Parent served vegetable portion sizes and perception of food leftovers across different meal combinations: A cross sectional, online study

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Abstract

Despite vegetables being commonly served at UK mealtimes, children's consumption remains insufficient. Because portion sizes provided by parents predict children's intake, understanding how parents decide on vegetable portions during meals is critical but underexplored. This study examined whether meal context and food combinations influence parent portion size decisions. In a novel online portion size task, 407 parents (203 female) of 4–8-year-old children selected portions of protein, carbohydrate, and vegetable items across nine meal combinations. Parents then anticipated how much food their child would leave after each meal. Meal factors (food items), child factors (food liking, familiarity, anticipated leftovers, eating traits, gender) and parental factors (mealtime goals and feeding practices) were explored as predictors of parent vegetable portion sizes and anticipated child vegetable leftovers. Smaller vegetable portions were associated with lower perceived child vegetable liking, greater anticipated vegetable leftovers, and parental goals to avoid mealtime stress, whereas goals to serve healthy foods predicted larger portions. Meal combinations had a stronger effect on anticipated vegetable leftovers than on portion sizes. Parents expected more vegetable leftovers when non-vegetable items were highly liked or anticipated to be leftover, while higher vegetable liking and familiarity predicted fewer leftovers. These findings suggest that parents base vegetable portion sizes primarily on expectations about individual foods rather than the overall meal. However, when anticipating leftovers, parents appear to consider the influence of more palatable, non-vegetable items on their child's vegetable intake. Understanding these decision-making processes may inform strategies to support parents in serving appropriate vegetable portions and encouraging their intake.

Keywords: portion size; serving size; vegetables; mealtimes; parenting; liking; food waste.

1 Introduction

Serving meals to children can be a challenging daily task for parents. Importantly, parents must consider two central decisions: the types of food offered, and how much of each (portion sizes) to provide. Deciding the type of meal to prepare each day can be demanding, as parents may balance healthy eating goals with their children's food preferences (Ramirez et al., 2024). Vegetables in particular are widely seen by parents as essential to serve to children as part of a healthy diet (Hingle et al., 2012), yet they are commonly disliked by children. However, parents are generally less well informed about appropriate portion sizes for children (Acolatse, Pourshahidi, Logue, McCann, & Kerr, 2023). While vegetables are commonly served at mealtimes in the UK (dependent on accessibility and availability: Barrett *et al.*, 2017), children consume, on average, only one portion per-day (Chawner, Blundell-Birtill, & Hetherington, 2021). This highlights two potential issues: that parents may serve vegetables in small portions at mealtimes, and that children may not eat the vegetables provided. However, it is undetermined whether characteristics of the meal itself may in part drive smaller parental portions, or lower child consumption, of vegetables within meals (e.g. due to competition between foods). The current study aimed to examine both vegetable portion sizes provided by parents and parents' anticipation of vegetable leftovers by children (4-8 years) across different meal combinations, utilising a novel online portion size selection task.

In the UK, national recommendations for what to eat are informed by the Eatwell guide (OHID, 2016), which outlines the proportions of different food groups (e.g. proteins, carbohydrates, fruits and vegetables, dairy, etc.) that should make up our diets over time (e.g. across a week), rather than at a single meal. However, recommendations for portion sizes - how much to eat - are provided in a separate document (Department for Education, 2025) that specifies appropriate amounts for individual foods at a single occasion (although, the recommendations only address child ages 4-10 years and 11-18 years, not children under 4 years). Research suggests that although parents want to know ***what*** to serve to their children, parents do not typically seek out portion size (***how much to serve***) information (Philippe, Issanchou, Roger, Feyen, & Monnery-Patris, 2021; Porter, Langford, Summerbell, Dobrescu, & Johnson, 2023). Yet, those who do search for portion size information may struggle to serve appropriate portions to their child due to complex and inaccessible guidelines. For 4-10 year olds, the "five-a-day" message for fruits and vegetables is salient, yet parents often struggle to understand which foods count and what constitutes a portion (Eck et al., 2018). For example, beans and pulses count toward the daily quota, but only for one portion, whereas potatoes do not count as they are too starchy (NHS UK, 2022). Additionally, while most vegetable portions for 4-10-year-olds should be

40-60 grams, there are no clear guidelines for whether these amounts should be adjusted for age. Confusion extends to other food groups, as portion sizes are expressed in a range of units for different foods - including grams, tablespoons, or whole items (e.g. 1 egg), and within a food group portion sizes can vary greatly (e.g. a portion of bread is 50g-70g, whereas a jacket [baked] potato is 200g-280g). Furthermore, some portion sizes are provided as raw and dried weights, whereas others are cooked weights (e.g. red meat: 50-80g raw; rice: 35-55g dried). In practice, parents do not weigh every food item they serve, as it is both impractical and time consuming (Croker, Sweetman, & Cooke, 2009). Though, even if parents weighed foods, food weights and nutritional composition change with cooking, making precise portioning difficult. With guidelines that are difficult both to find and to follow, parents resort to making meal portion size decisions based on a range of other factors, including their own beliefs, child and contextual cues, and physical portioning strategies (Eck et al., 2018).

Firstly, parents make different portion size decisions based on the eating context. For snack foods, parents use packaging and dishware sizes as visual cues for portion sizes (Reale, Marr, Cecil, Hetherington, & Caton, 2019). Although these cues vary between foods, parents adjust portion sizes for their child's age and portion size recommendations (Tang, Chawner, Chu, Nekitsing, & Hetherington, 2022). However, packaging is often unavailable as a portioning cue at mealtimes, especially for vegetables. Instead, quantitative studies suggest that parents' portioning decisions at mealtimes are determined by perceived child hunger, parent and child body size, and a desire to promote a healthