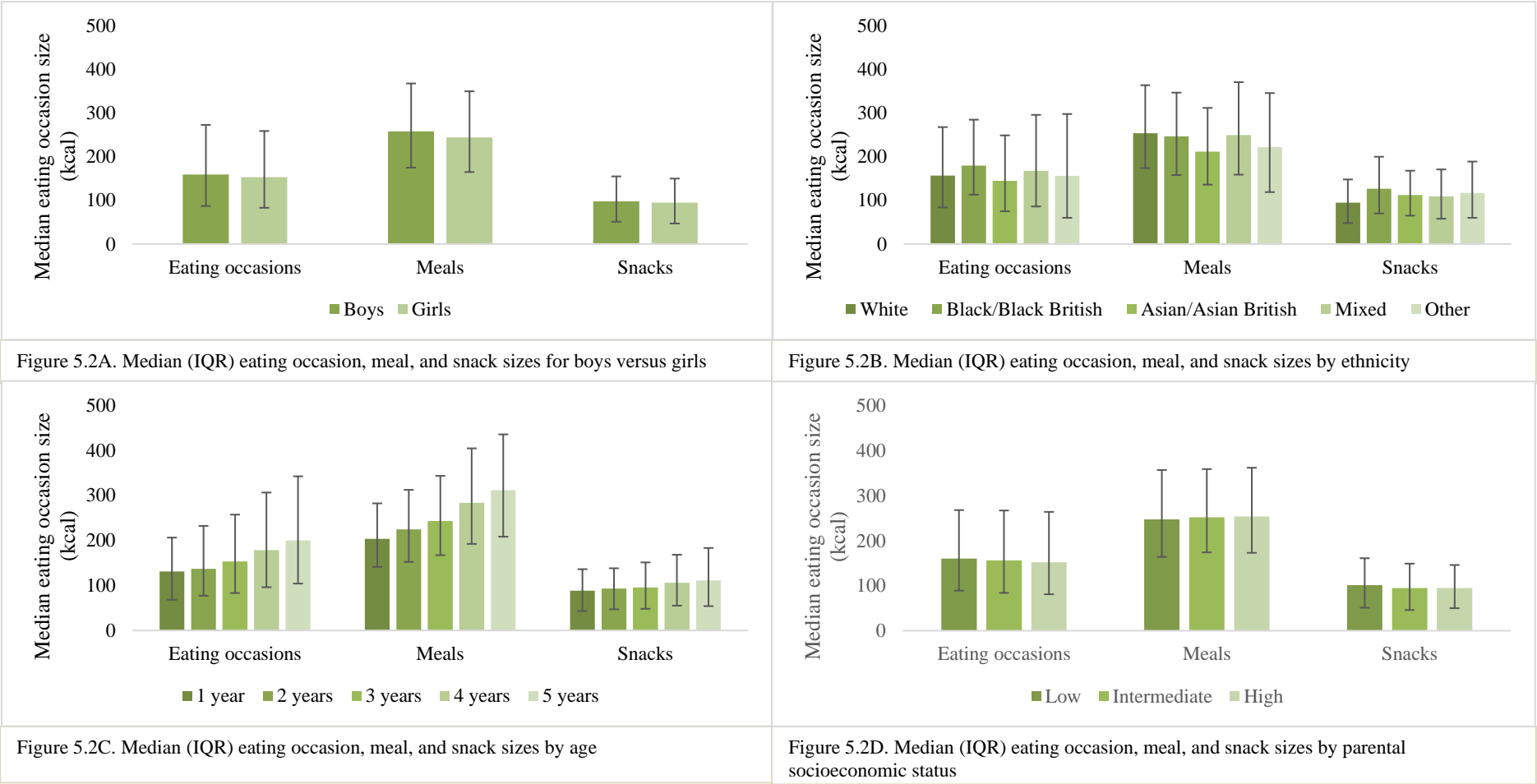
All preschool children reported eating at home, 60% in childcare and 51% 'on the go'. Fewer preschool children ate at a friend's or relative's house (46%), in eateries (34%) and at activity places (40%). Eighty percent of children ate with their parents/carers and 77% with family and friends. Fewer children ate with parents and siblings (54%) and with friends (54%). Only 36% of children ate alone. Most children reported eating watching TV (92%) and not watching TV (99%). Similarly, 96% of children reported eating sitting at a table and 92% whilst not. Sitting at a table versus not was more common in childcare (68%) and eateries (74%); more common between 12:00-14:00 (61%) and less common after 20:00 (17%); more common when eating with friends (67%) and less common when eating alone (24%) (Appendix 23).

Table 5.4. Characteristics of preschool children (n 1962) in the UK National Diet and Nutrition Survey 2008-17

	N	%
Gender		
Boys	1034	53
Girls	928	47
Socioeconomic status		
Low	744	39
Intermediate	368	19
High	812	42
Ethnicity		
White	1688	86
Black/Black British	49	3
Asian/Asian British	122	6
Mixed	64	3
Other	39	2
Misreporting of energy intake		
Plausible reporter	1233	63
Under-reporter	338	17
Over-reporter	391	20
	N	Mean (SD)
Age (years)	1962	3.1 (1.3)
BMI z score*	1593	0.4 (1.2)
Total daily eating frequency	1962	6.7 (1.8)
Total daily energy intake (kcal)	1962	1198 (278)

*calculated using WHO BMI z-scores for 1.5-3 years and UK 1990 BMI z-score 4-5 years

Figure 5.2. Median (IQR) size of eating occasions and eating occasions defined as meals and snacks among preschool children (n 1962) by individual characteristics (gender, ethnicity, age and parental socioeconomic status), in the UK National Diet and Nutrition Survey 2008-17



5.4.2 Multilevel model results

5.4.2.1 Associations of eating contexts with eating occasion size

Figure 5.3 presents the association of eating contexts with eating occasion size in kilocalories from Models 3.1 to 3.4 (adjusted for potential confounders and mediators). Table 5.5 presents the ratios and 95% CI from Models 3.1 to 3.4. Model 3 provided the best model fit (Table S9) and allowed for the most meaningful interpretation of results. Appendix 24 presents the ratios and 95% CI from Models 1.1 to 1.4 and 2.1 to 2.4 before adjustment for potential mediators. Eating in eateries was associated with the largest eating occasion size in preschool children, being over 50% larger than eating at home, equating to a difference of 90kcal. Eating sitting at a table was associated with a larger eating occasion size; 47kcal larger versus not sitting at a table. Eating in childcare and at a friend's or relative's house were associated with larger eating occasion sizes, compared to eating at home (29kcal and 15kcal larger, respectively). Eating with parents and siblings, and family and friends were associated with slightly larger eating occasion sizes, equating to 14kcal and 17kcal larger than eating with parents only, respectively. Eating alone was associated with smaller eating occasion size; 27kcal smaller than eating with parents. Eating occasions were slightly larger when watching TV versus not, equating to a 11kcal difference. Eating occasion type was added as a potential mediator to the models to account for meals potentially being more frequently consumed in certain eating contexts than snacks and therefore explaining why eating occasion size is larger (because meals are systematically larger than snacks). After adding eating occasion type, eating on-the-go, at activity places and with friends were no longer associated with eating occasion size (fully mediated relationship). Estimates were partially mediated after adding eating occasion type for the sitting at a table and eating companion variables (Table 5.5, Appendix 24).

Figure 5.3. Associations of eating contexts with eating occasion size among preschool children, in the National Diet and Nutrition Survey 2008-17

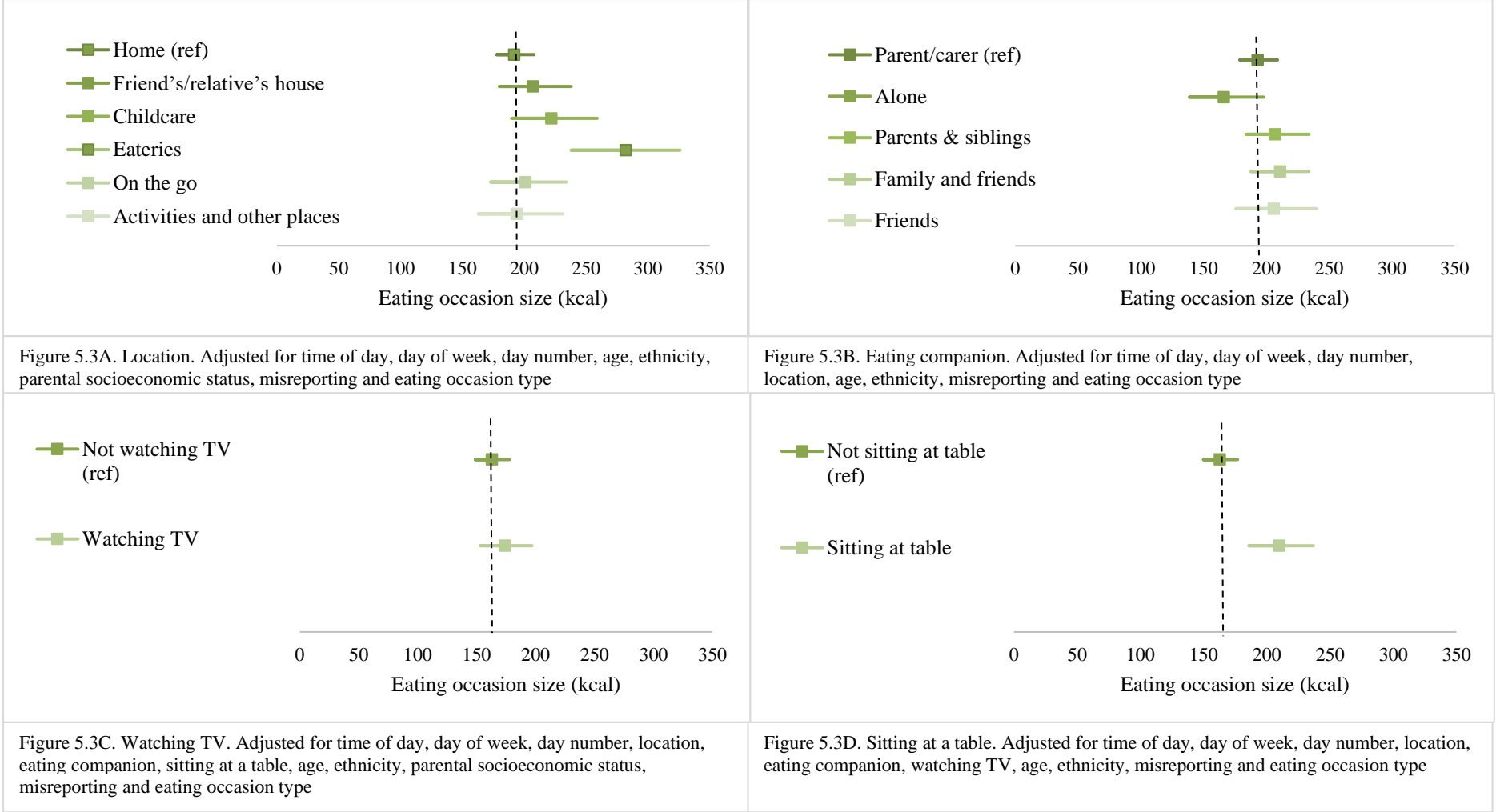


Table 5.5. Relationship of eating occasion size with eating contexts and individual characteristics among preschool children (n 1962) in the UK National Diet and Nutrition Survey 2008-19. Presents results from Model 3

	Models 3.1-3.8 – Adjusted for potential confounders and mediators (eating occasion type and eating frequency)			
Exposure	Ratio*	95% confidence intervals		p value
Eating contexts				
Model 3.1 - Location†				
Home (ref)	1.00			
Friend’s/relative’s house	1.08	1.02	1.14	0.014
Childcare	1.15	1.07	1.24	<0.001
Eateries	1.47	1.34	1.56	<0.001
On the go	1.05	0.98	1.13	0.199
Activities and other places	1.01	0.92	1.11	0.857
Model 3.2 - Eating companion‡				
Parent/carer (ref)	1.00			
Alone	0.86	0.78	0.95	0.002
Parents & siblings	1.07	1.03	1.12	0.002
Family and friends	1.09	1.05	1.13	<0.001
Friends	1.06	0.99	1.15	0.114
Model 3.3 - Watching TV whilst eating§				
Not Watching TV (ref)	1.00			
Watching TV	1.07	1.03	1.11	0.001
Model 3.4 - Sitting at table whilst eating				
Not sitting at table (ref)	1.00			
Sitting at table	1.29	1.24	1.34	<0.001

	Ratio*	95% confidence intervals		p value
Individual characteristics				
Model 3.5 - Age¶				
1 year (ref)	1.00			
2 years	1.04	0.94	1.14	0.479
3 years	0.97	0.87	1.07	0.541
4 years	1.00	0.89	1.13	0.947
5 years	1.00	0.89	1.12	0.995
Model 3.6 - Gender¶				
Boys (ref)	1.00			
Girls	0.99	0.95	1.02	0.407
Model 3.7 - Ethnicity¶				
White (ref)	1.00			
Black/Black British	1.20	1.12	1.27	<0.001
Asian/Asian British	1.19	1.12	1.26	<0.001
Mixed	1.16	1.09	1.23	<0.001
Other	1.23	1.14	1.32	<0.001
Model 3.8 - Parental SES**				
Low (ref)	1.00			
Intermediate SES	1.02	0.96	1.08	0.518
High SES	1.04	0.99	1.08	0.118

*To improve interpretability, ratios are presented as the exponentiated values of the log-transformed coefficients and represent changes in the ratio of the mean eating occasion size (kcal). For example, an exponentiated value of 1.14 represents a 14% difference in eating occasion size between the specified eating context/individual characteristic and its reference category.

†adjusted for time of day, day of week, day number, age, ethnicity, parental SES and misreporting (and eating occasion type as potential mediator), ‡adjusted for time of day, day of week, location, day number, age, ethnicity and misreporting (and eating occasion type as potential mediator), §adjusted for time of day, day of week, location, eating companion, sitting at the table, day number, age, ethnicity, parental SES and misreporting (and eating occasion type as potential mediator), |adjusted for time of day, day of week, location, eating companion, watching TV, day number, age, ethnicity and misreporting (and eating occasion type as potential mediator), ¶adjusted for misreporting, total daily energy intake and zBMI (and eating frequency as potential mediator), **adjusted for misreporting, total daily energy intake, ethnicity and zBMI (and eating frequency as potential mediator)

5.4.2.2 Associations of individual characteristics with eating occasion size

Figure 5.4 presents the association of individual characteristics with eating occasion size in kilocalories from Models 3.5 to 3.8. Table 5.5 presents the ratios and 95% CI from Models 3.5 to 3.8. Preschool children of Black, Asian, Mixed and Other ethnicities had eating occasion sizes slightly larger than children of White ethnicity, by 23kcal, 22kcal, 19kcal and 27kcal, respectively. Gender and parental SES showed no evidence of association with eating occasion size. Eating frequency was added as a potential mediator to the models to account for eating occasion size being larger due to eating less frequently. After adding eating frequency, being older was no longer associated with eating occasion size (fully mediated relationship) (Table 5.5, Appendix 24).

5.4.2.3 Explaining eating occasion size variation by eating occasion versus child characteristics

Table 5.6 presents the variance estimates for each of the multilevel models. The null-intercept model showed most of the variation in eating occasion size was attributed to characteristics of the eating occasion (90% variance), leaving just 10% variation attributable to characteristics of the preschool children. Eating contexts (location, eating companion, watching TV, and sitting at a table) explained 16% of the total variance in eating occasion size, whereas the individual characteristics (age, gender, ethnicity, parental SES) explained just 2%. When all exposures and confounders were added, total variance explained was 23%, which increased to 41% when mediators (eating occasion type and eating frequency) were added.

Figure 5.4. Associations of individual characteristics with eating occasion size among preschool children, in the National Diet and Nutrition Survey 2008-17

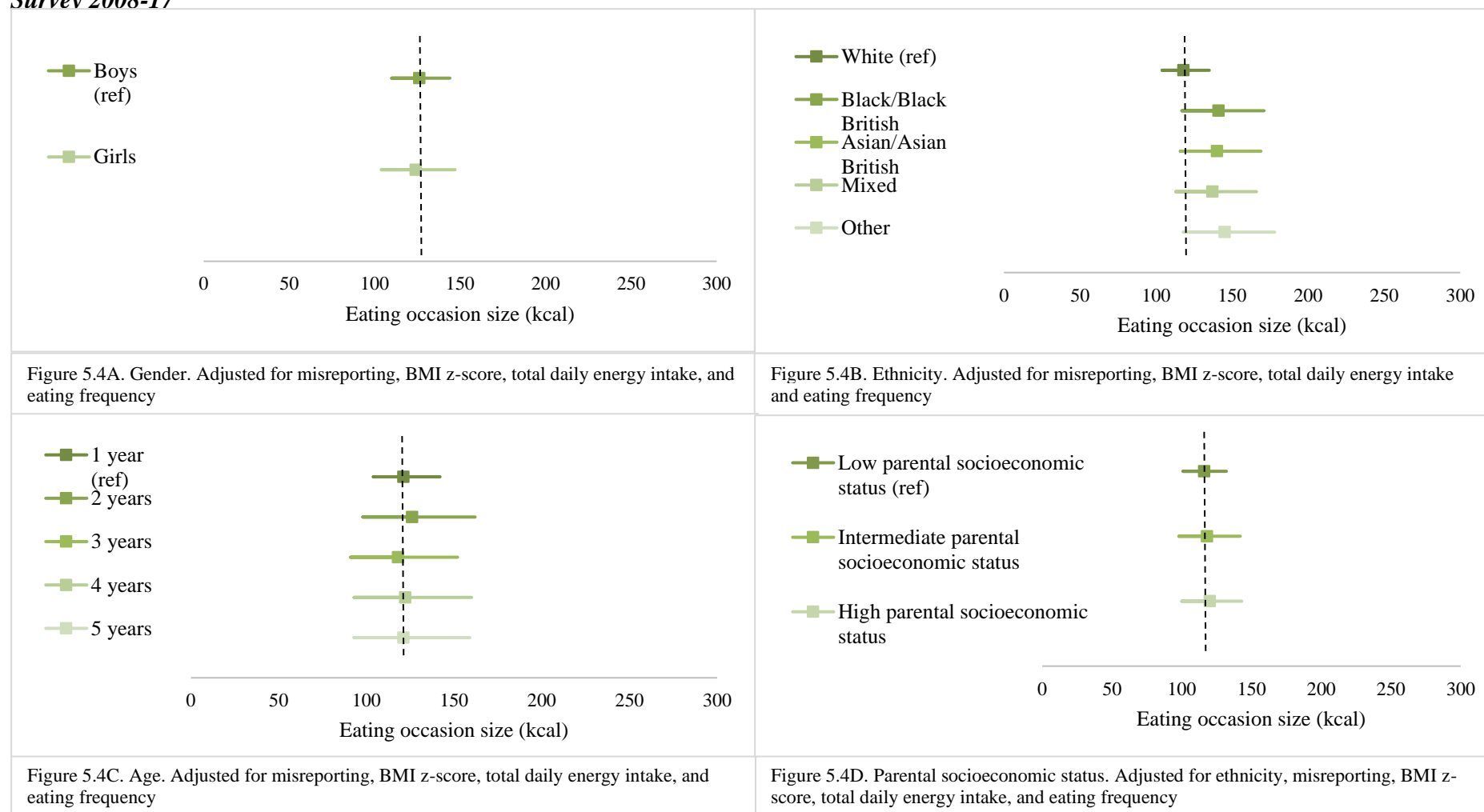


Table 5.6. Within and between-person and total variance explained across the different models among young children 1-5 years (n 1962), in the UK National Diet and Nutrition Survey 2008-17

	Null intercept	Models 1.1-1.8 - Unadjusted		Models 2.1-2.8 – Adjusted for potential confounders	Models 3.1-3.8 – Adjusted for potential confounders and mediators
		Eating contexts	Individual characteristics	All exposures and confounders	All exposures, confounders, and mediators
Variance (%)*					
Between-child variance explained (%)†	n/a	22	19	55	84
Within-child-between EO variance explained (%)†	n/a	16	0	20	36
Total variance explained (%)†	n/a	16	2	23	41
Log maximum likelihood	155890	127359**	153548**	99677**	91736**
N young children	1,962	1,955	1,924	1,558	1,558
N eating occasions	48,419	42,225	47,559	33,578	33,578

*Inter-class correlation (ICC) calculated and multiplied by 100 to give percentage variance

†Calculated as percentage change from Model 1 (null intercept model with no explanatory variables)

**P<0.001. A likelihood ratio test was conducted by comparing the deviance across models

5.5 DISCUSSION

Ninety percent of the variation in eating occasion size was within children, with only 10% attributed to differences between children. Eating contexts explained 16% of the total variance in eating occasion size, compared to only 2% explained by individual characteristics. These findings suggest factors that differ from one occasion to another (such as eating contexts) can better help us to understand why portion sizes are larger in this sample of preschool children than factors that differ from one child to another (such as individual characteristics). The findings align with Toumpakari et al.,¹²⁷ who found 89% of variation in non-core energy intake in adolescents was attributed to characteristics of the eating occasions. I therefore support future research and guidance to focus on the eating environment in preschool children.^{169,261}

Public Health England (PHE) recommended children should only consume two 100kcal snacks (excluding fruit and vegetables) per day.²⁶² The findings suggest preschool children in this sample, on average consumed more than three 96kcal snacks per day, which could exceed PHE recommendations. Median meal size was 251kcal. A systematic review of resources recommending portion sizes for one- to five-year-olds found recommended meal sizes across resources were between 113kcal and 421kcal.¹⁶⁹ A comparison should be interpreted with caution because several resources included in the review recommended portion sizes to meet energy requirements of 3-5-year-olds (whereas this sample also included young children, with lower energy requirements). If following certain recommendations, such as those from the Infant and Toddler Forum,³¹ preschool children in this sample could be consuming larger meals than recommended. This highlights the need to promote consumption of age-appropriate portion sizes to meet energy requirements.

Sitting at a table was independently associated with an eating occasion size on average 43kcal larger than not sitting at a table. Compared to eating with parents only, eating occasion size was larger when eating with parents and siblings and with family and friends, by 14kcal and 17kcal, respectively. Compared to eating at home, eating occasion size was larger when eating in childcare and at a friend's or relative's house, by 29kcal and 15kcal, respectively. Similarly, Marr et al.,²⁶³ found preschool children consumed more energy, as well as greater sodium, saturated fat, added sugars and vegetables per

eating occasion when eating with the wider family compared to with just parents but less added sugars and more fruit when eating in childcare compared to with parents. Although portion sizes may be larger in these contexts, this is only problematic if portions are large enough to result in surplus energy intake, as this could lead to excessive weight gain.⁵⁴ It may be larger portions of healthy foods, such as vegetables are being consumed in these contexts,⁶³ due to larger servings,⁴⁶ or consumption being encouraged and modelled by others.²⁶⁴ However, large portions of vegetables are not likely to result in calorie dense eating occasions because of their low-calorie content. If high energy dense foods such as desserts are being consumed in these contexts,²⁶⁵ this could substantially increase the calorie content of an eating occasion and lead to a surplus energy intake. The results suggest larger eating occasions were more energy dense, contained more food groups and were being driven the most by a greater percentage energy from starchy foods and proteins (Table 5.2 and Table 5.3). The findings suggest parents and childcare settings may need education on how to achieve balanced meals containing appropriately sized portions across food groups.

I accounted for other eating contexts and individual characteristics that could have been associated with eating at a table, with others, and out-of-home (such as sitting at a table being more likely in eateries and during lunch, when meals are larger).^{231,266} Parental feeding styles and practices,⁴⁸ modelling behaviours²⁶⁷ and how much parents serve themselves¹⁰⁷ influence what and how much preschool children eat. Certain practices and behaviours, such as encouraging plate-cleaning, can lead parents to override their children's ability to self-regulate their intake, leading to long-term over-consumption.²⁶⁷ It may be that when children eat at the table with their parents (and others), the social influences contribute towards consuming more. Interventions targeting parent feeding styles^{268,269} should incorporate portion size advice to help promote children's self-regulation from a young age.

Eating in eateries (such as cafes, fast food outlets and restaurants) was independently associated with the highest eating occasion size; on average, 90kcal larger than eating at home. This is not surprising considering the existing literature suggesting restaurant meals (including children's meals) are large in portion size, too energy dense²³¹ and do not meet nutritional standards.²⁷⁰ In addition, eateries are associated with higher consumption of ultra-processed²⁷¹ and non-core¹²⁷ food, in children and adolescents. In

this sample, only 34% of preschool children ate at eateries (only 2% of the total number of eating occasions). Similarly, Mak et al.,⁶³ found only 2.3% of the total eating occasions were consumed in eateries among seven- to 10-year-olds. However, large portion sizes served in eateries could influence consumption norms, by distorting both parents' and children's understanding of appropriate portion sizes,⁸³ especially when children are more susceptible to consuming large portions.⁴⁸ As stated in the UK Childhood Obesity plan,¹¹ reducing calorie content (and therefore portion size) of meals served in eateries could be a target for action. The number of out-of-home eating occasions may have been under-reported by parents due to the increased burden.²⁷² However, given the small number of eating occasions that were reported in eateries, to have a greater effect on reducing child population-level portion sizes, it may be more appropriate to target the home and childcare environments, where I found more meals and snacks were consumed (73% and 11%, respectively).

Although, I and others^{61,106} have identified individual characteristics and eating contexts associated with consuming larger portions, the models only explained 41% of the total variation. This suggests there are several other factors that need to be identified to fully explain why portion size varies in preschool children. A child's susceptibility to consume large portion sizes is due to a complex combination of nature (e.g genetics), nurture (e.g parent feeding practices), individual traits (e.g satiety), and the environment (e.g home food environment).⁴⁸ Child-related factors, such as eating traits and liking of the food, caregiver-related factors such as caregiver portion sizes and feeding practices¹⁰⁸ and food-related factors, such as energy density¹¹⁴ may all interact to influence the portion sizes children consume. The results suggest research should focus on building the evidence base for factors associated with portion size that vary from one eating occasion to another (because this is where most of the variation in eating occasion size lies). Factors such as the food environment, child temperament, hunger and liking, parental feeding practices, serving method and food type should be further explored, whilst also considering how individual traits and characteristics may be bidirectionally related.⁴⁸

Experimental portion size manipulation studies have shown significant increases in energy intake from a meal or snack, as a result of serving large portion sizes, by between 15 and 83 kilocalories.^{45,97,103,113,114,125,171,273} Although I do not have data on the served portions and the data on consumed portions is an estimate of energy intake, I observed

associations, which equated to eating occasions being between 11 and 90 kilocalories larger than reference category eating occasions. The difference in kilocalories is relatively small when comparing one eating context or child to another. However, if preschool children consistently consume meals or snacks in certain contexts or because of individual characteristics, which are associated with larger portions, this may have implications for excessive energy intake over time, and excessive weight gain.^{42,54} Hebestreit et al.,⁹⁰ found daily food intake (grams) and total energy intake (kcal) were positively associated with BMI z-score in two- to nine-year-old children. However, in a combined model only total energy intake was independently associated. As portion size is highly related to energy intake, the consistent consumption of large calorie dense portion sizes may contribute to excessive total energy intake and weight gain over time.⁵⁴ Therefore, the focus on age-appropriate portion sizes and energy intakes is critical.²⁷⁴ In addition, caregivers may benefit from guidance highlighting how the food environment can encourage the consumption of larger portions.

5.5.1 Strengths and limitations

Using multilevel modelling, I have accounted for the clustered hierarchical nature of our data (whereby eating occasions are nested within individuals). The multilevel models have accounted for both within, as well as between variation in eating occasion size in preschool children, which minimises the potential biases related to person-level unmeasured variables associated with our outcome variable.²⁷¹ I used combined data from the NDNS Years 1-9, which enabled analysis of a large, UK nationally representative sample. I considered each exposure variable as a separate model to ensure appropriate adjustment for confounders and mediators, and to increase reliability.

The main limitation was energy density of and types of foods in the eating occasions were not analysed in detail, which limits our interpretations. Although based on previous research^{258,275} and preliminary work (Appendix 15), my chosen definition of eating occasion type may have inaccurately classified some eating occasions as meals and snacks and affected estimates. Despite this, Model 3, which included eating occasion type and eating frequency as potential mediators was presented as the final model. Model 2 was provided for comparison between models. Including eating occasion type in Model 3 provided a more meaningful interpretation of the estimates because only meals were compared to meals and only snacks compared to snacks, which accounted for the

systematic difference in size between meals and snacks. For example, eating on-the-go was associated with a smaller eating occasion size in Model 2 but in Model 3, when accounting for snacks being the predominant eating occasion on-the-go, an association was no longer observed. Similarly, including eating frequency in Model 3 provided more meaningful interpretation because the size of an eating occasion may depend on how frequently a child eats.

Due to the cross-sectional nature of the data, the findings do not provide evidence of causation. The sample included mostly White British preschool children (86%) and so the findings may be less generalisable to other ethnic groups. Although, misreporting of energy intake was calculated and added to models, the parent-reported dietary data were subject to mis-reporting and subject bias.⁴⁹ The variables selected for analysis only explained 41% of the variation in eating occasion size, which limits the interpretations. The survey lacked data on appetite traits and parental feeding behaviours,⁴⁸ which may have improved the percentage variance explained and enhanced our interpretations.

5.5.2 Future research and policy implications

Future research should continue to focus on eating habits of children and how these may affect energy intake, dietary intake, and weight gain. Future research should pull together data or create new datasets that include all the factors previously associated with portion size in children, to better understand which factors have the greatest influence on increasing children's susceptibility to consuming larger portions. Future research should explore how the portion sizes of specific food groups or individual foods are combined and how they contribute to large eating occasions. It is also important to establish an accepted consensus for classifying eating occasions as meals and snacks where participant-reported eating occasions are not available. Future research should compare consumed meal and snack sizes reported in national surveys with the recommendations, to establish whether young children are overconsuming.

Governments and food industries should work together to agree on policies to reduce out-of-home portion sizes of children's meals and snacks. This could be achieved through the combination of reducing dishware and packet sizes,^{129,130} introducing calorie caps on meals in eateries (similar to the UK Soft Drinks Industry Levy)²⁷⁶ and/or price incentives for selecting smaller portions.²⁷⁷

5.5.3 Conclusion

To conclude, efforts to reduce portion sizes in children should focus on eating contexts rather than children with certain demographic characteristics. Eating in eateries, sitting at a table, in childcare, with other family members and friends, and watching TV were all eating contexts associated with larger eating occasions. Young children may be consuming larger than appropriate meals and snacks. Therefore, effective strategies to promote the consumption of age-appropriate portion sizes, especially in the home environment should be developed.

5.6 IMPLICATIONS FOR THE THESIS

The findings of this study suggest eating contexts that vary from one eating occasion to another may be more important than demographic characteristics that vary between children in explaining why consumed portion sizes are larger in preschool children. Promoting the consumption of age-appropriate portion sizes in these eating contexts may be particularly important for maintaining healthy weight gain among preschool children.

CHAPTER 6. DISCUSSION

6.1 OVERVIEW

This final chapter summarises, synthesises and triangulates the main findings of the three studies presented in this thesis. The first study was a systematic grey literature review, identifying existing portion size guidance resources. The second was a qualitative study exploring parental portioning practices and awareness of existing portion size guidance resources among first-time parents of one- to two-year-olds. The third study was a secondary data analysis of the National Diet and Nutrition Survey (NDNS), to explore factors associated with large eating occasions. In this chapter, I will discuss the study findings and their contribution to the existing literature, present the strengths and limitations of the thesis, and discuss implications for future research and policy. I end this chapter with an overall conclusion, focusing on how this thesis can inform future research and strategies to promote the consumption of age-appropriate portion sizes among preschool children.

6.2 SUMMARY AND SYNTHESIS OF MAIN FINDINGS

Large portion sizes have been suggested to contribute to the rise in obesity.³⁷ Previous research suggests the consumption of large portions may be a problem among preschool children because 1) portion sizes of high energy dense foods have increased over time, increasing the availability of large portions to preschool children,⁶⁴ 2) large portion size has been associated with excessive weight gain in preschool children,⁵⁴ and 3) preschool children are susceptible to the portion size effect, whereby they consume more energy when served a larger portion of food.¹⁰² Previous literature has explored factors that may increase preschool children's susceptibility to the portion size effect. In addition, previous research has identified parental portioning practices, which influence the amount children are served. However, key questions arose from the previous literature, which were addressed in this thesis.

Table 6.1 presents an overview of the research objectives and main findings of each study. I identified an abundance (N=22) of portion size guidance resources available in the UK (CHAPTER 3), which my qualitative study (CHAPTER 4) identified were not generally being accessed by parents to help determine the portion sizes served to

preschool children. Other qualitative studies have also found parents in the UK are not generally aware of or do not use portion size guidance to help determine served portions.^{140,152,153} The finding that parents are not aware of portion size recommendations (and do not want to strictly follow guidance resources), and therefore may not be serving age-appropriate portions is particularly important. Comparing the median recommended portion sizes for breakfast (249kcal), main meal (242kcal) and snacks (142kcal) across all guidance resources (see section 3.4.7), with the estimated median consumed portion size of meals (including breakfast and main meals) (251kcal) and snacks (96kcal) in the NDNS sample (see section 5.4.1.1) suggests preschool children may be consuming portion sizes in line with current recommendations. However, there was variability between resources in the meal and snack sizes recommended (some resources recommended much smaller meal sizes) and variability in the estimated median consumed portion sizes. In addition, several guidance resources stated recommending portion sizes to meet the energy needs of three- to four-year-olds, whereas the NDNS sample included a wider age range of one- to five-year-olds. The variability suggests for certain children or in certain contexts consumed portion sizes may be larger than recommended.

CHAPTER 5 found eating contexts, such as eating in eateries, eating sitting at a table, eating in childcare, eating with others, and eating whilst watching TV to be associated with the consumption of larger portion sizes (more calories were consumed in an eating occasion in these contexts). Parents have some control over the serving and/or consumption of their children's portion sizes in most of these eating contexts. Other studies which used the NDNS to explore portion sizes and eating occasions found the consumption of high energy dense foods was also associated with eating in eateries, eating with others, and eating watching TV.^{61,127} Therefore, future research and policies should focus on how parents can be supported to serve age-appropriate portion sizes across a range of eating contexts.

Table 6.1. Summary of key findings for each study and the research objectives addressed

Research objective	Main findings
<p>Systematic grey literature review (Chapter 3)</p> <ul style="list-style-type: none"> • To identify existing portion size guidance resources in the UK and Republic of Ireland aimed at feeding preschool children. • To describe their content, presentation, intended audience and how they were informed and to compare portion size recommendations across guidance resources. 	<ul style="list-style-type: none"> • 22 portion size guidance resources aimed at feeding one- to five-year-olds were identified. • Resources either presented portion size recommendations as individual foods or within meals. • 59% of resources were aimed at childcare providers and 31% aimed at parents. Other resources were aimed at health professionals and preschool inspectors. • Resources included consistent recommendations for portion sizes of fruit and vegetables. • Variability was observed across resources for recommended portion sizes of foods for dairy, starchy, and protein food groups and for main meals.
<p>Qualitative study interviewing first-time parents of one- to two-year-olds (Chapter 4)</p> <ul style="list-style-type: none"> • To understand the portioning practices used by first-time parents of one-to-two-year-olds to serve child portions and the influences affecting these practices. • Informed by study one, to explore first-time parents' awareness of and opinions on existing portion size guidance resources. 	<ul style="list-style-type: none"> • Most first-time parents were unaware of and did not use the existing portion size guidance resources shown to them. • Parents used their own experience, alongside physical indicators of portion size (such as dishware and package size) to determine the portions to serve to their one- to two-year-olds. • Parents used a spectrum of practices to encourage eating and limit or restrict portions, which were influenced by the type of food, child-related, parent-related and external factors. • Parents suggested any written guidance needed to be short and concise, available in a range of accessible formats and from a trusted source, and include bold colours and food images that provide visual representation of portion sizes. • Parents liked to be child-led and expressed they would probably not strictly follow the portion size recommendations in guidance resources.

Research objective	Main findings
<p>Secondary data analysis of the National Diet and Nutrition Survey (Chapter 5)</p> <ul style="list-style-type: none"> • To explore the within and between variation in consumed portion size among preschool children to better understand the contribution of individual versus environmental-level factors that may lead to the consumption of larger portions. • To explore whether certain individual characteristics and eating contexts are associated with larger portion sizes. 	<ul style="list-style-type: none"> • 90% of variation in eating occasion size was attributed to differences between eating occasions, with only 10% attributed to differences between preschool children. • Eating contexts that vary from one eating occasion to another are more important than demographic characteristics that vary between children in explaining variation in consumed portion sizes in preschool children. • Eating in eateries, sitting at a table, in childcare, with others and whilst watching TV were eating contexts associated with larger portion sizes per eating occasion. • Preschool children of Black, Asian, Mixed and Other ethnicities consumed larger portion sizes per eating occasion than White preschool children.

6.3 STRENGTHS AND LIMITATIONS

Strengths and limitations of the individual studies are presented in sections 3.5.2, 4.5.2, and 5.5.1. The broader strengths and limitations of the thesis are discussed here. Studies presented in CHAPTER 3 and CHAPTER 4 were the first to identify and explore the use of existing portion size guidance aimed at feeding preschool children in the UK in detail. A key strength of this thesis was the use of multiple methods to address the research objectives using the most appropriate method. The topic area was considered both quantitatively and qualitatively to gain insight into associations, as well as in-depth understanding of practices. Using multiple methods, I have gained understanding of portion sizes in preschool children from the policy and guidance perspective (CHAPTER 3), the parental serving perspective (CHAPTER 4), and the child consumption perspective (CHAPTER 5), which when triangulated help better direct and inform future research, policy and practice.

Information about how the portion size guidance resources identified in CHAPTER 3 were informed was collected via internet searches and contacting the organisations responsible for creating and disseminating the resources. However, a full assessment of the quality of resources was not conducted, as no formal framework exists to assess the quality or risk of bias of grey literature. Such a framework would have been useful to help suggest which resources could be used in future research and to inform strategies to promote the consumption of age-appropriate portion sizes. In addition, it is possible that new or updated portion size guidance resources have been published since the searches were conducted.

In CHAPTER 5, the NDNS dataset was used, which includes dietary data from a representative sample of preschool children in the UK and is one of the most generalisable datasets available to explore consumed portion sizes in children. The sample of preschool children in the NDNS were predominantly White (86%), which is representative of the whole population in England and Wales (86% White).²⁷⁸ The sample of first-time parents recruited to the qualitative study in CHAPTER 4 were also predominantly White (67%). Thirty-three percent of first-time parents recruited were from an ethnic minority group (compared to 14% of the whole population in England and Wales being from an ethnic minority group). However, this only included nine parents,

therefore cultural differences in portioning practices and use of guidance could not be established. A greater percentage of the sample of first-time parents recruited to the qualitative study were highly educated (first degree (or equivalent) or above) (89%), compared to a measure of population-level education in England (44% of 17- to 29-year-olds had a first degree (or equivalent) or above in 2019).²⁷⁹ Portioning practices and opinions on portion size guidance could differ among parents with lower educational attainment in the UK.

The consumed portion size data analysed in CHAPTER 5 was based on parental report of what and how much food and drink preschool children consumed over three to four consecutive days. Therefore, data were subject to misreporting.⁴⁹ The findings from CHAPTER 4 and CHAPTER 5 may have been subject to social desirability bias (the tendency of participants to respond to questions in a way that will be viewed as favourable by the interviewer).⁶⁰ In both studies, parents may have responded to interview questions and completed the food diaries in a way that they perceived to be more socially acceptable. The qualitative interviews were limited to retrospective accounts of portioning practices and although food diaries are supposed to be completed at the time of consumption, retrospective accounts may have been used. Due to the level of subjectivity required to analyse qualitative data, the data may also be subject to a level of interpretative bias (tendency of the researcher to inappropriately analyse or interpret data).²⁸⁰ Participant observation methods may have complemented the findings from CHAPTER 4 and CHAPTER 5 but could not be conducted due to time restraints and COVID-19 restrictions.

Including a measure of parental serving size in CHAPTER 5 could have aided interpretation of the thesis, by providing additional links with the qualitative study and grey literature review, however was not collected in the NDNS. Key potential factors highlighted in the qualitative study and previous research,^{48,108} such as child appetite traits (possible between-child factor), parental feeding practices, parental feeding motivations and child hunger (possible within-child factors) were also unavailable in the NDNS dataset but could have helped to explain more of the variation in eating occasion size.

6.4 IMPLICATIONS FOR FUTURE RESEARCH

It has been suggested that reducing portion sizes of commercially available food should be a key focus of childhood obesity prevention programmes.²⁸¹ I acknowledge that programmes to prevent childhood obesity should have multiple components, focusing on not only portion size but also the whole system including the wider food-environment, dietary intake, enabling physical activity and reducing sedentary time.²¹ However, in this discussion I focus specifically on implications for research and policy regarding portion size in preventing childhood obesity. Ensuring the consumed portions sizes of meals and snacks are appropriate to meet, but not exceed, total daily energy needs among preschool children is important.⁵⁴ To achieve this, a combination of downsizing energy dense food portions (e.g. food high in fat and sugar), as well as promoting intake of low energy dense fruit and vegetables and adequate (but not excessive) intake of other food groups is likely required.

Robinson et al.,²⁸² conducted a systematic review and meta-analysis of experimental studies (not peer reviewed) exploring the effect of reducing the served food portion on daily energy intake and body weight in children and adults. Results from the preprint article showed a moderate-to-large reduction in daily energy intake (kcal) when serving smaller versus larger portion sizes (portions reduced by 20-74%) (standardised mean difference = -0.709 95% CI -0.956, -0.461, $p < 0.001$), which equated to a reduction in daily energy intake of 236kcal. In addition, effect size was greater when more than two meals across the study period (which ranged from one to 28 days across studies) were served as smaller portions. Serving smaller portions was also associated with gaining less weight (over four days to six months) among adults (no studies in children included). However, results suggested smaller portions were partially compensated for by consuming more energy at later meals. This review provides evidence for the causal relationship between portion size, daily energy intake, and subsequent changes to body weight. However, findings were predominantly based on studies in adults (only two studies in children). Therefore, more research is needed to establish the impact of serving smaller portions on daily energy intake and body weight in children. In addition, future research should focus on developing interventions and informing policies to downsize large portions of food and drinks commonly consumed by children.

Previous prospective research suggests the consumption of large portions, in terms of total energy consumed from an eating occasion is associated with excessive weight gain in preschool children.⁵⁴ Future research should focus on collecting objective measures of served and consumed portions, which are less subject to misreporting, such as food photography.²⁸³ This data should be used to explore what is driving the consumption of large portions, especially in eating contexts such as eateries, childcare, sitting at a table, eating with others and watching TV, which I found to be associated with larger eating occasions in section 5.4.2.1.

It has not been established whether large eating occasions (i.e. the total calorie content of an eating occasion) are driven by the inclusion of certain high-calorie foods or food groups (such as energy dense foods high in fat and sugar) or driven by large portions across all foods and food groups. Results from the descriptive analyses in section 5.4.1.1 suggested larger eating occasions were positively correlated with percentage energy from all food groups, with correlations being strongest for the starchy and protein food groups. Variability in the recommended portion sizes (in terms of calories) of foods from the starchy and protein food groups was also observed across guidance resources in section 3.4.6, suggesting portion size recommendations for starchy and protein foods may not be clear.

The qualitative findings from CHAPTER 4, and other studies⁴¹ suggest parents try to achieve balance across food groups when serving meals to their children, however it is uncertain what parents perceive a healthy balance to be in terms of portion sizes. Parents often encourage eating of meals but limit or restrict foods high in sugar and salt (although parents may not necessarily adhere to the recommended portion size limits of these foods). Johnson et al.,²⁸⁴ found a high energy dense, low fibre, high fat diet consumed at age five and seven to be associated with adiposity in children at age nine. Together, these results suggest large eating occasions may be driven by large portions of more than one food group. However, more research is needed to explore meal patterns²⁸⁵ and their contribution to portion size, daily energy intake and excessive weight gain in preschool children. Although restriction of foods high in fat and sugar may be required to reduce total energy intake, the balance of other food groups is also important. Increasing portions of fruit and vegetables rather than more energy dense starchy and protein foods to ensure fullness may be an effective strategy to maintain energy balance for healthy growth. A

multi methods approach, involving participant observations and objectively measured food and energy intake may provide a more robust way to identify the social, environmental, as well as food-level factors associated with larger eating occasions.

Fruit and vegetables are low in energy density and therefore may drive down the total calorie content of eating occasions, if the intake of fruit and vegetables is replaced by the intake of other higher energy dense foods. Roe et al.,¹²⁴ found increasing fruit and vegetable portions by 50%, whilst decreasing all other foods by an equivalent weight across five consecutive days, resulted in an increase in fruit and vegetable intake, as well as a decrease in total daily energy intake (kcal) by 6%. Similarly, Reale et al.,²⁸⁶ found replacing high energy dense snacks with vegetable snacks for one week resulted in a 145kcal reduction in total daily energy intake. Increasing the portions of fruit and vegetables within meals and snacks (whilst reducing portions of other food groups) or replacing energy dense snacks with fruit or vegetables may be effective in reducing overall eating occasion size, whilst also increasing the intake of fruit and vegetables. However, it is important to note the potential barriers of this strategy. Children may not like fruit and vegetables²⁸⁷ and so repeat exposure by parents to increase familiarity, liking and therefore intake^{288,289} would be required for some children. In addition, fruit and vegetables may be less affordable and accessible to socially disadvantaged parents, who may also not be in a position to provide repeated exposure, due to the risk of food waste.²⁹⁰ Therefore, work is needed to significantly improve the availability and accessibility of healthy foods to disadvantaged communities and assist parents to swap energy dense snacks for fruit or vegetables.^{262,291}

Current qualitative evidence mostly reflects portioning practices of parents of middle to high socioeconomic status.⁴¹ Parents of lower socioeconomic status may be less likely to restrict high energy dense foods due to these foods being more affordable, accessible, and quicker to prepare.²⁹⁰ In addition, parents of lower socioeconomic status may have less knowledge of what constitutes a healthy balanced diet and fewer strategies to resist pester power (children continue to ask for unhealthy foods).^{292,293} An association between child overall eating occasion size and parental socioeconomic status was not observed in CHAPTER 5. However, previous research observed an association between lower parental socioeconomic status and larger consumed portions of high energy dense snack foods among children aged up to 18 years.⁶¹ If large eating occasions are being partly

driven by the consumption of high energy dense foods, environmental strategies could be put in place to reduce availability and accessibility of these foods to parents and children, whilst making healthy alternatives, such as fruit and vegetables more affordable and accessible.^{133,210,294} Future research should focus on exploring the drivers of large eating occasions and strategies to reduce excessive consumption, whilst also considering the impact of socioeconomic status and food inequality, to ensure health inequalities are also reduced.

6.5 IMPLICATIONS FOR POLICY AND PRACTICE

There are three key settings where reducing portion sizes could impact preschool children's intake. The first and most important is the home environment, as CHAPTER 5 found 73% of eating occasions were consumed at home, with most (85%) also being consumed with parents. The second is childcare settings, as more than 90% of three- to four-year-olds attend nursery in the UK^{295,296} and consume food in this setting. The third is eateries (restaurants, cafes, takeaways, fast-food places). Although eating in eateries is less common among preschool children (I found only 34% of preschool children in the NDNS sample ate in an eatery during the four days food diaries were completed), evidence suggests eating out-of-home becomes more frequent during adolescence¹²⁷ and the portion sizes consumed in eateries may distort perception of appropriate portion sizes to serve to preschool children.⁸³ In addition, findings from section 5.4.2.1 suggest consumed portion sizes are larger in several eating contexts in the home environment (sitting at a table, eating with others, watching TV) and in childcare and eateries. Therefore strategies that target all three settings are required to reduce consumption of large portions in preschool children, with the priority being the home environment.

A population approach²⁹⁷ may be more effective in reducing large portions to prevent child overweight, than targeting high-risk children. In CHAPTER 5, I found only 10% of variation in portion size was due to differences between preschool children (such as individual characteristics that could be used to identify children at most risk), a finding which has been similarly observed among adolescents.¹²⁷ In addition, in CHAPTER 4 I found parents influence the portion sizes children consume through portioning practices that rely on external indicators of portion size, such as dishware and packaging. Parents are a key influence on children's intake¹⁵ because they model eating behaviours²⁶⁴ and the portions parents serve themselves are associated with the portions served to their

children.¹⁰⁷ Therefore, to reduce consumption of large portions among preschool children, parents should be the main intervention target and we ideally need to reduce portion sizes among parents too.

Considering the COM-B framework for understanding behaviour,²⁹⁸ a parent's behaviour to reduce large portion sizes will be influenced by: parental motivation to carry out the behaviour (i.e. whether they feel it is important to reduce large portions), capability (i.e. whether parents have the knowledge and resources to serve age-appropriate portions), and opportunity (i.e. whether parents have the opportunity to purchase, prepare and serve age-appropriate portions). Figure 6.1 illustrates the COM-B framework for understanding parental behaviour to serve age-appropriate portion sizes. Interventions aiming to reduce child consumption of large portions of high energy dense foods and promote age-appropriate consumption across food groups within meals and snacks should target parental motivation, capability and opportunity to do so, and be evaluated for acceptability and effectiveness. The level of agency required should also be considered when developing interventions. Agency refers to the level of personal resources required to change behaviour.²⁹⁷ Low agency interventions require little to no personal thought or action (such as supplementing all flour with folic acid to increase population levels of folic acid), whereas high agency interventions require personal engagement and action (such as accessing, reading, understanding and acting on information available in a leaflet).²⁹⁷ The level of agency can also be considered in terms of level of coercion or intrusion, with low agency interventions being the most coercive or intrusive (e.g. restricted to only consuming bread supplemented with folic acid) and also needing a higher level of justification and public acceptance.²⁹⁹ Figure 6.2 presents potential interventions aimed to promote the consumption of age-appropriate portion sizes in preschool children, illustrated using the Nuffield Council on Bioethics 'intervention ladder' from lowest to highest agency. Each 'step' of the ladder is discussed below.

Figure 6.1. The COM-B system – a framework for understanding behaviour applied to the consumption of age-appropriate portion sizes among preschool children²⁹⁸

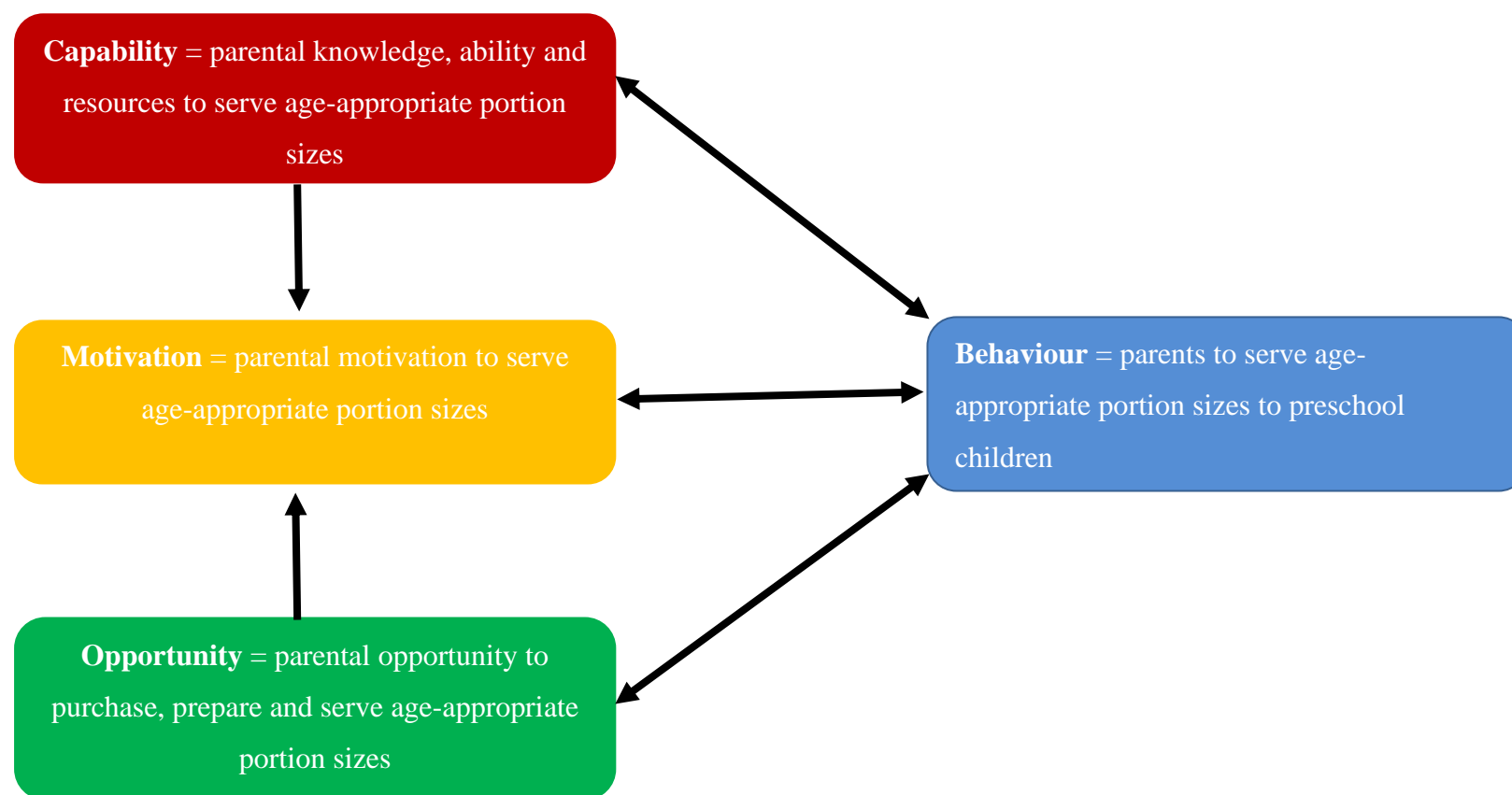
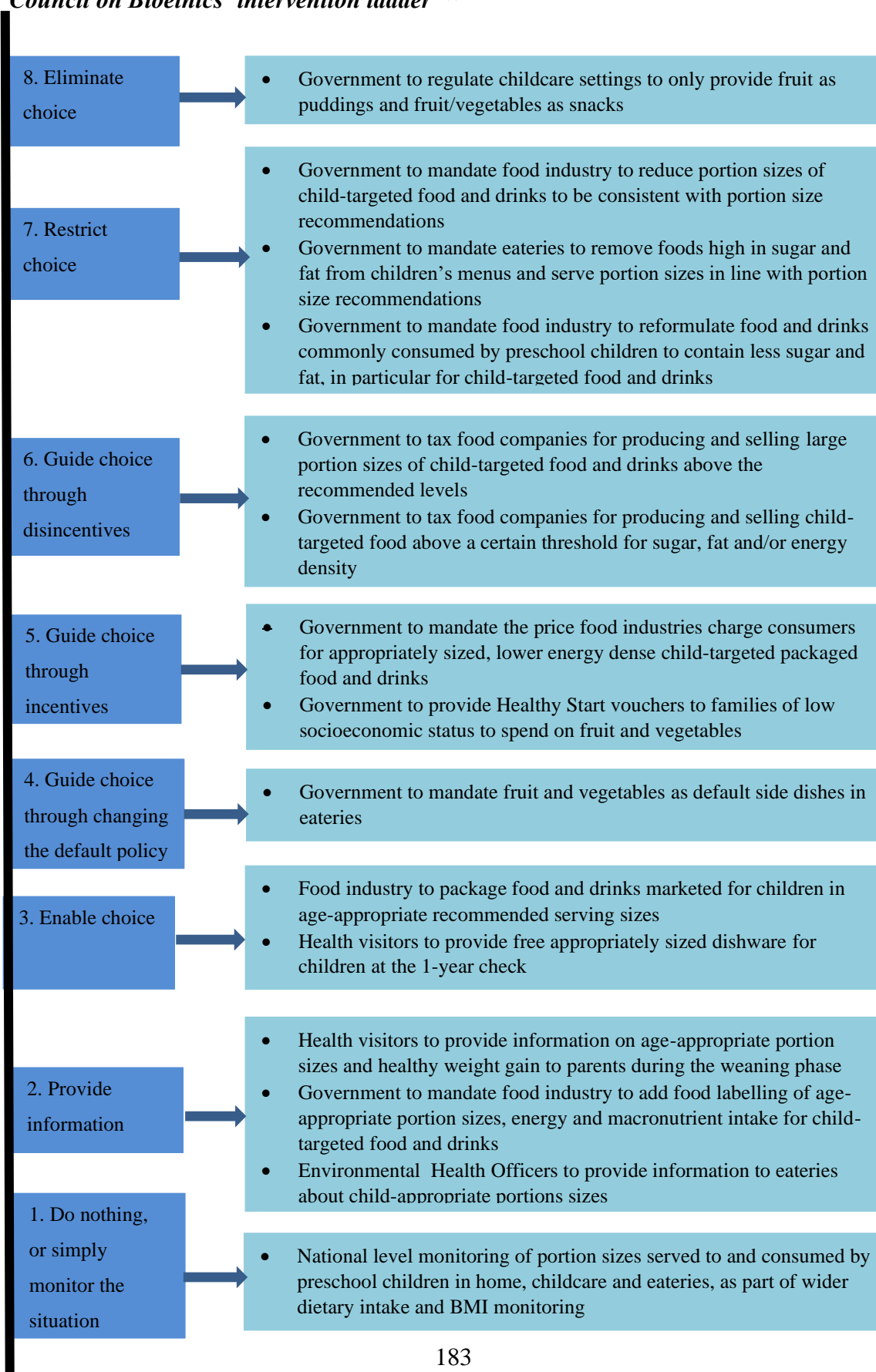


Figure 6.2. Potential interventions to promote consumption of age-appropriate portion sizes in preschool children from low to high agency, illustrated using the Nuffield Council on Bioethics ‘intervention ladder’²⁹⁹



6.5.1 Do nothing, or simply monitor the situation

The first step on the intervention ladder is to do nothing, or simply monitor the situation (Figure 6.2).²⁹⁹ With the increasing levels of childhood obesity⁴ and prospective evidence suggesting large portion sizes are associated with excessive weight gain in preschool children,⁵⁴ doing nothing should not be considered an option. There is currently no national level monitoring of served or consumed portions and as section 2.4 found, there is very limited research on portion size trends in children in the UK. The NDNS collects dietary intake data (including estimated consumed portions) from a nationally representative sample, including preschool children, but does not evaluate or report portion size data.³⁰⁰ Findings from CHAPTER 5 and other studies^{61,62} show consumed portion size data for eating occasions, individual foods and food groups can be evaluated using the NDNS (although data on served portions are not currently collected). The monitoring of served and consumed portions among children, alongside monitoring of dietary and energy intake and BMI could help build the evidence base needed to strengthen the relationship between portion size and BMI⁸⁴ and inform and justify the use of more coercive and intrusive (but lower agency) interventions.

6.5.2 Provide information

Step two on Figure 6.2 illustrates information about age-appropriate portion sizes could be provided to parents in different settings, as well as eateries. Research suggests children's meals in eateries are often one size and are too large for some children.^{270,301} Therefore, information on age-appropriate meal sizes for preschool and older children could be provided to eateries to implement. Recent findings from an Action on Sugar report (not peer reviewed) found 59% of parents stated that a 'no added sugar' label on packaged snacks marketed for toddlers would be a reason for purchasing the snack. However 88% of items did not list sugar in the ingredients list (because food companies are not legally obliged to list free sugars). In addition, the report highlighted there are currently no government guidelines on sugar consumption for children under four years or guidelines on how toddler food and drinks should be produced and marketed.²³³ The UK government should provide clear dietary guidelines for preschool children, including age-appropriate portion sizes, which food companies should include on food labels to better inform parental decisions.

Findings from CHAPTER 4 suggest parents do not access portion size guidance resources because they are not aware of them, or are not deemed necessary for portioning, particularly beyond the weaning stage. However, parents expressed greater interest in knowing about feeding recommendations at the weaning stage, therefore, information could be provided by health visitors during the weaning phase, as part of the UK Healthy Child Programme (described in section 1.3). This could include disseminating one or more of the portion size guidance resources aimed at parents, identified in CHAPTER 3. In addition, public health commissioning teams could commission training for health visitors to recognise when children are at risk of excessive weight gain, as research suggests parents often inaccurately perceive overweight children to be normal weight.³⁰² However, information provided to parents should focus on promoting healthy weight gain trajectories rather than preventing excess weight gain to better align with parental motivations.⁴¹

Although strategies to provide information are non-coercive and sometimes require less or no policy changes (which can be time and resource-consuming),²⁹⁹ parents are required to engage with the information, have a level of health literacy, and be motivated to change their behaviour (i.e. change the portion sizes served to their child to be in line with recommendations) and are therefore considered high-agency.²⁹⁷ I and others⁴¹ have shown parents are not motivated to measure portions or restrict meals and do not want to strictly follow guidance. Therefore, other strategies, which enable, guide and restrict choice, requiring less agency are also required.

6.5.3 Enable choice

Step three of Figure 6.2 presents strategies that would enable parents to serve age-appropriate portion sizes of meals and snacks if they choose to do so. In section 4.4.1.1.1, I showed several parents used package size to determine the portion size to serve to their child. Increasing the availability of smaller portions at the point of sale by changing the packaging of child-targeted foods (especially if energy dense) to be in line with portion size recommendations (identified in CHAPTER 3) could be an effective strategy to reduce the intake of large portion sizes.³⁰³ This would give parents the opportunity to purchase and serve smaller portions but require less motivation because the food and drinks are already pre-packaged appropriately.

A systematic review by Chu et al.,³⁰³ suggested manipulating packaging by reducing the package size, displaying smaller servings on the front of packaging, partitioning packaging, and making packaging resealable may all be effective strategies to reduce consumption of high energy dense foods. Tang et al.,³⁰⁴ presented parents of two- to 13-year-old children with five foods high in fat and/or sugar (cookies, chocolate buttons, cereal, candy, and orange juice), which were packaged in a child-friendly way to promote age-appropriate consumption. The packaging included visual cues to indicate recommended serving size, partitioning, and cartoon-like images that portrayed a strong narrative for the recommended serving size. Tang et al.,³⁰⁴ explored parent's acceptability of, and willingness to pay for the newly packaged foods across two studies (one conducted at a UK science museum and one conducted as an online survey). The studies measured parental education (72% and 50% of parents had university education in study one and two, respectively). Overall, parents preferred the newly designed packaging compared to the original branded packaging, especially after being informed the packaging aimed to reduce intake of these foods. Some parents believed the packaging was a good reminder of recommended portion sizes and would help encourage child autonomy to serve themselves appropriate portions. However, other parents believed the packaging would not be helpful because they did not use package size to determine served portions. In general, parents were willing to pay more for the newly packaged foods compared to the original packaged foods. Willingness to pay more was higher among parents who were concerned about their children's weight and lower among parents who were concerned about price. Tang et al.,³⁰⁴ provide evidence that repackaging high energy dense foods targeted at children to promote consumption of smaller portions may be acceptable to parents and align with parental motivations to limit these foods and provide their children a healthy diet.⁴¹ However, parents should not have to pay more money for packaged food and drinks, which are appropriately sized and labelled, as this would likely increase health inequalities. Instead healthy, low energy dense, appropriately portioned foods should be made more affordable than unhealthy, high energy dense large portioned foods.²⁹⁴

As stated in section 6.4, promoting age-appropriate consumption across food groups and particularly increasing fruit and vegetable intake is required, as well as reducing portion sizes of high energy dense foods. Therefore, enabling parents (by creating opportunity and increasing capability) to put together appropriately sized meals and snacks is

important. Small et al.,³⁰⁵ conducted a pilot study with 45 mothers of four- to six-year-olds in the USA. A theory-led intervention to provide practical skill-based information to serve age-appropriate portions, as well as motivational support and general nutritional information was tested using a single group pre/post study design. The focus of the intervention was promoting a healthy weight gain trajectory. As part of the intervention, parents were asked to serve meals on a child-friendly plate, which was divided into sections to provide a visual guide of appropriate servings of each key food group. Results showed the average total daily energy served by parents and consumed by children decreased post-intervention to be in line with the recommended daily energy intake. Children were not asked whether they liked the plates, however the plates were generally well accepted by parents. This aligns with the qualitative findings in CHAPTER 4 and a review of parental portioning practices,⁴¹ as using dishware appears to be a key practice used to serve portions to children. The study by Small et al.,³⁰⁵ did not include random assignment to a control or intervention group and therefore is subject to confounding. However, the study provides promising evidence for the use of appropriately sized child plates to increase parental capability to serve age-appropriate meals and snacks, which are balanced across food groups and in line with daily energy intake recommendations. It is unknown whether current child-specific plates are manufactured in line with the portion size recommendations and so research into and regulation on this may be required. The portion size guidance resources identified in CHAPTER 3 could be used to inform the manufacturing of child dishware. Public health commissioning teams could train health visitors to provide child-specific appropriately-sized plates, as well as practical skill-based information on how to use the plates to promote consumption of age-appropriate portion sizes across food groups and healthy weight gain. Critically, these plates should be provided to parents before children turn one year (at which point parents may be most receptive to receiving feeding advice) to ensure knowledge is embedded before it is needed.²⁶⁸ This strategy is similar to other public health interventions, whereby health visitors provide parents a free toothbrush and toothpaste for their child to use, as part of a wider oral health education intervention, to improve oral health among young children.^{306,307}

6.5.4 Guide choice through changing default policy

Step four of Figure 6.2 suggest a strategy to increase intake of fruit and vegetables and reduce intake of more energy dense foods, by changing the default foods available in eateries and childcare settings. Findings from section 5.4.2.1 showed eating occasions in eateries to be on average 90kcal larger than eating at home among preschool children. Therefore, strategies to reduce children's meals in eateries such as serving fruit or vegetables as the default side dish³⁰⁸ and using smaller dishware²¹⁰ should be mandated by government.

6.5.5 Guide choice through incentives

Step five of Figure 6.2 suggests strategies, which would involve governmental policies to incentivise or mandate the food industry, to encourage parents to purchase and serve healthy, appropriately portioned child-targeted food and drinks. As stated in section 6.5.3, smaller sized, healthier food should be lower in price than larger, unhealthier food to provide not only nutritionally aware, affluent parents but all parents the opportunity to afford age-appropriate food for themselves and their children.²⁹⁴ Shifting purchasing to become healthier should be a social responsibility of the food industry²⁹⁴ but will require the government to mandate prices or incentivise food companies to ensure this change. Ensuring parents and the general public understand the need for this change is also very important to establish public acceptance.²⁹⁹ Winkler suggests a publicly accepted strategy (which avoids taxation) would be to create a price gap between healthy and unhealthy food by raising the price of sugar, whilst decreasing the production, to provide an economic incentive to purchase healthier options.³⁰⁹ Additional strategies such as providing socially disadvantaged families of preschool children food vouchers, to spend on fruit and vegetables could be an effective way to improve availability and accessibility of low energy dense foods,³¹⁰ which could also help narrow diet-related health inequalities.

6.5.6 Guide choice through disincentives

Step six of Figure 6.2 presents governmental strategies to tax food companies for producing and selling child-targeted food and drinks, which exceed recommendations for portion size, energy density, sugar and/or fat. Many of the current UK government strategies aimed at the food industry, as part of the UK childhood obesity plan¹¹ are

voluntary. These include challenging the food industry to reduce total sugar and total calories in food and drink products commonly consumed by children by 20%, by 2024, which could be achieved through reduction in portion sizes or reformulation. The UK government are also urging eateries to reduce calorie content of all meals (including child meals) and has produced voluntary maximum calorie guidelines. As a disincentive to food companies, part of the plan is to publicly name and shame companies which fail to meet these voluntary measures.¹¹ However, this would only be effective if efforts are made to ensure public acceptance of the measures.²⁹⁹ This and previous governmental obesity plans have been highly criticised by researchers for being ineffective and unlikely to prevent or reduce childhood obesity.^{12,311} The government could introduce a levy (tax, fee or fine) on child-targeted products that fail to meet the targets, similar to the UK soft drinks industry levy,²⁷⁶ which may force the food industry to reformulate and/or reduce portions if they do not want to incur extra expenses or increase prices to customers. Time series analyses have been conducted to estimate the potential effectiveness of the UK soft drinks industry levy.^{312,313} Results suggested some manufacturers reformulated soft drinks to contain less sugar (to fall below the levy threshold of containing >5g per 100ml), whilst others increased the price of soft drinks to consumers to cover taxation costs.³¹² In terms of consumer purchasing, results suggested the volume of soft drinks purchased had not changed one year post-levy, however, the amount of sugar in the purchased soft drinks was reduced by 10% (or 30g) per household per week (equivalent to one 250ml soft drink containing 5-8g of sugar per person, per week).³¹³ Subsequently, food and drink taxation has been criticised by researchers because taxes often cannot be high enough to result in meaningful changes to consumption.³¹⁴

6.5.7 Restrict choices

Step seven of Figure 6.2 illustrates interventions requiring the low agency but high level of coercion and intrusion. These strategies require the government to mandate food companies and eateries to produce, sell and serve child-targeted food and drinks, which are consistent with portion size recommendations, as well as energy and dietary recommendations. These strategies have the potential for a wider reach and require minimal demand on parents.¹² However, the first step to achieving this is for the government to develop and publish dietary guidelines, including portion size recommendations for preschool children, which are currently lacking (currently no

official government guidelines for fat intake under the age of four, and carbohydrate and sugar intakes under the age of two).³¹⁵ The portion size guidance resources identified in CHAPTER 3 could help inform these guidelines, which could then be used to mandate food companies and eateries.

6.5.8 Eliminate choice

Eliminating choice with regards to portion size would be difficult to achieve in the home environment, due to the vast variety of food and drinks available for parents to purchase and serve to their children, including a large range of child-targeted products.²³³

However, step eight of Figure 6.2 illustrates a strategy, which could be implemented in childcare settings to eliminate choice. This involves the government mandating childcare settings to only serve fruit as desserts and fruit and/or vegetables as snacks, therefore eliminating the choice to serve foods high in fat and sugar.

As part of the UK government childhood obesity plan to support early years settings (e.g. nurseries), Public Health England (PHE) commissioned the Children's Food Trust to develop revised menus¹¹, which were incorporated into voluntary guidelines for early years settings to follow (included in CHAPTER 3). These guidelines suggest serving fruit and vegetables as snacks and desserts, which could help to reduce calorie content of eating occasions, where consumption is excessive. In section 4.4.2.3.2, the qualitative findings suggested some parents perceived portion sizes to be smaller in childcare than at home and would therefore offer more food when their child got home. However, findings from section 5.4.2.1 showed eating occasions in childcare to be on average 29kcal larger than eating at home among preschool children. The median estimated size of a meal (which included breakfast, lunch and dinner) consumed in childcare was 311kcal in the NDNS sample. This is in line with the median PHE main meal size recommendation (323kcal) but greater than the median PHE breakfast size recommendation (263kcal) (reported in section 3.4.7). It is unknown whether early years settings follow the serving recommendations included in the guidelines. Guidelines for early years settings could be made mandatory in the whole of the UK (as they are in Scotland), therefore becoming requirements rather than guidelines.³¹⁶ These requirements should include elimination of foods high in fat and sugar being served as desserts or snacks, with fruit and/or vegetables being served in their place. Guidelines could also better highlight the importance of serving the recommended age-appropriate portion sizes of meals and

snacks to meet dietary and energy intake recommendations, encourage early years settings to use appropriately sized child plates to indicate serving sizes, and encourage childcare staff to use appropriate feeding practices (such as asking children whether they are still hungry, rather than whether they want more food).³¹⁷ In addition, parents could receive more information about the portions served to their children in childcare to feel reassured their children have eaten enough.

Overall, effective strategies to reduce portion sizes of high energy dense foods and promote consumption of age-appropriate portion sizes across food groups, meals and snacks, such as promoting the use of child plates, manipulating packaging, food industry regulations, and portion size guidelines in early years settings are required to help prevent excessive weight gain in preschool children. Although low agency interventions may be preferred to reduce the need for parental engagement and health literacy, and reduce health inequalities, higher agency interventions may be required in the meantime due to the time and resources required to develop and implement government level policies.²⁹⁷ The combined efforts of parents, the food industry, policy makers, the government and childcare staff across the key settings preschool children consume food (at home, in childcare, eateries) are required.

6.6 CONCLUSION

This thesis provides novel information about the content and parental use of portion size guidance and highlights the importance of eating contexts in influencing portion size among preschool children. This thesis adds to the evidence base of parental portioning practices and the role of external cues in determining portion sizes served to preschool children. Twenty-two portion size guidance resources were identified, which are not being accessed by parents to determine served portions but could be used to inform future strategies to downsize large portions of energy dense foods and promote the consumption of age-appropriate meals and snacks. Parents play a key role in promoting age-appropriate consumption to prevent excessive weight gain in preschool children. Parents should be provided with the opportunities, knowledge, and resources to serve age-appropriate portions, especially in eating contexts where larger portions may be consumed, such as in eateries, childcare, sitting at a table and with others. Future research should focus on exploring the meal patterns, which drive the consumption of large meals and snacks across eating contexts and could lead to excessive weight gain. Policies and

interventions to downsize large portions of energy dense foods and promote consumption of age-appropriate meals and snacks are required. These should be developed with and/or accepted by parents, childcare staff, researchers, the food industry and health professionals to enhance motivation, opportunity and capability to promote age-appropriate consumption and prevent child overweight and health inequalities.

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APPENDICES

Appendix 1. The National Diet and Nutrition Survey

The National Diet and Nutrition Survey (NDNS) is a nationally representative cross-sectional survey of people aged 1.5 years and older conducted in the UK.²⁴³ The NDNS is a rolling programme, which started in 2008 and collects data every year. The organisation NatCen Social Research, who are funded by Public Health England and the Food Standards Agency currently carry out the survey.³⁰⁰ Ethical approval for the survey was obtained from the Oxfordshire A Research Ethics Committee.

Aims

The survey collects quantitative data on food and nutrient intakes, characteristics of individuals, eating habits and contexts, physical activity, blood and urine, and anthropometrics (e.g. height and weight). With this data, the NDNS aims to provide population-level information about; the sources of nutrients, nutritional status, trends in food and nutrient intake, total energy expenditure and physical activity levels, characteristics of people with intakes below or above national averages, how diets of population sub-groups compare to dietary recommendations, and the relationships between socio-demographic, dietary, biochemical and health factors. The survey results are often used to inform the government and the public about the nutritional status of the UK population, how to improve the diet and nutrition of the population and how to reduce the risk of health-related diseases.

Sampling

The survey aims to sample approximately 1000 people (500 adults aged 19 years and over and 500 children aged 1.5-to-18-years) across the UK each year. Using the Postcode Address File (list of all postcodes in the UK), private households are randomly selected from 130 geographical regions across England, Wales, Scotland, and Northern Ireland. Extra addresses in Wales, Scotland and/or Northern Ireland are selected each year to boost the sample size in these countries, to allow cross-country comparisons. One adult and one child or one child only are randomly selected from each household to take part in

the survey. Recruitment materials are sent to each selected household and selected participants are asked to consent to take part in the survey.

Weighting factors are applied to the data to remove selection bias and reduce non-response bias. Selection bias arises from the survey design because only one adult and one child from each household can take part, and therefore people are less likely to be selected from a household with multiple adults or children.. The non-response bias arises from the multi-stage design, whereby participants can choose to withdraw at any stage of the survey. Weights are also applied to account for the extra addresses selected in Wales, Scotland and Northern Ireland and ensures the NDNS population proportions match those of the UK population. Data from all NDNS years (currently 2008 to 2017) can be combined and analysed as one dataset, however survey weights from each survey year must be re-scaled and then combined to ensure the sets of data are in the correct proportion.

Data Collection

Participants are asked to take part in two stages of the survey. During the first stage, participants are visited by an interviewer three times. The visits in this stage involve a face-to-face computer assisted personal interview (CAPI), collection of height and weight measurements and completion of a four-day estimated food diary. During the first visit, the CAPI is completed, which involves asking participants questions applicable to their circumstances and habits that could affect their dietary intake. These include access to food, eating, drinking, and smoking habits, health (general, dental, and mental), dietary supplements, sun exposure, education, employment and income. In addition, the main provider of food in the household (may or may not be the selected participant) is interviewed about the purchase of food, food preparation practices and cooking facilities. The person who owns or rents the property with the highest income (the household reference person) is interviewed about housing tenure and employment to determine the socio-economic status of the household, using the National Statistics Socio-economic Classification groups.²⁵¹ Height and weight measurements are taken by the interviewer. Participants aged 16 years and older are asked to complete the Recent Physical Activity Questionnaire and those aged four to 16 years are asked to wear an ActiGraph accelerometer (activity monitor) for seven consecutive days.

Also during the first visit, participants are asked to complete a four-day estimated food diary. This involves keeping a record of everything they eat and drink, in and out of the home for four randomly selected consecutive days using the diary provided. Participants aged 12 years and older complete the diary themselves. A parent/carer of children aged 12 years or younger are asked to complete the diary with help from the child if possible. Additional food diaries are included for those who may care for children under 12 years (e.g. teacher, nursery staff, friend's parent) to complete on behalf of the child. The interviewer visits participants on day one or two of the diary to check compliance, answer questions and review the diary. At the end of the four days, the interviewer will again review the completed diary to identify any missing detail.

Participants should report a detailed description of each food/drink item (e.g. fresh/frozen, semi-skimmed/ full fat milk, thick/thin slice of brown bread), how it was prepared (e.g. grilled/fried chicken breast), the brand name if applicable and the exact time it was consumed. Where homemade or composite dishes are reported, participants should record each ingredient in the dish, the amounts, how many people the dish serves and a brief description of the cooking method. Participants are asked to estimate the portion size of each item using household measures (e.g. tablespoons), weights from labels (e.g. 300g tin), the number of items (e.g. two sausages) and picture examples provided, where participants indicate which image best estimates their consumed portion size. The food photography atlas, which includes a range of portion sizes for commonly consumed foods⁵⁷ is provided to help participants estimate portion size. When reviewing the diaries, the interviewer uses an age-appropriate food atlas to ask the participant or parent/carer to select a photo for each food included in the atlas. Participants are asked to account for leftovers when estimating their consumed portion sizes. In addition, participants are asked to report the eating context of each item (where and with whom the item was consumed, e.g. whilst watching TV and/or whilst sat at a table). At the end of each diary day, participants should report whether their consumption was typical for that day, details of any supplements taken and whether this was typical of their usual eating habits. Participants receive a £30 high street voucher at the end of the four days if at least three diary days are completed.

The second stage of the survey involves a nurse visiting participants within four months of the previous visit. With consent, the nurse collects age-appropriate measures of blood

pressure, infant length, waist and hip circumference, demi-span, mid upper arm circumference, 24-hour urine sample, non-fasting blood sample, fasting blood sample and details of prescribed medications. Nurses and interviewers are briefed and trained before undertaking data collection and regular quality checks are carried out.

The response rates for the completion of at least three diary days across all participants for Years 1-4 combined, 5-6 combined and 7-8 combined were 56%, 53% and 53%, respectively. Of those who completed the food diary, in Years 1-4 combined, 5-6 combined and 7-8 combined, 51%, 57% and 50% of adults and 27%, 28% and 25% of children gave blood samples, respectively.

Data Processing

The food diaries are coded by a team of trained coders and editors. A modified version of the dietary assessment system DINO (Diet In Nutrients Out) and the Public Health England food composition NDNS Nutrient Databank is used to code the food diaries. Each food/drink item in the diary is matched to a food and portion code from DINO. If an item cannot be matched, it is flagged for discussion with an editor. Estimated portion sizes and portion sizes selected from the atlases are converted to weights in the DINO system. If portion sizes are missing, these are flagged and other days in the diary are used to help estimate habitual consumption of that item. Quality control checks are carried out during the coding process. Editors check 10 complete diaries for each coder and an additional 10% of diaries. The DINO system is used to match each food/drink item to a food code, a main food group, a sub-food group, a weight, energy content and energy density. The NDNS Nutrient Databank is used to assign each item to a value for 54 different nutrients. The final food-level dataset therefore contains detailed information about each reported food item for each participant.

Data collected from the CAPI are used to explore relationships between socio-demographic, and dietary factors and explore nutritional status and food intake across sub-groups. The physical activity data is used to estimate energy expenditure. Anthropometric measures are used to explore relationships between health-related and dietary factors.

Access and Use

NDNS data from 2008-2017 can be accessed and downloaded for additional analyses via UK Data Service. Data was collected in 2018-2020, however this is not yet publicly available. Many published articles have used the NDNS data to explore eating patterns, nutritional status, dietary patterns, and adherence to dietary recommendations. For example, a PubMed search of articles from 2008 onwards including the keyword “national diet and nutrition survey” returned 202 results.

Use of the NDNS in Chapter 5

Using the NDNS data for my multilevel model study, exploring factors associated with eating occasion size, allowed me to compare my methodology and results to previous literature. This was particularly useful when deciding how to define eating occasions and eating occasion size. Previous research using NDNS data and multilevel modelling has been conducted; one study exploring factors associated with portion size of energy dense snacks among children;⁶¹ and one study exploring the between and within-person variation in and factors associated with non-core energy intake among adolescents.¹²⁷ These two key research studies were used to help inform the aims and statistical analysis of this present study.

The outcome of this study was eating occasion size. The NDNS was chosen as a suitable dataset to explore this outcome because of the detailed food-level reporting. In particular, participants recorded the exact time each food/drink item was recorded, which could be used to define eating occasions, meals, and snacks, based on previous literature.^{61,245,318-320} As this study aimed to explore both between and within-person variation in eating occasion size, it was important to identify potential person-level and eating occasion-level factors (exposure variables) that could be associated with eating occasion size. The NDNS collected data on participant characteristics, as well as eating contexts and so this allowed analysis of both person-level and eating occasion-level factors. The data I chose to analyse were participant age, gender, socioeconomic status, and ethnicity (person-level), and eating location (where), eating companion (whom with), and eating watching TV and eating sitting at a table (eating occasion-level). I also included the variables day of the week, time of day, BMI z-score (calculated using participants height and weight data), total daily energy intake, and misreporting (calculated using energy intake, energy expenditure and weight) as potential confounders. NDNS food-level and person-level data files from 2008-2017 were combined to conduct the multilevel model analyses.

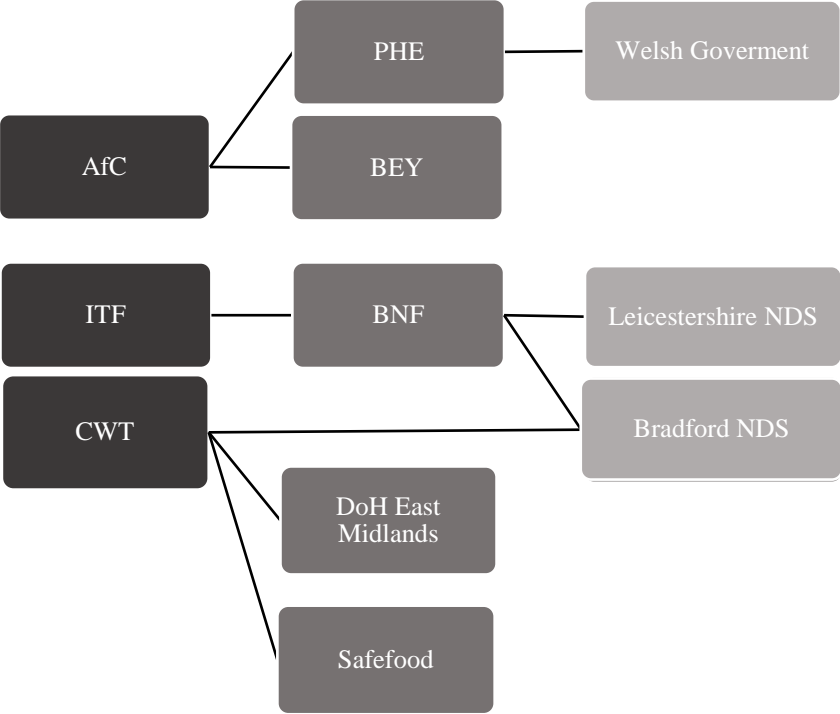
Appendix 2. PRISMA Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	49
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	N/A
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	49-51
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	51-52
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	52
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	53-54
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	52-53
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	52
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	53-54 & Figure 3.1

Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	54-55
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	54-55
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	55
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	55-56
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Figure 3.1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	56-59 (Table 3.1)
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	N/A
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			

Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	88-92
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	92-93
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	93
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	N/A

Appendix 3. Hierarchical model illustrating the resources that were used to inform the portion size information of other resources



Resources in the black boxes were independently developed, resources in the dark grey boxes used existing resources to further develop their own portion size information, resources in the light grey boxes replicated the portion size information from other resources.

Appendix 4. Number and percentage of individual food and drink items included in each resource by food group

Resource	All foods	All drinks	Dairy	Fruit	Vegetables	Protein	Starchy	Foods high in fat and sugar
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
AfC 2017	100 (96)	4 (4)	11 (11)	19 (18)	25 (24)	25 (24)	20 (19)	4 (4)
Bord Bia IFB 2018	27 (93)	2 (7)	5 (17)	8 (28)	3 (10)	7 (24)	6 (21)	-
Bradford NDS 2013	33 (94)	2 (6)	4 (11)	8 (23)	5 (14)	7 (20)	8 (23)	3 (9)
BEY 2018	92 (99)	1 (1)	5 (5)	25 (27)	24 (26)	21 (23)	18 (19)	-
BNF 2014	84 (99)	1 (1)	11 (13)	19 (22)	15 (18)	21 (25)	19 (22)	-
CWT 2015	82 (100)	-	5 (6)	23 (28)	25 (30)	15 (18)	14 (17)	-
DoH East Midlands 2010	52 (96)	2 (4)	5 (9)	16 (30)	19 (35)	7 (13)	7 (13)	-
DoH Ireland 2004	30 (94)	2 (6)	5 (16)	6 (19)	3 (9)	10 (31)	8 (25)	-
FSNT 2018	106 (95)	5 (5)	11 (10)	19 (17)	29 (26)	24 (22)	28 (25)	-
HSC PH Agency 2018	30 (100)	-	3 (10)	8 (27)	2 (7)	11 (37)	6 (20)	-
ITF 2016	41 (95)	2 (5)	6 (14)	6 (14)	2 (5)	7 (16)	10 (23)	12 (28)

ITF 2015	61 (97)	2 (3)	5 (8)	15 (24)	12 (19)	9 (14)	11 (17)	11 (17)
Leicestershire NDS 2017	58 (97)	2 (3)	5 (8)	15 (25)	14 (23)	10 (17)	14 (23)	2 (3)
NHS Health Scotland 2018	30 (94)	2 (6)	4 (13)	9 (28)	4 (13)	5 (16)	10 (31)	-
Safefood 2013	44 (96)	2 (4)	5 (11)	10 (22)	6 (13)	12 (26)	13 (28)	-
Median (IQR)	52 (30-84)	2 (2-2)	5 (5-6)	15 (8-19)	12 (3-24)	10 (7-21)	11 (8-18)	4 (3-11)

Appendix 5. Number and percentage of food/drink items within meals included in each resource by food group

Resource	All foods	All drinks	Dairy	Fruit	Vegetables	Vegetable mixed dishes*	Protein	Protein mixed dishes†	Starchy	Starchy mixed dishes‡	Foods high in fat and sugar
	<i>N (%)</i>	<i>N (%)</i>	<i>N (%)</i>	<i>N (%)</i>	<i>N (%)</i>	<i>N (%)</i>	<i>N (%)</i>	<i>N (%)</i>	<i>N (%)</i>	<i>N (%)</i>	<i>N (%)</i>
AfC 2017	42 (98)	1 (2)	4 (9)	10 (23)	6 (14)	2 (5)	1 (2)	4 (9)	10 (23)	-	6 (14)
CWT 2015	124 (98)	2 (2)	7 (6)	20 (16)	19 (15)	15 (12)	6 (5)	12 (10)	25 (20)	4 (3)	18 (14)
FSNT 2015	50 (96)	2 (4)	6 (12)	12 (23)	12 (23)	3 (6)	4 (8)	1 (2)	8 (15)	2 (4)	4 (8)
FSNT 2017	40 (98)	1 (2)	4 (10)	10 (24)	8 (20)	1 (2)	3 (7)	1 (2)	10 (24)	1 (2)	3 (7)
FSNT 2018	60 (97)	2 (3)	2 (3)	11 (18)	11 (18)	9 (15)	2 (3)	1 (2)	15 (24)	2 (3)	9 (15)
HSE 2016	10 (83)	2 (17)	2 (17)	3 (25)	2 (17)	-	2 (17)	-	3 (25)	-	-
ITF 2015	42 (100)	-	3 (7)	5 (12)	7 (17)	1 (2)	5 (12)	5 (12)	8 (19)	2 (5)	6 (14)

PHE 2017	186 (99)	1 (1)	7 (4)	24 (13)	21 (11)	40 (21)	8 (4)	33 (18)	24 (13)	7 (4)	23 (12)
Safefood 2013	32 (100)	-	-	2 (6)	1 (3)	5 (16)	1 (3)	13 (41)	1 (3)	3 (9)	6 (19)
Start4Life	47 (98)	1 (2)	4 (8)	7 (15)	13 (27)	1 (2)	3 (6)	6 (13)	12 (25)	1 (2)	1 (2)
Welsh Government 2018	186 (99)	1 (1)	7 (4)	24 (13)	21 (11)	40 (21)	8 (4)	33 (18)	24 (13)	7 (4)	23 (12)
Median (IQR)	47 (40-124)	1 (1-2)	4 (3-7)	10 (5-20)	11 (6-19)	4 (1-15)	3 (2-6)	6 (1-13)	10 (8-24)	2 (2-4)	6 (4-18)

*Includes vegetable, pulses and meat alternative mixed dishes,

†Includes meat, fish, and egg mixed dishes,

‡Includes cereal based mixed dishes (e.g. pasta, rice)

Appendix 6. Average portion size of food/drink items within meals included in each resource by food group

Median (IQR) portion size g or ml									
Resource	Dairy	Fruit	Vegetables	Vegetable mixed dishes*	Protein	Protein mixed dishes†	Starchy	Starchy mixed dishes‡	Foods high in fat and sugar
AfC 2017	60 (60-100)	40 (33-40)	40 (40-40)	105 (90-120)	50 (50-60)	150 (110-150)	25 (20-95)	-	35 (4-60)
CWT 2015	50 (20-60)	40 (40-70)	30 (30-40)	90 (48-118)	48 (40-50)	90 (60-95)	25 (20-50)	80 (63-95)	60 (33-75)
FSNT 2015	54 (20-100)	45 (35-55)	40 (30-40)	80 (25-125)	45 (35-50)	165 (165-165)	50 (39-68)	90 (80-100)	41 (24-51)
FSNT 2017	43 (34-75)	33 (25-80)	40 (38-43)	35 (35-35)	30 (15-50)	40 (40-40)	23 (10-30)	85 (85-85)	35 (30-50)
FSNT 2018	100 (100-106)	40 (20-40)	40 (35-40)	90 (40-90)	33 (15-50)	90 (80-100)	30 (20-50)	80 (80-80)	30 (30-50)
HSE 2016	200 (200-200)	100 (50-150)	68 (68-68)	-	75 (75-75)	-	75 (60-80)	-	-

ITF 2015	31 (18-125)	38 (26-38)	19 (12-38)	108 (108-108)	42 (35-62)	83 (60-94)	21 (19-50)	69 (64-75)	61 (58-81)
PHE 2017	60 (45-100)	40 (40-40)	40 (30-40)	130 (110-148)	95 (50-135)	120 (95-170)	35 (25-63)	185 (168-211)	60 (35-75)
Safefood 2013	-	45 (30-60)	40 (40-40)	156 (149-246)	60 (60-60)	156 (121-176)	80 (80-80)	165 (97-182)	116 (89-153)
Start4Life	15 (14-60)	40 (14-40)	40 (30-40)	140 (140-140)	58 (50-108)	125 (71-155)	35 (30-40)	130 (130-130)	4 (4-4)
Welsh Government 2018	60 (45-100)	40 (40-40)	40 (30-40)	130 (110-148)	95 (50-135)	120 (95-170)	35 (25-63)	185 (168-211)	60 (35-78)
All	60 (20-100)	40 (36-40)	40 (30-40)	123 (90-145)	50 (45-95)	120 (90-156)	30 (20-53)	165 (80-190)	60 (35-75)

*Includes vegetable, pulses and meat alternative mixed dishes,

†Includes meat, fish, and egg mixed dishes,

‡Includes cereal based mixed dishes (e.g. pasta, rice)

Appendix 7. Descriptive statistics of eating occasion size (defined by all food and drink reported at the same clock time) in one-to five-year-olds in the National Diet and Nutrition Survey

Age (years)	N (eating occasions)	Size in grams (based on all food and drinks)			Size in grams (based on food only drinks excluded)		
		Median	IQR		Median	IQR	
1	4598	200	100	334	174	83	295
2	9284	216	108	353	184	85	307
3	8945	230	113	388	200	98	339
4	6857	250	122	420	210	100	375
5	6685	275	150	471	227	105	404
1-5 years	36369	232	116	394	200	97	343

Data on the size of eating occasions from years 1-9 of the National Diet and Nutrition Survey rolling programme (2008-2017). Data downloaded from

<https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=6533> accessed 01/11/2019

Appendix 8. List of portion size guidance resources aimed at feeding one- to five-year-olds included in this thesis with links to access full resources

List of 22 guidance resources included in grey literature review chapter (CHAPTER 3)

Name of resource	Organisation	Resource link
Eat better, start better. A practical guide. Voluntary food and drink guidelines for Early Years settings in England	Action for Children	https://www.foundationyears.org.uk/wp-content/uploads/2017/11/Eat-Better-Start-Better1.pdf
Food Portion Book for 1-4 year olds	Bristol Early Years	https://www.bristolearlyyears.org.uk/wp-content/uploads/2019/01/Food-Portions-Book-1-4-years.pdf
5532 a-day	British Nutrition Foundation	https://www.nutrition.org.uk/attachments/article/734/BNF%20Toddler%20Eatwell%20Leaflet_OL.pdf
Nutrition for one to fives	Bord Bia Irish Food Board	https://www.bordbia.ie/consumer/aboutfood/nutrition/pages/nutritionfortwotofives.aspx
Every Baby Matters. Guidelines for good nutrition in Bradford and Airedale Nutrition and 1-5 year olds	Bradford Nutrition and Dietetics Service	https://www.bradford.gov.uk/media/1908/7-nutrition-guidelines-1-to-5-years.pdf
Eating well for 1-4 year olds	Caroline Walker Trust	https://www.cwt.org.uk/wp-content/uploads/2015/02/CHEW-1-4YearsPracticalGuide3rd-Edition.pdf
Nutrition in Nursery Schools	Department of Health East Midlands	https://www.nottinghamcity.gov.uk/media/361919/healthy_eating_regional_guidance.pdf
Food and Nutrition Guidelines for Pre-School Services	Department of Health Ireland	https://health.gov.ie/wp-content/uploads/2014/03/Food-and-Nutrition-Guidelines-for-Pre-School-Services.pdf
Eating well: snacks for 1-4 year olds	First Steps Nutrition Trust	https://static1.squarespace.com/static/59f75004f09ca48694070f3b/t/5afc5f01f950b7630a19e028/1526488846381/Eating_well_snacks_for_1-4_years_for_web.pdf
Good food choices and portion sizes for 1-4 year olds	First Steps Nutrition Trust	https://static1.squarespace.com/static/59f75004f09ca48694070f3b/t/5a926be4ec212d9451c595ce/151

		9545331398/Good food choices and portion sizes Jan2018.pdf
Eating well: Packed lunches for 1-4 year olds	First Steps Nutrition Trust	https://static1.squarespace.com/static/59f75004f09ca48694070f3b/t/5a926d288165f549b5a68ca2/1519545646246/Packed_lunches_Dec_17.pdf
Eating well: vegan infants and under 5s	First Steps Nutrition Trust	https://static1.squarespace.com/static/59f75004f09ca48694070f3b/t/5a5a4935ec212dd5067a0622/1515866446317/Eating_well_Vegans_Oct_2017_final.pdf
Nutrition matters for the early years	HSC Public Health Agency	https://www.publichealth.hscni.net/sites/default/files/Nutrition%20Matters%20for%20the%20early%20years%200118.pdf
Healthy Food for Life. Food Pyramid to Daily Meal Plan	Health Service Executive	https://www2.hse.ie/wellbeing/healthy-eating-for-families.html
Portion sizes for children 1-4 years	Infant & Toddler Forum	Portion Sizes for Toddlers - Infant & Toddler Forum (infantandtoddlerforum.org)
10 steps for healthy toddlers	Infant & Toddler Forum	https://www.infantandtoddlerforum.org/media/upload/pdf-downloads/HR_ten_steps_leaflet.pdf https://www.infantandtoddlerforum.org/media/upload/pdf-downloads/HR_toddler_booklet_green.pdf
Eatwell Guide. What is a portion? 1-5 years old	Leicestershire Nutrition and Dietetics Service	https://www.lnds.nhs.uk/Library/Whatisaportionsize15yearsoldApril2017LNDS130.pdf
Setting the Table. Nutritional guidance and food standards for early years childcare providers in Scotland	National health Service Health Scotland	http://hub.careinspectorate.com/media/177298/nhs-setting-the-table.pdf
Example menus for early years settings in England. Part 2: Recipes	Public Health England	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/658872/Early_years_menus_part_2_recipes.pdf
What is a serving size?	Safefood	https://www.safefood.eu/SafeFood/media/SafeFoodLibrary/Documents/Publications_1/G6101-Safefood-App-Port-Control-Guide_single-pages.pdf

Recipes and meal ideas	Start4Life	https://www.nhs.uk/start4life/weaning/recipes-and-meal-ideas/
Food & Nutrition for Childcare settings	Welsh Government	https://beta.gov.wales/sites/default/files/consultations/2018-06/food-and-nutrition-volume-2.pdf

List of six guidance resources included in qualitative chapter (CHAPTER 4)

Name of resource	Organisation	Resource link
Food Portion Book for 1-4 year olds	Bristol Early Years	https://www.bristolearlyyears.org.uk/wp-content/uploads/2019/01/Food-Portions-Book-1-4-years.pdf
5532 a-day	British Nutrition Foundation	https://www.nutrition.org.uk/attachments/article/734/BNF%20Toddler%20Eatwell%20Leaflet_OL.pdf
Every Baby Matters. Guidelines for good nutrition in Bradford and Airedale Nutrition and 1-5 year olds	Bradford Nutrition and Dietetics Service	https://www.bradford.gov.uk/media/1908/7-nutrition-guidelines-1-to-5-years.pdf
Eating well: Packed lunches for 1-4 year olds	First Steps Nutrition Trust	https://static1.squarespace.com/static/59f75004f09ca48694070f3b/t/5a926d288165f549b5a68ca2/1519545646246/Packed_lunches_Dec_17.pdf
Portion sizes for children 1-4 years	Infant & Toddler Forum	Portion Sizes for Toddlers - Infant & Toddler Forum (infantandtoddlerforum.org)
Recipes and meal ideas	Start4Life	https://www.nhs.uk/start4life/weaning/recipes-and-meal-ideas/

Appendix 9. Standards for Reporting Qualitative Research (STOR)²¹⁶

No.	Topic	Item	Page number
Title and abstract			
S1	Title	Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended	94
S2	Abstract	Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions	N/A
Introduction			
S3	Problem formulation	Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement	94-96
S4	Purpose or research question	Purpose of the study and specific objectives or questions	96
Methods			
S5	Qualitative approach and research paradigm	Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale	101 Appendix 14
S6	Researcher characteristics and reflexivity	Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	101 Appendix 14
S7	Context	Setting/site and salient contextual factors; rationale	96-97
S8	Sampling strategy	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale	96 Appendix 11 Appendix 12

S9	Ethical issues pertaining to human subjects	Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	97
S10	Data collection methods	Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale	96-98, 101
S11	Data collection instruments and technologies	Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	97
S12	Units of study	Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	96 Table 4.2
S13	Data processing	Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymization/deidentification of excerpts	101
S14	Data analysis	Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale	101
S15	Techniques to enhance trustworthiness	Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale	101
Results/ findings			
S16	Synthesis and interpretation	Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	102-134
S17	Links to empirical data	Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	102-134
Discussion			
S18	Integration with prior work implications, transferability,	Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/	134-142

	and contribution(s) to the field	generalizability; identification of unique contribution(s) to scholarship in a discipline or field	
S19	Limitations	Trustworthiness and limitations of findings	138-139
Other			
S20	Conflicts of interest	Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	N/A
S21	Funding	Sources of funding and other support; role of funders in data collection, interpretation, and reporting	N/A

Appendix 10. Topic Guide

Question	Prompt
Section 1	
Background info	
Tell me a bit about you and your little one. What's it like being a first-time parent?	How old? Boy or girl?
What age did you start feeding him/her solid foods?	
Briefly, what does he/she eat now in a typical day?	Still on milk?
The typical feeding experience	
Talk me through a typical meal with your child	Who prepares the food? Do you eat the same foods? Do you eat together? What's the experience like for you?
Are you primarily responsible for feeding him/her?	Who else is involved?
Is your child involved in choosing what or how much food to eat?	
Does how much your child eats vary from meal to meal or day to day?	
Concerns around portion size and feeding	
What kind of appetite does your child have?	
Is how much your child eats a concern for you?	What makes you say that?
Are there any other concerns that you have when it comes to his/her eating?	
Decisions on portion sizes	
How do you decide how much to serve your child or how much or child eats?	How do you know how much to give? What do you do if your child wants more food? What do you do if your child doesn't eat everything served? Do you use any aids?
Is there anything that influences your decision?	To do with you or your child? How do you know if he/she is full? Do your decisions differ depending on whether it's a meal or snack?
Do you feel that you have a good idea about what's an appropriate amount for your child to be eating?	For every meal? What about snacks?
Restriction of portion sizes	
Are there certain foods that you control portions of or restrict all together?	What foods? Why is this? How would you feel if she/he ate too much of this food?
Are there certain foods that you don't restrict portion of?	What foods? Why is this?

Portion sizes specific to types of meals and foods	
Are there any foods that you find difficult to decide the portion of or to portion out?	
How much would you decide to give your child of a pre-packaged food?	Examples – crisps, cereal bars, raisins, ready meals, chocolate bar
You say you decide how much to feed your child by... does this differ if it's a meal or a snack?	
What do you do if you are eating out?	Example – restaurant or café?
Who influences portion size decisions	
Are there other people involved in deciding how much to feed your child?	Who are they? How often are they involved?
How do you feel about their decisions/the way they do things?	
Is there anyone else who influences your decision about how much to feed him/her without necessarily being involved in feeding him/her?	
How confident are you with the people who influence your decisions?	
Other influences	
Is there any other information that you've used to help you with feeding your child?	Online? Health visitors?
How much have you used this information? Do you trust the information?	
Use of general portion size guidance	
Do you know of any information or resources that gives guidance/advise on how much to feed your child?	Can you remember it? Where did you find it? Who gave it to you? Did you use it?
Section 2	
Awareness of and thoughts on existing guidance (Participants shown PowerPoint)	
Have you seen any of these before?	Where did you see it? Did you use it? If so why/why not? Was it useful?
What are your initial thoughts on seeing these?	Any interest you?
Opinions on certain aspects of the guidance	
If you were to use this sort of information resource, would you want it to include individual foods and drinks or meal and recipes?	Or combination of both? Why do you say that?
How many examples of foods/drinks or meals/recipes do you think is good for a resource to include?	
Would you rather a resource be age specific, for the exact age of your child (different guidance for 1 years vs 2 years) or more generic, for an age range (1-4 years for example)?	How do you think your child's' feeding might change with age?

Would you want resources to include guidance about foods high in fat and sugar?	Examples - chocolate, biscuits, sweets, crisps
Use of the guidance	
How would you feel if you were feeding your child more than guidance suggested?	
After seeing these, would you be interested in using any or looking for this kind of information?	
In what form would you like the guidance to be in?	Printed, leaflet, app, given by someone?
How would you use/engage with this sort of information?	Read it in full, scan it, refer back to it?
Are there any other things to do with portioning or just feeding in general that you think would be useful to have guidance on?	

Appendix 11. Study advert

Are you a first-time parent or carer of a child aged between 1 and 2?

Chat to a
researcher at the
University of Bristol
and receive a
**£20 Love2Shop
voucher**



Why do we need you?

We are interested in learning about how first-time parents feed their child.

What will you have to do?

You will be asked to take part in an informal interview (like a chat) with a University of Bristol researcher. We will do the interview over Skype (we will help get you set up and you can choose to have your video on or off). You will be asked to talk about your experiences and thoughts on feeding your young child. Interviews will last about 1 hour. Interviews will be audio recorded. Everything you say will be kept private.

Can I take part?

To take part you should:

- Be a first-time parent or carer
- Have a child aged between 1 and 2 years
- Be available for an informal interview (time suitable for you)
- Have access to a computer/laptop/tablet

**For more information or to take part please contact Alice Porter (researcher)
by emailing alice.porter@bristol.ac.uk or calling 07731375601**

Study advert v1.1

This study is funded by the National Institute for Health Research (NIHR) School for Public Health Research (Grant Reference Number PD-SPH-2015). The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care

Appendix 12. Participant information sheet

First-time parents feeding 1 to 2 year olds

Information for Participants

What is the study about?

The study aims to learn about how first-time parents feed their young children, through interviewing parents about their thoughts and experiences.

What will happen?

If you decide to take part, you will be invited to **take part in an informal interview (like a chat)**. It will last about 1 hour. The interview will take place **over Skype for Business** (similar to Skype) with Alice Porter who works at the University of Bristol. If you need help setting up or using Skype, Alice will help you beforehand. You can choose to turn your video off if you would prefer your face not to be shown. The interview will be arranged at a date/time that suits you.

You will be asked questions about your experiences and thoughts on feeding your child. We will also ask some general questions about you. You do not have to answer all the questions if you don't want to.

Interviews will be audio recorded so we can listen to them again, but we will not record your face.

You will receive a £20 Love2Shop voucher to say thank you for your time.

Will my information be private and confidential?

Yes. All the information you give during the interview will be **private and will be stored safely**. Your information will be **anonymous**, meaning that we will remove your name and personal information.

How will my information be used?

Your information will be used to write a research paper. Your name and personal information **will not** be included. What you say in the interview will be stored in the University of Bristol computer and made available to other researchers. Your personal information will not be shared.

You will be sent a summary of the research findings if you would like them.

What if I change my mind?

You are free to change your mind about taking part in the interview. After doing the interview, if you decide you no longer want your interview to be used in the research study you can let us know. You need to let us know within 2 weeks if you have changed your mind.

Am I able to take part?

You can take part if:

- You are a first-time parent or carer.
- You have a child aged between 1 and 2 years.
- Your child does **not** have a chronic illness/condition or special feeding requirements (allergies are fine).
- You have access to a computer/laptop/tablet.

Who do I contact to ask questions?

Alice Porter (photo to right) will be very happy to answer any questions you may have.

Contact her on [redacted] or email alice.porter@bristol.ac.uk.



What should I do now?

If you are interested in taking part, **please contact Alice Porter to arrange a date and time for the interview**. You would have also received a consent form. Please read through this before the interview, as this confirms you are happy to take part. We will fill in the consent form together at the start of the interview.

This research has been approved by the University of Bristol's Faculty of Health Sciences Ethics Committee. If you have any ethical concerns, please contact Liam.McKervey@bristol.ac.uk or complaints contact research-governance@bristol.ac.uk

Participant information sheet v1.1

This study is funded by the National Institute for Health Research (NIHR) School for Public Health Research (Grant Reference Number PD-SPH-2015). The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care

Appendix 13. Consent form

INTERVIEW CONSENT FORM

Title of Project: **Qualitative study exploring the views of first-time parents on feeding their 1 to 2 year old child**

Name of Researcher: **ALICE PORTER**

Please initial all boxes (the first letter of your names)

1. I confirm that I have read and understand the information sheet dated **[29.01.2020]** (version **[V1.0]**) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I do wish to take part in the interview and am happy for the researcher to arrange a convenient time and place for the interview. ☐
3. I understand that the interview will be audio-recorded but my responses will remain private (confidential). Any use of direct quotes will not use my name (will be anonymised), and I will not be able to be identified in any results. ☐
4. I understand that my participation is voluntary. I understand that I may stop the interview at any time and withdraw from the study up to 2 weeks after the interview, without needing to give a reason. ☐
5. I understand that the information collected during this interview will be stored securely. I understand that the information may be used to support other research in the future and may be shared anonymously with other researchers. ☐
6. I agree to take part in the above study. ☐

Name of Participant Date Signature

Researcher name Date Signature

If you would like to be sent a summary of the study findings once the study has been completed, please provide your email address here:

Consent form date of issue:
Consent form version number: v1.0
This study is funded by the National Institute for Health Research (NIHR) School for Public Health Research (Grant Reference Number PD-SPH-2015). The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care

Appendix 14. Reflexive thematic analysis and reflexivity

Qualitative research methods

Qualitative research can be described most simply as the use of words as data. Qualitative analysis aims to describe and interpret the words (data) by organising the data into key overarching concepts (often called themes) that help us to understand the meaning of the data.³²¹ There are several methods that can be used to analyse qualitative data. The study design and aims, as well as the researchers' qualitative expertise should be considered when choosing the most appropriate method.

Reflexive thematic analysis was chosen as the most appropriate method to analysis my qualitative data. Reflexive thematic analysis originates from thematic analysis (TA), which was developed by Braun & Clarke. They published a paper outlining TA how to conduct it.³²² Since this paper was published, TA has become a universal method to analyse qualitative data. Braun & Clarke have since reflected on their original approach. They have clarified and revised elements of and processes around their original method, which they now call reflexive TA.^{323,324} Other methods were considered before choosing reflexive TA and are discussed below. Supplementary Table 1 presents the advantages and disadvantages of each method considered.

Framework Analysis (FA) was developed for applied policy research by Ritchie & Spencer (1994).³²⁵ The method is based on TA and focuses on developing a structured framework for analysis. FA is particularly applicable to research questions that are required to meet specific information needs. The research outputs are targeted towards answering questions and having potential for actionable outcomes, therefore is usually accessible to a wider audience. FA can be used to answer several types of research questions and would be particularly relevant to the final part of the topic guide in this study, where participants were asked their opinions on specific aspects of the portion size guidance resources. The processes of FA include familiarisation with the data; identifying a thematic framework (making notes on recurrent themes and concepts); indexing (systematically applying the thematic framework to all of the data); charting (lifting data from its original source and arranging into matrices according to themes and indexes); and mapping and interpretation (pulling together the key characteristics and interpreting the data as a whole by comparing accounts and searching for patterns).³²⁵ Comparing to

TA, a key difference is that FA uses structured charts and matrices to organise, compare and synthesise the data. Each main theme tends to be charted in a matrix, where key indexes from each participant are organised into rows and sub-themes are organised into columns.³²⁵

It is argued that the systematic charting process of FA is easy to follow for less experienced researchers and provides a straightforward visual structure to understand the patterns of the data.³²⁶ However, Braun & Clarke argue although thematic analysis and FA share a similar qualitative philosophy, FA is less organic and flexible. Therefore, resulting in generating only superficial codes and domain summaries rather than a deeper understanding of the data.²¹⁷ As this qualitative study aimed to gain a deeper understanding of parental portioning practices and the topic guide was designed to be exploratory and open, I deemed reflexive TA more appropriate than FA.

Interpretative Phenomenological Analysis (IPA), Grounded Theory (GT) and Discourse Analysis (DA) were also considered, as these are other popular well-known analysis methods and approaches. Briefly, IPA focuses on how people make sense of their own lived experiences by staying close to participant's accounts of their experiences but also by viewing their experiences with a critical lens, asking why participants may view their experiences in a certain way. IPA is best suited for case studies and small datasets.²¹⁷ IPA was not deemed appropriate for this study because of the larger sample and because the study research questions did not align with the focus of the method.

GT is an approach focusing on building theory from the data. GT is best suited to research questions exploring influencing factors and the social processes that underpin a phenomenon. GT is more complex, time and resource demanding compared to other methods, and less suitable for less experienced researchers. GT also ideally requires the researcher to not engage with prior literature, to ensure the outputs are grounded in theory rather than led by preconceptions.^{217,321} Although GT would align with the research questions of this study, it was not deemed the best approach because my study aimed to compliment and add to the existing literature, and therefore literature was read, collated, and reviewed prior to starting the analysis.

DA focuses on patterns in language and social reality (how objects or events are constructed and communicated in particular ways). The approach is interested in

explaining why people do things rather than the descriptions that people give. DA requires a critical realist view, which can be challenging and time consuming to grasp. There is no universal guidance or step-by-step process for conducting DA, so can be more difficult for less experienced researchers.³²¹ DA was deemed inappropriate for this study because the analysis aimed to focus on participants' decisions and experiences, rather than participants' use of language and socially patterned meaning of why they do things.

Reflexive TA can be used flexibly for different theoretical frameworks and research questions. It involves identifying themes and patterns across a dataset, which helps tell a story about the data and answer the research questions. Reflexive TA involves a number of phases, which have been developed to guide researchers through the process. The phases involve familiarisation, coding, generating initial themes, reviewing themes, defining and naming themes and writing up. Supplementary Figure 1 presents each of the phases as outlined by Braun & Clarke.³²³ Braun & Clarke state the process should be fluid and organic, with movement back and forth between steps and should not involve developing a rigid and inflexible coding framework that then needs fitting to the entire dataset.³²⁴ They say the "*final analysis is a product of deep and prolonged data immersion, thoughtfulness and reflection, something that is active and generative*".³²³ A key point made by Braun & Clarke is that themes do not simply 'emerge' from the data. Rather they are "*creative and interpretive stories about the data*", produced by the researcher using the data and their analytical resources and skills. Researchers should go beyond just reporting and paraphrasing the data and instead tell the reader what the data means, and the potential implications of the themes identified.³²³ Another key comparative aspect of reflexive TA is the role of the second coder. In other types of qualitative analysis, the second coder acts to find agreement with the coding framework and provide reliability. In reflexive TA, the second coders' role is to enrich the coding process by providing another perspective and additional expertise, for example to identify codes that may have been missed in the first instance.³²³ Reflexive TA embraces the researchers' subjectivity. A key aspect of reflexive TA involves acknowledging the researchers' role in shaping the analytic process through their personal positioning, theoretical assumptions and study design choices.³²⁴

Reflexive TA was chosen as the preferred method to analyse the qualitative data because it allowed flexible exploration of the data. Reflexive TA was suitable for use with the final sample size and for semi-structured interviews. Reflexive TA was suitable for answering my research questions, which focused on parental practices, behaviours, experiences, reasons for making decisions, and opinions. Reflexive TA was suitable for a less experienced researcher like myself and would allow outputs to be more accessible to a wider audience than other qualitative analysis methods.²¹⁷

Supplementary Table 1. A summary of qualitative methods/approaches considered

Method	Summary of method/approach	Advantages	Disadvantages
Reflexive Thematic analysis (RTA)	A theoretically flexible method to identify patterns of meaning in a dataset that provides answers to research questions across a variety of research fields/disciplines	<ul style="list-style-type: none"> -Flexible for use across many datasets and research questions -Accessible for researchers with little qualitative experience because relatively easy to learn -Accessible to a wider audience, who may not have qualitative experience 	<ul style="list-style-type: none"> -Not deemed to be as theoretically driven as other methods -Can result in simple descriptions of the data -Can lose granular details and individual accounts due to focusing on patterns
Framework analysis (FA)	A method that focuses on applied and specific research questions. Involves creating a matrix of themes to describe and interpret events and experiences in a certain setting	<ul style="list-style-type: none"> -Appropriate for applied research and accessible to a wider audience -Provides a visual and easy-to-use framework to manage and analyse data -Accessible to researchers with limited qualitative experience 	<ul style="list-style-type: none"> -Can result in superficial, simplistic descriptions of the data -Matrix format can result in quantification of data -Less organic and flexible compared to other methods
Interpretative Phenomenological Analysis (IPA)	A method that focuses on how people make sense of their own lived experiences	<ul style="list-style-type: none"> -Accessible to less experienced researchers -Analysis procedures are easy to follow 	<ul style="list-style-type: none"> -Only appropriate for case studies or small groups of participants -Lacks theoretical flexibility

		-Allows focus on an individuals' experience	-Only certain research questions about experiences, perceptions and understandings can be answered
Grounded Theory (GT)	A sociological approach that focuses on building theory from data, usually about social processes	-Can be used with a variety of theoretical frameworks -Analysis procedures are clear and useful for all qualitative analysis -Useful for understanding social and psychological processes	-Advised not to engage with previous literature before analysis, which can be difficult to do -Time and resource demanding -Can be complex and so less accessible to researchers with little qualitative experience
Discourse Analysis (DA)	A method that focuses on patterns in language use and how people construct and then verbalise events and objects	-Can be used for a range of research questions -Allows exploration and understanding of subtle uses of language -Allows interpretative engagement in the data	-Requires a critical realist view, which can be difficult to learn -Can be complex and time consuming to learn the theoretically frameworks that underpin the method -Not appropriate for applied research where findings need to be accessible to a wider audience

Reflexivity

A key aspect of reflexive TA is to be reflexive. This involved considering my position, epistemology, and orientation, as well as the approach to coding and analysis. Regarding my position, I considered who I am, how I presented myself to participants and how that could influence the collection and analysis of my data. I also considered my place on the insider-outsider researcher continua. An insider is defined as “*an individual who possesses a priori intimate knowledge of the community and its members*”.²¹⁸ For example, a medical doctor interviewing NHS staff. An outsider is defined as “*where the*

researcher is not a priori familiar with the setting and people s/he is researching”²¹⁸ For example, a female university staff member interviewing male construction workers. As I was interviewing first-time parents, I considered myself to be mostly an outsider because I am not a parent and therefore not a member of the parent community.

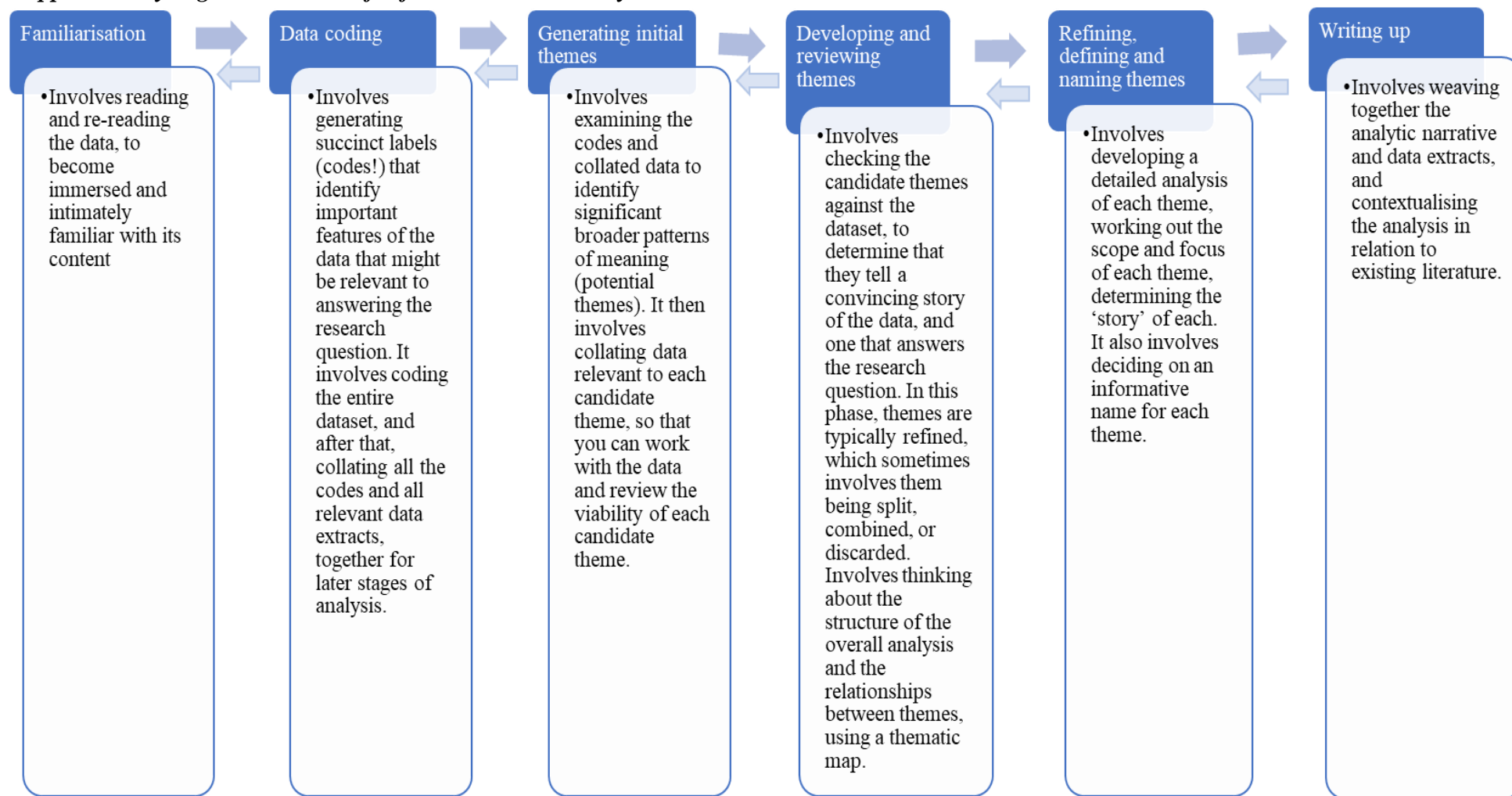
I considered my epistemology, in order to conceptualise how I understood and should therefore interpret the data. Epistemology lies on a continuum between essentialist and constructionist. An essentialist epistemology “*adopts a unidirectional understanding of the relationship between language and communicated experience*”²¹⁹, assuming what is said is a direct reflection of the experience and meaning, and therefore tends to be less interpretative. A constructionist epistemology adopts “*a bidirectional understanding of the language/experience relationship*”²¹⁹, considering language to be an important aspect of how experience and meaning are communicated. With this approach not only the recurrence of information but also the meaning of information is considered when coding and developing themes. I considered my epistemology to be more constructionist because I was interested in the meaningfulness of information.

I considered my orientation. An experiential orientation “*typically prioritises the examination of how a given phenomenon may be experienced by the participant*”²¹⁹, which involves exploring the meaning and meaningfulness of the topic for each participant and appreciating that their responses reflect their own personal state. A critical orientation “*analyses discourse as if it were constitutive, rather than reflective of, respondents’ personal states*”²¹⁹, and aims to interpret beyond that directly communicated by participants, to examine how the wider social context may influence participant meaning. I considered my orientation to be experiential because the study aimed to examine participants’ own accounts of their attitudes, opinions, and experiences.

I considered my approach to analysis as being deductive or inductive. A deductive approach is ‘theory-driven’ and uses prior knowledge of theory or conceptual frameworks to develop themes. Whereas an inductive approach is ‘data-driven’ and involves solely producing codes and themes that reflect the data.²¹⁹ My approach used a combination of deductive and inductive analysis, as I inductively developed codes and initial themes, but had a prior knowledge of relevant literature and used literature to help name some themes.

I considered my approach to coding as being semantic or latent. Semantic coding considers the “*explicit or surface meaning of the data*”²¹⁹ and therefore describes what the participants say, without interpreting the meaning further. Latent coding is more interpretative and involves the researcher taking on “*a more creative and active role*”²¹⁹. My approach to coding was both semantic and latent. Some data was presented descriptively, whilst the meaning of other data was interpreted beyond what the participant directly said. Semantic coding was firstly used to describe the data, followed by latent coding to develop my ideas around themes.

Supplementary Figure 1. Phases of reflexive thematic analysis



Appendix 15. Defining eating occasions, eating occasion size and eating occasion type

This study involved preliminary work to define key terms and variables before the main analysis could be conducted. Here I describe my preliminary work to choose the most appropriate definitions for eating occasion (key term used to define outcome variable), eating occasion size (outcome variable), and eating occasion type (key variable).

Eating Occasions

There is not a universally agreed definition of eating occasions in the literature.^{327,328} Therefore a degree of subjective decision making was required to define eating occasions before the main analysis could be conducted. I considered the advantages and disadvantages of each existing definition in the literature, reviewed previous eating occasion research, and conducted preliminary descriptive analysis of the National Diet and Nutrition Survey (NDNS) dietary data to select the most appropriate definition for my study.

Supplementary Table 2 lists the definitions of eating occasions used in previous research.^{327,328} I could not use the participant identified definition because respondents of the NDNS (parent/carer of the preschool children in this study sample) were not asked to define eating occasions as meals or snacks. Respondents were only asked to record the exact time at which each food or drink was consumed. The time-of-day definition was deemed inappropriate because the times used are based on adult eating occasions (and may not reflect the times preschool children eat). The definitions using energy criteria were also deemed inappropriate for this sample of preschool children, owing to the potential small portions eaten. Not using energy criteria avoided subjective judgements about energy content, which may not be reliable for this age group,⁵⁴ as young children's meal intake can be highly variable.⁹⁵

Supplementary Table 2. Summary of nine different eating occasion definitions³²⁷

Definition	Description
Participant identified	Meals are reported by participants as breakfast, brunch, lunch, dinner, and supper. Snacks are reported as snack, morning/afternoon tea and drink break
Time of day	Meals are classified as the largest eating occasion occurring between 06:00 and 10:00, 12:00 and 15:00 and 17:00 and 21:00 Snacks are classified as eating occasions outside of these times.
Exact time interval	An eating occasion is separated in time from the preceding and succeeding eating occasion
15-minute time interval	An eating occasion is separated in time from the preceding and succeeding eating occasion by >15mins
15-minute time interval plus 210 kJ energy criterion	An eating occasion is separated in time from the preceding and succeeding eating occasion by >15mins and contains a minimum energy content of 210 kJ
30-minute time interval	An eating occasion is separated in time from the preceding and succeeding eating occasion by >30mins
30-minute time interval plus 210 kJ energy criterion	An eating occasion is separated in time from the preceding and succeeding eating occasion by >30mins and contains a minimum energy content of 210 kJ
60-minute time interval	An eating occasion is separated in time from the preceding and succeeding eating occasion by >60mins
60-minute time interval plus 210 kJ energy criterion	An eating occasion is separated in time from the preceding and succeeding eating occasion by >60mins and contains a minimum energy content of 210 kJ

Three definitions were considered for this analysis. All three definitions have been used in previous research exploring eating behaviours in children. Firstly, to define **an eating occasion as any occasion in which food and drinks were consumed at a single clock time** (e.g foods consumed at 12:00 and 12:09 would be counted as two distinct eating occasions).^{54,63,258,329,330} Secondly, to define **an eating occasion as any occasion in which food and drinks were consumed within the same 15-minute period**. If two items are consumed ≤ 15 mins, these are considered as a single eating occasion, if > 15 mins separate two items, these are considered distinct eating occasions (e.g foods consumed at 12:00 and 12:14 would be counted as one eating occasion).^{61,80,245,318-320,331-333} Thirdly, to define **an eating occasion as any occasion in which food and drinks**

were consumed within the same 30-minute period. If two items are consumed ≤ 30 mins, these are considered as a single eating occasion, if >30 mins separate two items, these are considered distinct eating occasions (e.g foods consumed at 12:00 and 12:22 would be counted as one eating occasion).^{334,335}

An advantage of using the single clock time definition would allow me to account for the potentially more sporadic eating of young children, as children may eat little and often.⁹⁵ An advantage of using the 15-minute or 30-minute time interval definitions would allow me to account for the potential that young children may consume second helpings and pudding as part of a meal (typically lunch and/or dinner), which may have been recorded at separate times.

A descriptive analysis of the NDNS food-level data was conducted to compare the three definitions. Supplementary Table 3 compares the total number of reported eating occasions and median eating occasion size (study outcome) by definition.

Supplementary Table 3. Comparison of three eating occasion definitions using data from preschool children (n 1962) in the NDNS 2008-17.

	Single clock time	15-min time interval	30-min time interval
Total number of eating occasions*	51275	50611	49089
Median (IQR) eating occasion size (kcal)	146 (71, 257)	148 (75, 260)	155 (80, 268)

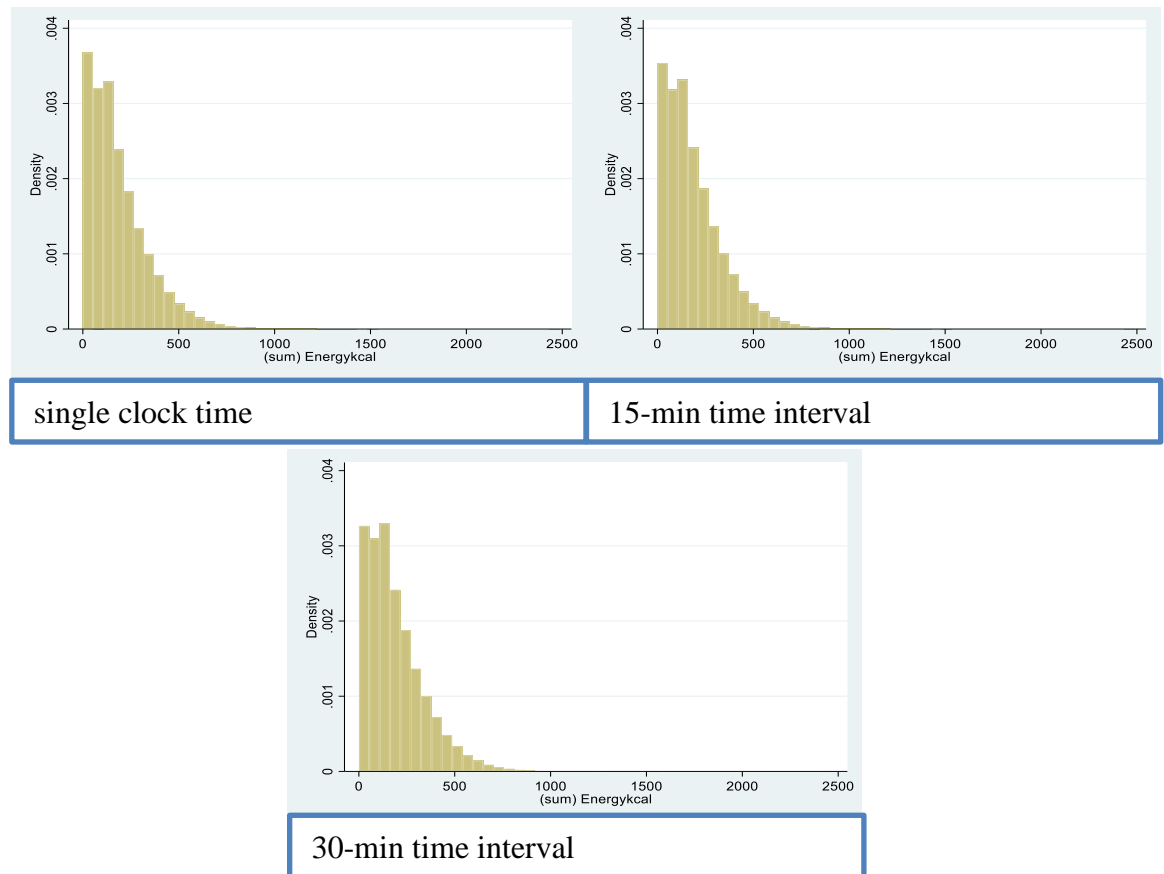
*Across all preschool children and all diary days

The total number of eating occasions per child were compared across the three definitions. When comparing the single clock time definition to the 15-minute time interval definition, the mean difference in total number of eating occasions per child was 0.3 eating occasions (SD 0.9, Range 0-8). There was a difference of ≥ 1 eating occasions for 375 (19%) preschool children. When comparing the single clock time definition to the 30-minute time interval definition, the mean difference in total number of eating occasions per child was 1.1 eating occasions (SD 2.0, Range 0-16). There was a difference of ≥ 1 eating occasions for 850 (43%) preschool children. When the 15-minute time interval definition was compared to the 30-minute time interval definition, the mean difference in total number of eating occasions per child was 0.8 eating occasions (SD 1.4,

Range 0-12). There was a difference of ≥ 1 eating occasions for 739 (38%) preschool children.

Supplementary Figure 2 shows the distribution of eating occasion size (study outcome) was similar when comparing the three definitions of eating occasion. The outcome variable was positively skewed regardless of definition used. As observed from the data, the choice of definition was unlikely to make a significant difference to the outcome variable.

Supplementary Figure 2. Histogram plots of eating occasion size (outcome variable) using the three possible eating occasion definitions. Histograms show the distribution of energy (kcal) across all eating occasions.



I decided to disregard the 30-minute definition because it has been used less in previous studies in children, therefore making it more difficult to draw comparisons with other studies. To further explore the differences between the single clock time and 15-minute definitions, I identified all preschool children IDs in the data where the definition of eating occasion made a difference to the total number of eating occasions recorded. The difference in total number of eating occasions recorded between the two definitions was 664 (from 375 participants). I explored the raw food-level data for the first 30% of IDs (113 participants, equating to 214 eating occasions) to check whether combining foods/drinks within 15-minute time periods into eating occasions seemed contextually appropriate. Although this involved some subjective thinking, it was important to check the eating occasion definition chosen was applied most appropriately for the survey respondents (parents of preschool children) in the NDNS data.

Supplementary Table 4 shows a description of the first 214 eating occasions in the NDNS data where one or more food/drinks recorded at different times but within a 15-minute time interval have been defined as a single eating occasion. In the raw data, I looked at the food/drinks recorded, as well as the time recorded to contextually describe each eating occasion. Most frequently, where items had been combined within a 15-minute time interval was when a drink was recorded at a separate time close to a recorded meal or snack. Other common scenarios included a pudding item consumed soon after a meal; individual items recorded close together; and a single item was recorded close (either before or after) to a meal. Following this data exploration, I felt confident the foods/drinks combined within 15-minute periods could plausibly be defined as single eating occasions.

Supplementary Table 4. The frequencies and percentages of contextual scenarios where foods/drinks have been combined within 15-minute periods to define an eating occasion

Context	Frequency	Percentage
Breastfeed close to a meal	1	0.47
Hot chocolate	1	0.47
Drink with pudding	2	0.93
Vitamins with a drink	2	0.93
Two drinks consumed close together	4	1.87
Vitamins with food	6	2.8
Second serving	8	3.74
Pudding with a meal	16	7.48
Food item consumed soon before or after meal	28	13.08
Individual foods consumed close together in time	44	20.56
Drink with a meal	50	23.36
Drink with a snack	52	24.3
Total	214 eating occasions	

Considering both previous literature and the NDNS data, I decided that the 15-minute definition of eating occasion was the most appropriate definition to use for this analysis. This definition is most commonly used in previous literature in children^{61,80,245,318-320,331-333} and has been deemed the most appropriate to examine eating pattern outcomes in adults.³²⁷ Leech et al.,³²⁷ concluded using the eating occasion definition of 15-minute interval plus a 210kJ energy criterion best predicted variance in total energy intake and total food and drink intake among adults. As stated above, the addition of an energy criterion would be inappropriate for this sample of preschool children. After exploring the

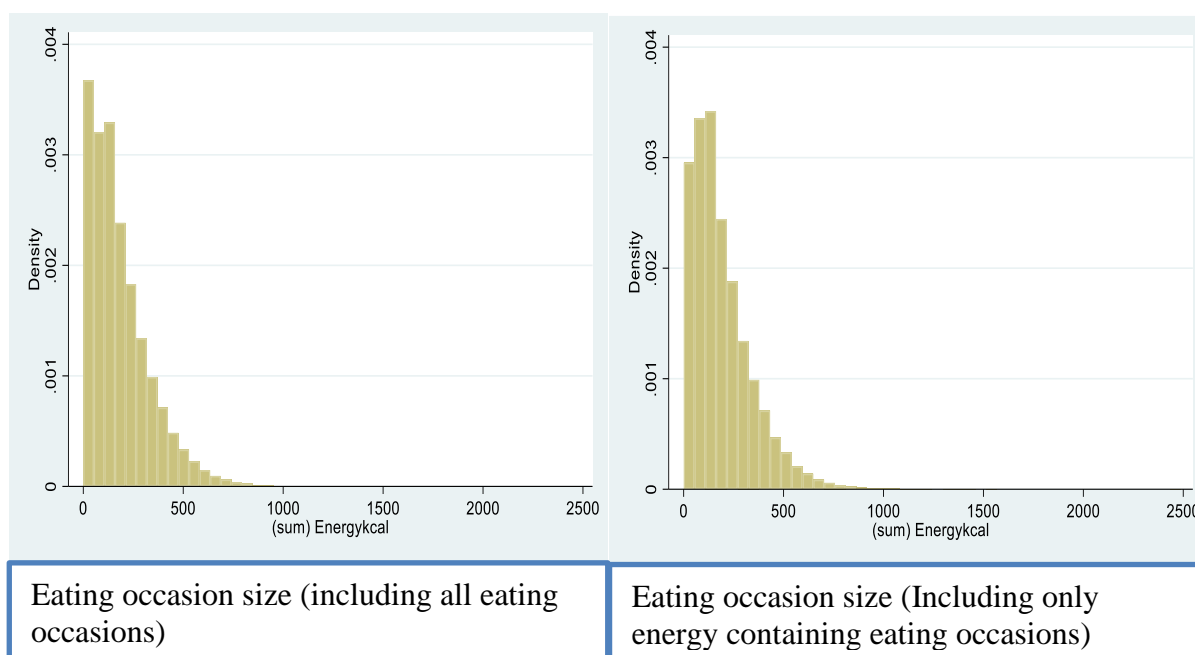
raw food-level NDNS data, I found the statistical method to define eating occasions within 15-minute time intervals did reasonably combine foods/drinks that could plausibly be considered as one eating occasion. I therefore felt confident using the 15-minute time interval definition was most appropriate for my study.

I also considered whether to include non-energy containing eating occasions (0 kcal) and drinks in the analysis. There is not a common rule in the literature for whether non-energy containing eating occasions and drinks should be included in the definition of an eating occasion. Of the 17 studies reviews by Leech et al.,³²⁷ nine studies included all eating occasions regardless of energy content (i.e included water and non-energy food and drinks), two studies excluded water only, one study excluded non-energy containing drinks (e.g water, tea, black coffee), and five studies did not include drinks in the definition of an eating occasion. I decided to include drinks as they could plausibly make a significant contribution to eating occasion size (i.e the calorie content of an eating occasion) and overall energy intake, especially as preschool children are likely to consume milk as snacks or as part of a meal.³³⁶ In addition, I conducted descriptive analyses to explore the inclusion of drinks (Table 5.2 and Table 5.3). Results showed the percentage of eating occasions including drinks was higher in larger vs smaller eating occasions (41% vs 61%). Energy density was greater in larger eating occasions vs smaller eating occasions both when drinks were included (0.4kcal/g vs 1.1kcal/g) and excluded (1.1kcal/g vs 2.0kcal/g). Energy density was also correlated with eating occasion size both when drinks were included (0.2716) and when drinks were excluded (0.0884).

Descriptive analysis was conducted to help decide whether to exclude non-energy eating occasions in the definition of eating occasions. Supplementary Figure 3 shows eating occasion size was positively skewed regardless of whether all eating occasions are included versus only energy containing eating occasions (excluding 0kcal eating occasions).

Supplementary Figure 3. Histogram plots of eating occasion size (outcome variable) showing all eating occasions versus energy containing eating occasions only.

Histograms show the distribution of energy (kcal) across all eating occasions.



The raw food-level data was explored to identify the 0kcal eating occasions. 2,192 eating occasions contained zero calories. Excluding 0kcal eating occasions reduced the total number of eating occasions from 50,611 to 48,419. Supplementary Table 5 presents the foods and drinks included in 0kcal eating occasions. These eating occasions were most commonly water only occasions. Other 0kcal eating occasions include tea, calorie free soft drinks and vitamins.

Supplementary Table 5. Foods and drinks included in non-energy containing (0kcal) eating occasions

Food Name	Frequency	Percent (%)
7-UP LIGHT LOW CALORIE BOTTLED	2	0.09
BASSETTS EARLY HEALTH VITAMINS A,B6,C..	8	0.36
BASSETTS SOFT AND CHEWY VITAMINS A,C,..	21	0.96
BEROCCA STAY SHARP MULTIVITAMINS AND ..	1	0.05
BOOTS MULTIVITAMIN SYRUP 4 MONTHS TO ..	4	0.18
CALCIUM 1000MG AND MAGNESIUM 500MG WL..	1	0.05
CALCIUM 250MG AND VITAMIN D 5MCG	2	0.09
CALCIUM CARBONATE TABLET 1250MG	1	0.05
CARBONATED DRINK NO JUICE CANNED L..	1	0.05
CARBONATED DRINKS NO JUICE LOW CAL..	7	0.32
CHEWING GUM SUGAR FREE	4	0.18

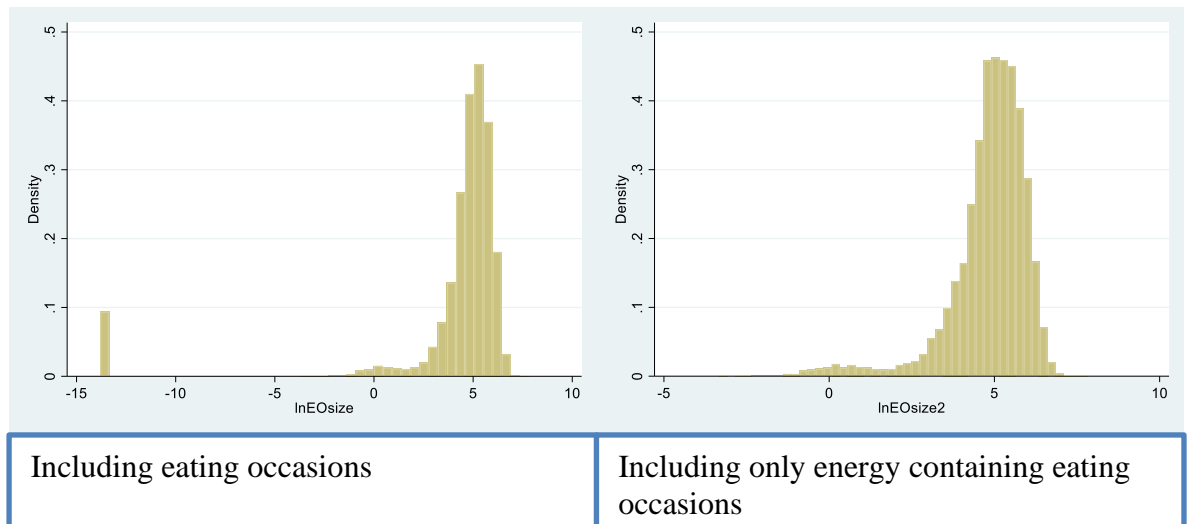
ENDEKAY FLUORIDE DROPS	1	0.05
HALIBORANGE KIDS MULTIVITAMIN FRUIT S..	8	0.36
HEALTHY START CHILDRENS MULTIVITAMIN ..	7	0.32
HERBAL TEA AS SERVED	17	0.78
IRN BRU LOW CALORIE CANNED	1	0.05
KETOVITE TABLETS	2	0.09
LIQUID IRON SUPPLEMENT 27.5MG	1	0.05
MAGNESIUM TABLET 100MG	1	0.05
MINERAL WATER CARBONATED FLAVOURED NO..	70	3.19
MINERAL WATER STILL OR CARB WITH ARTI..	12	0.55
MINERAL WATER STILL OR CARBONATED NOT..	228	10.40
MULTISANOSTOL MULTIVITAMIN AND CALCIU..	3	0.14
MULTIVITAMIN DROPS FOR BABIES AND CHI..	10	0.46
RTD FRUIT FLAVOUR LOW CAL DRINK	11	0.50
SALT TABLE	1	0.05
SEVEN SEAS HALIBORANGE MULTIVITAMIN L..	10	0.46
SEVEN SEAS HALIBORANGE VITAMIN A,C,D ..	4	0.18
TABLE TOP SWEETENERS IN TABLETS OR ML..	1	0.05
TEA FRUIT ONLY AS SERVED NO MILK	3	0.14
TEA HERB AND FRUIT MIX AS SERVED NO M..	2	0.09
TEA NOT STRONG INFUSION DECAFFEINATED	2	0.09
TEA WEAK INFUSION	6	0.27
TEA, GREEN, INFUSION	1	0.05
TESCO CHILDRENS MULTIVITAMINS AND MIN..	13	0.59
VITAMIN C TABLET 100MG	1	0.05
VITAMIN D SUPPLEMENT 3000IU (75MCG)	1	0.05
VITAMIN E TABLET 500MG	1	0.05
WATER - DILUENT FOR CONCENTRATED LOW ..	5	0.23
WATER AS A DILUENT FOR INFANT FORMULA	1	0.05
WATER FOR CONCENTRATED SOFT DRINKS NO..	1	0.05
WATER NOT AS A DILUENT	1,707	77.87
WELLKID BABY AND INFANT VITAMIN AND M..	8	0.36
Total	2,192	100.00

As eating occasion size was positively skewed, the variable was log transformed to give a normal distribution and ensure the assumptions of running a multilevel model were met (assumption is that the outcome variable residuals are of normal distribution).

Supplementary Figure 4 shows the distribution of the log transformed eating occasion size variable when all eating occasions are included versus only energy containing eating occasions are included (excluding 0kcal eating occasions). The histogram plots showed that when all eating occasions were included, the distribution remained non-normal. When non-energy containing eating occasions were excluded, the distribution was normal. Median eating occasion size was 149kcal (IQR; 75, 260) when including all

eating occasions and 157kcal (IQR; 85, 267) when excluding non-energy eating occasions.

Supplementary Figure 4. Histogram plots showing distribution of log transformed eating occasion size variable (outcome variable) when all eating occasions are included versus energy containing eating occasions only



Because of the non-normal distribution, small difference in median eating occasion size and because non-energy eating occasions tended to be distinct from the energy containing eating occasions (tended to be water and vitamins), we decided to exclude non-energy eating occasions in this analysis. I therefore **defined eating occasions as any energy-containing (>0kcal) occasion in which food and drinks were consumed within the same 15-minute period.**

Eating occasion size (study outcome)

The outcome of interest was eating occasion size, calculated as the total energy (kcal) consumed per eating occasion. Kilocalories (kcal) were chosen as the unit for eating occasions rather than grams, as energy content was more commonly used to explore eating occasions or portion sizes in previous studies,^{54,80,260,337,338} which aided the compatibility of results with other studies, and has greater public health relevance (e.g can associate with energy intake). I chose to not define the outcome as ‘meal size’, as previously defined in a key study⁵⁴ because eating occasions were later classified as meals or snacks (described below).

The overall median eating occasion size was calculated as the total energy (kcal) of an eating occasion across all preschool children and all days (up to four days depending on number of completed food diary days). I focused on eating occasion size rather than portion sizes of individual food and drinks,^{61,106} to take into account that several foods and drinks are often consumed together as meals and snacks.

Descriptive analysis was conducted to explore the distribution of the outcome variable. Across all eating occasions, eating occasion size ranged from 0 to 2488kcal. I examined eating occasions >1500kcal, as these could be considered extreme values for preschool children. Only two eating occasions were found to be >1500kcal. Although large, both were deemed plausible intakes and therefore kept in analysis.

Meals and snacks (eating occasion type)

I considered how to classify eating occasions as either meals or snacks. This was important because as meals are systematically larger than snacks and therefore whether an eating occasion was a meal or snack (referred to here as eating occasion type) could help to explain (mediate) certain relationships between eating contexts and eating occasion size. Categorising eating occasions into meals and snacks involved a degree of subjective decision making. However, both the NDNS data and previous research was considered, to minimize the degree of error and bias. Meals and snacks have been defined in several ways in previous eating patterns literature.³²⁸ Supplementary Table 6 summarises the existing methods to define eating occasion type.

Supplementary Table 6. Summary of methods to define meals and snacks used in previous literature

Method to define meals and snacks	Description
Participant-identified	Participants report the food/drink consumed and the eating occasion associated with that food/drink from a list of pre-labelled eating occasions such as breakfast, lunch, dinner, morning snack, afternoon snack.
Energy content	Total daily energy intake is calculated for participants. The energy content of an eating occasion is used to define meals as eating occasions providing, for example, >10% of total daily intake and snacks as eating occasions providing <10% of total daily energy intake. The percentage of total

	daily energy intake that define a meal or snack is decided by the researcher.
Time-of-day	Eating occasions are defined as meals and snacks based on the time they are consumed. This also allows meals to be defined further as breakfast, lunch, and dinner. For example, eating occasions consumed between 06:00-10:00 are defined as breakfast, 12:00-15:00 as lunch and 18:00-21:00 as dinner. Any eating occasions consumed outside of these times are defined as snacks. Time slots can be based on previous studies or the data. For example, daily percent energy can be plotted against 30-minute intervals across a 24-hour day to examine time slots in which the highest percent of energy is consumed.
Time-of-day plus an energy criterion	Uses the time-of-day method, plus only eating occasions with the highest energy content within each of the mealtime slots are defined as meals and all other eating occasions with a lower energy content within that mealtime slot are defined as snacks.
Contextual information	Using reported data about the contexts in which foods/drinks are consumed to define meals and snacks. For example, contextual data about where eating occasions were consumed and who they were consumed with.
Food-based (food content)	Defining meals and snacks based on the energy density of eating occasions, nutrient composition of eating occasions or the contribution of core to non-core foods.
Food-based (number of food items)	Eating occasions are labelled as meals if includes two or more items labelled as meal foods or three or more items labelled as snack foods. Eating occasions are labelled as snack if includes one or two items labelled as snack foods or one item labelled as a snack food and one item labelled as a meal food. All foods are labelled as meal or snack foods based on previous research and/or researcher decisions (rather than participant information).

Considering previous research and the NDNS data, the time-of-day plus energy criterion method was deemed the most appropriate for this study. This method has previously been used to define meals and snacks in samples of children.^{258,260,275} I was unable to use the participant-identified method because participants of the NDNS were not asked to define foods/drinks as being part of a meal or snack. There was limited previous research using the energy content, contextual information, and food-based methods in eating patterns research in children.^{330,334,335,337} Therefore, these methods were deemed less appropriate

to use due to the lack of comparability. In addition, the energy content method was deemed inappropriate because of the subjective decisions required to set the percentage energy cut-off used to define meals and snacks. The contextual information method was deemed inappropriate because the study aimed to explore eating contexts as potential factors associated with the study outcome (eating occasion size) and therefore would cause exposure variables to be highly correlated with the eating occasion type variable. The food-based methods were deemed inappropriate because of the subjective decisions required to label food items and decide energy content cut-offs, which would introduce the most researcher bias.

To identify meals and snacks within the data, in line with previous research,²⁷⁵ I plotted a line graph of energy distribution (percent energy by time of day) in 30-minute intervals across a 24-hour day. This was to visualise the energy contribution of eating occasions across the day and to identify peaks in percentage energy, which could be defined as meals. To plot this graph, I firstly calculated total daily energy consumed per preschool child per diary day using the NDNS food-level dataset. I created a new time variable, where the exact time a food/drink was consumed corresponded to one 30-minute period across the 24-hour day (e.g. an exact time of 09:15 corresponded to 540 minutes or 9 hours into the day). I then collapsed the dataset into eating occasions (defined as any occasion is which food and drinks were consumed within the same 15-minute period). This created an eating occasion-level file, which provided information about the person ID, energy (size), time and diary day associated with each individual eating occasion. I calculated percentage energy from each eating occasion (energy (kcal) of an eating occasion was divided by total daily energy intake (kcal) and then multiplied by 100). I then collapsed this eating occasion-level dataset to calculate the average (mean) percentage energy of each eating occasion across all preschool children and all diary days, by time of day in 30-minute intervals (using the new time variable).

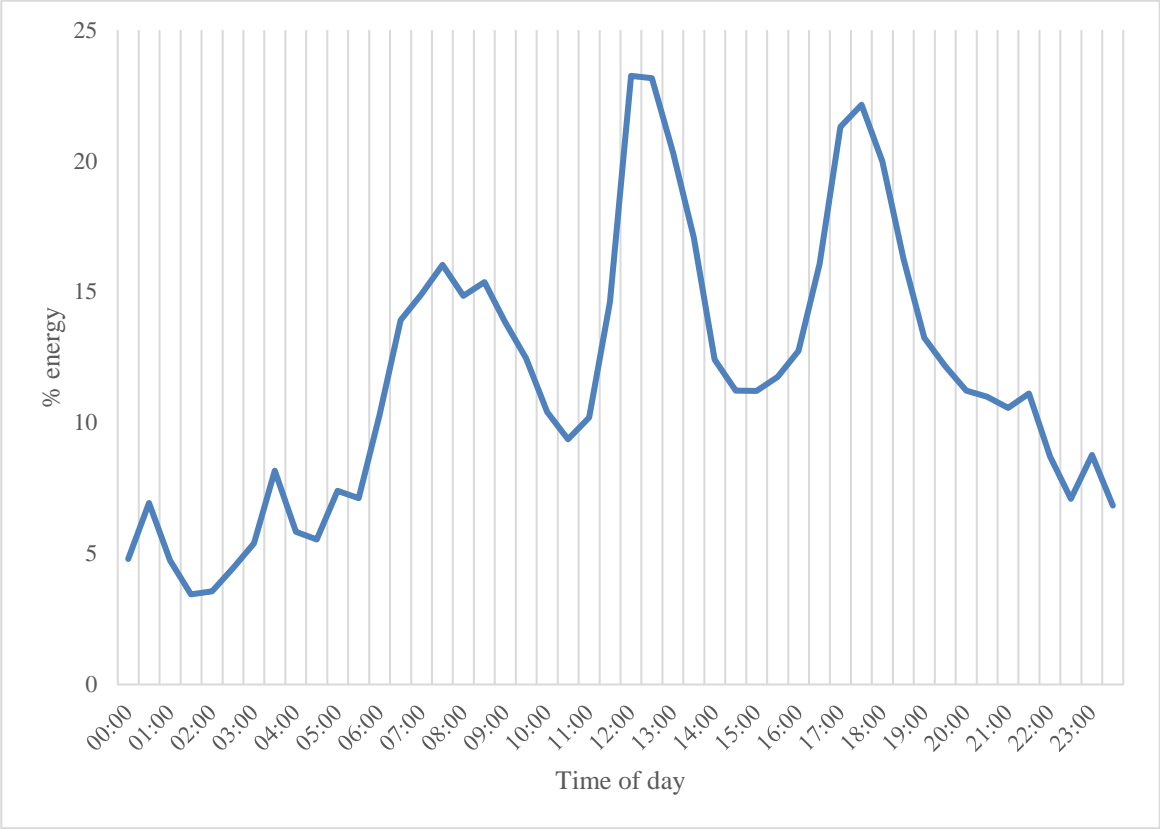
A simple two-way line graph was then produced (Supplementary Figure 5), with time-of-day in 30-minute intervals on the x-axis and % energy of eating occasions on the y-axis. This graph illustrated the percentage energy from eating occasions across the 24-hour day and allowed us to identify peaks in energy that could be defined as meals. The first peak in energy in the day was between 05:30-10:00. Eating occasions consumed within this time were labelled as a meal ('breakfast'). The second peak was between 11:00-14:00.

These eating occasions were labelled as a meal ('lunch'). The third peak was between 16:00-19:00. These eating occasions were labelled as a meal ('evening meal'). All other eating occasions outside of these mealtimes were labelled as snacks.

These timings were similar to those used in a previous study exploring eating patterns in children, which used the same time-of-day approach;²⁵⁸ breakfast occurred between 05:30–09:30, midday meal 11:30–14:30 and the evening meal 17:00– 21:30. The evening meal did differ from our data, however Fayet-Moore et al.,²⁵⁸ analysed data from a sample of children aged two-to-16-years. It is reasonable to accept this sample of preschool children would consume the evening meal at an earlier time.

As I observed relatively large time frames for meals in the data, it seemed appropriate to also include an energy criterion to help more accurately define meals and snacks, similar to previous studies.^{259,260} I defined the breakfast meal as the eating occasion with the largest percent energy between 05:30-10:00, the lunch meal as the largest between 11:00-14:00 and the evening meal the largest between 16:00-19:00. All other smaller eating occasions and eating occasions outside of these times were defined as snacks. Using an energy criterion ensured that snacks were not incorrectly defined as second meals (for example, if eating occasions were recorded at 06:30 and 08:30, only one was defined as breakfast, the other was defined a snack). I created this energy criterion by sorting eating occasions from largest to smallest percent energy by eating occasion type (breakfast, lunch, evening meal, snack), diary day and ID and then labelled the eating occasion with the largest percent energy as the meal and any smaller eating occasions as snacks. Although applying this time-of-day plus energy criterion method to define eating occasion type meant some eating occasions may have been incorrectly labelled as meals or snacks, I felt confident after reviewing the literature and conducting preliminary analyses that this was the most appropriate method for this study.

Supplementary Figure 5. Percentage energy of eating occasions consumed by time of day to classify eating occasions as meal and snacks



Appendix 16. Breakdown of original Location ('Where) eating context

Home	Home - Bedroom Home - Dining Room Home - Garden Home - Kitchen Home - Living Room Home - Other Home - Unspecified
Friend's or Relative's house	Holiday Accommodation Friend's or Relative's house
Childcare	School - Canteen - Bought food School - Canteen - Food from home School - Canteen - Other School - Classroom School - Other School – Playground Carer's home Nursery/Kindergarten
Eateries	Coffee shop, cafe, shop, deli, sandwich Fast food outlet Restaurant, pub, night club
On the go	Not At Home - Unspecified Outside - Other Street Bus, car, train
Activity and other places	Leisure Activities, shopping, tourist a Sports club, sports leisure venue Community Centre/Day Centre/Drop in Community centre/day centre/drop-in Place of Worship Public Hall/Function Room Other place Unspecified Work - Canteen - Bought food Work - Canteen - Food from home Work - Canteen - Other Work - Desk Work - Other

Appendix 17. Breakdown of original eating companion ('with whom') eating context

Alone	Alone
Parents/carers	Parent(s)/Carer Partner
Parents & siblings	Parent(s)/Carer & Siblings Siblings
Family & friends	Family (incl. Relatives) Family & Friends Carer & Other Children Partner & Children
Friends	Friends Child/Children Others - General Public Others General public Others - Known to Respondent Others known to Respondent Work colleagues
Not specified	Not specified

Appendix 18. Breakdown of parental socioeconomic status categories using the National Statistics Socio-economic classifications (NS-SEC)

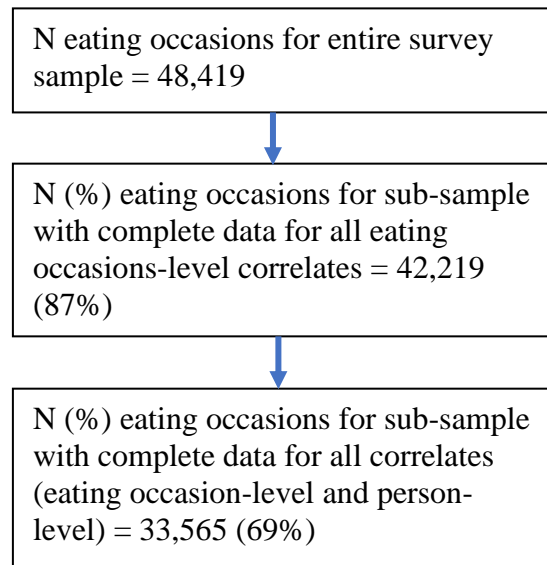
High	<p>Higher managerial, administrative and professional occupations</p> <p>Large employers and higher managerial and administrative occupations</p> <p>Higher professional occupations</p> <p>Lower managerial, administrative and professional occupations</p>
Intermediate	<p>Intermediate occupations</p> <p>Small employers and own account workers</p>
Low	<p>Lower supervisory and technical occupations</p> <p>Semi-routine occupations</p> <p>Routine occupations</p> <p>Never worked and long-term unemployed</p>

Appendix 19. Description of all multilevel models in analysis of variation in eating occasion size in preschool children

Model	Description	
Model 1	Random intercept null model. Includes no explanatory variables. Purpose is to partition within and between person variation using eating occasion size as the level one (within) variable and participant ID as the level two (between) variable	
Unadjusted models (1.1-1.8) to estimate the unadjusted associations between eating occasion size and potential exposure variables		
Model 1.1	Location of eating occasion (5 dummy variables)	
Model 1.2	Eating companion at eating occasion (5 dummy variables)	
Model 1.3	Watching TV eating at an eating occasion	
Model 1.4	Sitting at table eating at an eating occasion	
Model 1.5	Age (5 dummy variables)	
Model 1.6	Gender	
Model 1.7	Ethnicity (5 dummy variables)	
Model 1.8	Parental socioeconomic status (3 dummy variables)	
Adjusted models (2.1-2.8) to estimate the adjusted associations of the main exposure variables independent of potential confounding		
	Main exposure	Covariates
Model 2.1	Location	time of day, day of week, day number, age, ethnicity, parental SES, and misreporting
Model 2.2	Eating companion	time of day, day of week, location, day number, age, ethnicity, and misreporting
Model 2.3	Watching TV eating	time of day, day of week, location, eating companion, sitting at the table, day number, age, ethnicity, parental socioeconomic status, and misreporting
Model 2.4	Sitting at a table eating	time of day, day of week, location, eating companion, watching TV, day number, age, ethnicity, and misreporting

Model 2.5	Age	misreporting, total daily energy intake, and BMI z-score
Model 2.6	Gender	misreporting, total daily energy, intake and BMI z-score
Model 2.7	Ethnicity	misreporting, total daily energy intake, and BMI z-score
Model 2.8	Parental socioeconomic status	ethnicity, misreporting, total daily energy intake, and BMI z-score
Mediation models (3.1-3.8) to estimate the mediating effect on the associations between exposure variables and eating occasion size, after adjusting for potential confounding		
	Main exposure	Potential mediator
Model 3.1	Location	Eating occasion type
Model 3.2	Eating companion	Eating occasion type
Model 3.3	Watching TV eating	Eating occasion type
Model 3.4	Sitting at a table eating	Eating occasion type
Model 3.5	Age	Eating frequency
Model 3.6	Gender	Eating frequency
Model 3.7	Ethnicity	Eating frequency
Model 3.8	Parental socioeconomic status	Eating frequency

Appendix 20. STROBE flowchart of missing data, illustrating reduction in sample size as potential exposure variables are added to models



Appendix 21. STROBE-nut: an extension of the STROBE statement for nutritional epidemiology

Item	Item nr	STROBE recommendations	Extension for Nutritional Epidemiology studies (STROBE-nut)	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract. (b) Provide in the abstract an informative and balanced summary of what was done and what was found.	nut-1 State the dietary/nutritional assessment method(s) used in the title, abstract, or keywords.	143 N/A
Introduction				
Background rationale	2	Explain the scientific background and rationale for the investigation being reported.		143-45
Objectives	3	State specific objectives, including any pre-specified hypotheses.		145
Methods				
Study design	4	Present key elements of study design early in the paper.		145-146
Settings	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection.	nut-5 Describe any characteristics of the study settings that might affect the dietary intake or nutritional status of the participants, if applicable.	145-147
Participants	6	a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up. Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls.	nut-6 Report particular dietary, physiological or nutritional characteristics that were considered when selecting the target population.	

Item	Item nr	STROBE recommendations	Extension for Nutritional Epidemiology studies (STROBE-nut)	Reported on page #
		Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants. (b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed. Case-control study—For matched studies, give matching criteria and the number of controls per case.		145
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	nut-7.1 Clearly define foods, food groups, nutrients, or other food components. nut-7.2 When using dietary patterns or indices, describe the methods to obtain them and their nutritional properties.	146-147
Data sources - measurements	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group.	nut-8.1 Describe the dietary assessment method(s), e.g., portion size estimation, number of days and items recorded, how it was developed and administered, and how quality was assured. Report if and how supplement intake was assessed. nut-8.2 Describe and justify food composition data used. Explain the procedure to match food composition with consumption data. Describe the use of conversion factors, if applicable. nut-8.3 Describe the nutrient requirements, recommendations, or dietary guidelines and the	146-147, 149

Item	Item nr	STROBE recommendations	Extension for Nutritional Epidemiology studies (STROBE-nut)	Reported on page #
			evaluation approach used to compare intake with the dietary reference values, if applicable. nut-8.4 When using nutritional biomarkers, additionally use the STROBE Extension for Molecular Epidemiology (STROBE-ME). Report the type of biomarkers used and their usefulness as dietary exposure markers. nut-8.5 Describe the assessment of nondietary data (e.g., nutritional status and influencing factors) and timing of the assessment of these variables in relation to dietary assessment. nut-8.6 Report on the validity of the dietary or nutritional assessment methods and any internal or external validation used in the study, if applicable.	
Bias	9	Describe any efforts to address potential sources of bias.	nut-9 Report how bias in dietary or nutritional assessment was addressed, e.g., misreporting, changes in habits as a result of being measured, or data imputation from other sources	148-149
Study Size	10	Explain how the study size was arrived at.		145
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why.	nut-11 Explain categorization of dietary/nutritional data (e.g., use of N-tiles and handling of nonconsumers) and the choice of reference category, if applicable.	146-147
Statistical Methods	12	(a) Describe all statistical methods, including those used to control for confounding	nut-12.1 Describe any statistical method used to combine dietary or nutritional data, if applicable.	147-150

Item	Item nr	STROBE recommendations	Extension for Nutritional Epidemiology studies (STROBE-nut)	Reported on page #
		(b) Describe any methods used to examine subgroups and interactions. (c) Explain how missing data were addressed. (d) Cohort study—If applicable, explain how loss to follow-up was addressed. Case-control study—If applicable, explain how matching of cases and controls was addressed. Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy. (e) Describe any sensitivity analyses.	nut-12.2 Describe and justify the method for energy adjustments, intake modeling, and use of weighting factors, if applicable. nut-12.3 Report any adjustments for measurement error, i.e., from a validity or calibration study.	N/A 159 148 N/A
Results				
Participants	13	(a) Report the numbers of individuals at each stage of the study—e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed. (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram.	nut-13 Report the number of individuals excluded based on missing, incomplete or implausible dietary/nutritional data.	150
Descriptive data	14	(a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest	nut-14 Give the distribution of participant characteristics across the exposure variables if applicable. Specify if food consumption of total population or consumers only were used to obtain results.	150, 155 Table 5.4 Appendix 20

Item	Item nr	STROBE recommendations	Extension for Nutritional Epidemiology studies (STROBE-nut)	Reported on page #
Outcome data	15	(c) Cohort study—Summarize follow-up time (e.g., average and total amount) Cohort study—Report numbers of outcome events or summary measures over time. Case-control study—Report numbers in each exposure category, or summary measures of exposure. Cross-sectional study—Report numbers of outcome events or summary measures.		150, 155, Table 5.1 Figure 5.1 Table 5.4 Figure 5.2
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included. (b) Report category boundaries when continuous variables were categorized. (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period.	nut-16 Specify if nutrient intakes are reported with or without inclusion of dietary supplement intake, if applicable.	158, 162 Figure 5.3 Table 5.5 Figure 5.4 Appendix 24
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions and sensitivity analyses.	nut-17 Report any sensitivity analysis (e.g., exclusion of misreporters or outliers) and data imputation, if applicable.	N/A
Discussion				
Key results	18	Summarize key results with reference to study objectives.		165-168
Limitation	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision.	nut-19 Describe the main limitations of the data sources and assessment methods used and	168-169

Item	Item nr	STROBE recommendations	Extension for Nutritional Epidemiology studies (STROBE-nut)	Reported on page #
Interpretation	20	Discuss both direction and magnitude of any potential bias. Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	implications for the interpretation of the findings. nut-20 Report the nutritional relevance of the findings, given the complexity of diet or nutrition as an exposure.	170
Generalizability	21	Discuss the generalizability (external validity) of the study results.		168-169
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based.		N/A
<i>Ethics</i>			nut-22.1 Describe the procedure for consent and study approval from ethics committee(s).	N/A
<i>Supplementary material</i>			nut-22.2 Provide data collection tools and data as online material or explain how they can be accessed.	Appendices 15-24

**Appendix 22. Mean (SD) eating frequency and median (IQR) eating occasion size (kcal) of preschool children (n 1962), in the UK
National Diet and Nutrition Survey 2008-17**

	Eating occasion frequency Mean (SD) occasions/day			Eating occasion size Median (IQR) kcal/occasion		
	Total	Meal	Snack	Total	Meal	Snack
Gender						
Boys	6.6 (2.1)	2.9 (0.3)	3.4 (1.8)	159 (87, 273)	258 (175, 368)	98 (51, 155)
Girls	6.5 (2.0)	2.9 (1.3)	3.3 (1.7)	153 (83, 259)	244 (165, 350)	95 (47, 150)
SES						
Low	6.4 (2.1)	2.9 (0.3)	3.2 (1.8)	160 (89, 268)	247 (164, 357)	101 (51, 161)
Intermediate	6.6 (1.9)	2.9 (0.3)	3.3 (1.6)	156 (84, 267)	252 (174, 359)	95 (46, 149)
High	6.8 (2.1)	2.9 (0.3)	3.5 (1.8)	152 (81, 264)	254 (173, 362)	95 (50, 146)
Ethnicity						
White	6.6 (2.0)	2.9 (0.3)	3.3 (1.7)	157 (84, 268)	254 (174, 364)	95 (48, 148)
Black/Black British	5.6 (1.9)	2.8 (0.5)	2.7 (1.4)	180 (113, 285)	247 (158, 347)	127 (70, 200)
Asian/Asian British	7.1 (2.4)	2.9 (0.5)	3.9 (2.0)	145 (88, 239)	212 (138, 315)	112 (64, 168)
Mixed	6.5 (2.2)	2.9 (0.3)	3.3 (1.8)	168 (90, 282)	250 (164, 369)	109 (54, 178)
Other	6.7 (2.3)	2.8 (0.5)	3.4 (1.7)	156 (94, 247)	222 (148, 318)	117 (64, 169)
Misreporting of EI						
Plausible reporter	6.6 (2.0)	2.9 (0.3)	3.4 (1.7)	158 (85, 270)	258 (178, 365)	95 (49, 150)
Under-reporter	5.8 (1.8)	2.9 (0.4)	2.7 (1.4)	137 (77, 230)	204 (134, 299)	85 (40, 134)
Over-reporter	7.0 (2.4)	2.9 (0.3)	3.8 (2.0)	164 (93, 282)	270 (188, 390)	109 (58, 168)
	B (95% CI)			B (95% CI)		
Age (years)	-0.3 (-0.33, -0.26)	-0.006 (-0.01, -0.001)	-0.3 (-0.31, -0.26)	23 (22.5, 24.5)	31 (29.2, 32.1)	10 (9.4, 11.3)
BMI z score*	-0.06 (-0.11, -0.02)	0.004 (-0.002, 0.01)	-0.07 (-0.11, -0.03)	4 (2.6, 5.2)	5 (2.8, 6.6)	2 (0.6, 2.8)
Total daily eating frequency	.	.	.	-16 (-17.3, -16.1)	-11 (-11.7, -9.8)	-8 (-8.7, -7.7)
Total daily energy intake (per 1000 kcal)	1.2 (1.0, 1.3)	0.1 (0.08, 0.13)	0.9 (0.7, 1.0)	124 (120, 129)	204 (197, 211)	77 (73, 81)

Appendix 23. Characteristics of preschool children (n 1962), in the UK National Diet and Nutrition Survey 2008-17 across the eating contexts

	Preschool children		Boys		Girls		White		Black/Black British		Asian/Asian British		Mixed		Other		Age	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	Mean	SD
All	1962	100	1034	53	928	47	1688	86	49	3	122	6	64	3	39	2	3.1	1.3
Location																		
Home	1958	100	1032	100	926	100	1684	100	49	100	122	100	64	100	39	100	3.1	1.3
Friend's/relative's house	895	46	480	46	414	45	814	48	8	16	38	31	23	36	11	28	3.2	1.3
Childcare	1168	60	623	60	540	58	1021	60	21	43	61	50	40	63	20	51	3.5	1.2
Eateries	675	34	347	34	327	35	609	36	10	20	26	21	17	27	12	31	3.1	1.3
On the go	994	51	527	51	452	49	882	52	16	33	36	30	31	48	14	36	3.2	1.3
Activities and other places	794	40	402	39	362	39	673	40	15	31	38	31	27	42	11	28	3.1	1.3
Eating companion																		
Parents/carers	1558	80	834	81	724	78	1342	80	36	73	97	80	55	86	28	72	3.0	1.3
Alone	698	36	365	35	333	36	588	35	17	35	52	43	24	38	17	44	3.3	1.2
Parents & siblings	1063	54	564	55	499	54	926	55	24	49	54	45	38	59	21	54	3.3	1.3
Family and friends	1500	77	784	76	716	77	1326	79	26	53	86	71	41	64	21	54	3.1	1.3
Friends	1060	54	569	55	491	53	932	55	18	37	47	39	41	64	22	56	3.6	1.2
Watching TV																		
No	1952	99	1030	100	922	99	1683	100	46	94	120	98	64	100	39	100	3.1	1.3
Yes	1806	92	954	92	852	92	1560	92	46	94	110	90	58	91	32	82	3.1	1.3
Sitting at table																		
No	1814	92	959	93	855	92	1565	93	44	90	109	89	60	94	36	92	3.1	1.3
Not Specified	1398	71	748	72	650	70	1187	70	33	67	95	78	54	84	29	74	3.2	1.3
Yes	1892	96	992	96	900	97	1641	97	43	88	113	93	61	95	34	87	3.2	1.3

	Low SES		Intermediate SES		High SES		Plausible reporters		Under reporters		Over reporters		Total daily eating frequency		Total daily energy intake (kcal)		BMI z score	
	n	%	n	%	n	%	n	%	n	%	n	%	Mean	SD	Mean	SD	Mean	SD
All	744	39	368	19	812	42	1233	63	338	17	391	20	6.7	1.8	1198	278	0.4	1.2
Location																		
Home	743	100	366	99	811	100	1230	100	337	100	391	100	6.7	1.8	1198	278	0.4	1.1
Friend's/relative's house	344	46	172	47	362	45	564	46	153	45	177	45	6.6	2.0	1203	277	0.4	1.1
Childcare	376	51	225	61	540	67	762	62	191	57	210	54	6.5	1.7	1238	266	0.4	1.1
Eateries	211	28	109	30	338	42	453	37	99	29	122	31	6.5	2.1	1214	270	0.3	1.0
On the go	299	40	188	51	475	58	665	54	125	37	189	48	7.2	2.1	1234	270	0.3	1.1
Activities and other places	213	29	161	44	379	47	506	41	115	34	143	37	6.7	2.0	1218	276	0.4	1.1
Eating companion																		
Parents/carers	591	80	290	79	647	80	979	80	260	77	319	82	6.8	1.9	1185	275	0.4	1.1
Alone	283	38	131	36	269	33	447	36	110	33	141	36	7.1	2.0	1233	280	0.4	1.1
Parents & siblings	389	52	205	56	447	55	690	56	163	49	210	54	6.6	1.8	1225	277	0.4	1.1
Family and friends	549	74	274	75	649	80	964	78	245	73	291	75	6.7	1.9	1202	268	0.3	1.1
Friends	347	47	208	57	485	60	718	58	166	49	176	45	6.6	1.7	1257	270	0.4	1.1
Watching TV																		
No	736	99	368	100	810	100	1228	100	334	99	390	100	6.7	1.8	1199	277	0.4	1.1
Yes	711	96	344	93	715	88	1129	92	314	93	363	93	6.8	1.9	1199	277	0.4	1.1
Sitting at table																		
No	685	92	339	92	757	93	1152	93	296	88	366	94	6.8	1.9	1203	277	0.4	1.1
Not Specified	515	69	260	71	594	73	884	72	236	70	278	71	6.8	1.9	1206	281	0.4	1.1
Yes	697	94	360	98	799	98	1197	97	322	95	373	95	6.7	1.8	1201	277	0.4	1.1

Appendix 24. Relationship of eating occasion size with eating contexts and individual characteristics across among preschool children (n 1962), in the UK National Diet and Nutrition Survey 2008-17. Presents results from Models 1 and 2 before adjustment for potential mediators

	Models 1.1-1.8 - Unadjusted				Models 2.1-2.8- Adjusted for potential confounders			
Exposure	Ratio*	95% confidence intervals		p value	Ratio*	95% confidence intervals		p value
Eating contexts								
Model .1 - Location†								
Home (ref)	1.00				1.00			
Friend’s/relative’s house	1.11	1.04	1.18	0.001	1.04	0.97	1.11	0.257
Childcare	1.07	1.02	1.13	0.009	1.09	1.00	1.18	0.043
Eateries	1.88	1.72	2.05	<0.001	1.62	1.48	1.77	<0.001
On the go	0.77	0.71	0.82	<0.001	0.84	0.78	0.91	<0.001
Activities and other places	0.74	0.67	0.83	<0.001	0.88	0.79	0.98	0.025
Model .2 - Eating companion‡								
Parent/carer (ref)	1.00				1.00			
Alone	0.71	0.63	0.79	<0.001	0.74	0.66	0.82	<0.001
Parents & siblings	1.27	1.20	1.33	<0.001	1.18	1.13	1.24	<0.001
Family and friends	1.28	1.23	1.34	<0.001	1.19	1.14	1.25	<0.001
Friends	1.17	1.10	1.25	<0.001	1.12	1.02	1.22	0.014
Model .3 - Watching TV whilst eating§								
Not Watching TV (ref)	1.00				1.00			
Watching TV	0.95	0.91	0.99	0.008	1.07	1.03	1.12	0.001
Model .4 - Sitting at table whilst eating								
Not sitting at table (ref)	1.00				1.00			
Sitting at table	2.08	2.00	2.17	<0.001	1.79	1.72	1.88	<0.001
Individual characteristics								
Model .5 - Age¶								
1 year (ref)	1.00							
2 years	1.20	1.08	1.32	<0.001	1.24	1.08	1.43	0.002
3 years	1.18	1.07	1.31	0.002	1.18	1.03	1.35	0.020
4 years	1.48	1.34	1.64	<0.001	1.36	1.17	1.57	<0.001
5 years	1.63	1.47	1.79	<0.001	1.44	1.24	1.66	<0.001
Model .6 - Gender¶								
Boys (ref)	1.00				1.00			
Girls	0.95	0.90	1.01	0.094	1.00	0.95	1.05	0.896
Model .7 - Ethnicity¶								
White (ref)	1.00				1.00			
Black/Black British	1.38	1.22	1.55	<0.001	1.37	1.24	1.52	<0.001
Asian/Asian British	1.07	0.97	1.17	0.172	1.10	1.00	1.21	0.043
Mixed	1.21	1.05	1.40	0.010	1.24	1.10	1.39	<0.001
Other	1.09	0.97	1.22	0.142	1.20	1.06	1.36	0.004
Model .8 - Parental SES**								
Low (ref)	1.00				1.00			
Intermediate SES	0.98	0.92	1.05	0.584	1.00	0.94	1.07	0.977
High SES	1.00	0.95	1.05	0.965	1.00	0.95	1.06	0.980

*Ratios are presented as the exponentiated values of log-transformed coefficients and represent changes in the ratio of the mean eating occasion size. For example, an exponentiated value of 1.14 represents a 14% difference in eating occasion size between the specified eating context/individual characteristic and its reference category. †adjusted for time of day, day of week, day number, age, ethnicity, parental SES and misreporting, ‡adjusted for time of day, day of week, location, day number, age, ethnicity and misreporting, §adjusted for time of day, day of week, location, eating companion, sitting at the table, day number, age, ethnicity, parental SES and misreporting, |adjusted for time of day, day of week, location, eating companion, watching TV, day number, age, ethnicity and misreporting, ¶adjusted for misreporting, total daily energy intake and zBMI, **adjusted for misreporting, total daily energy intake, ethnicity and zBMI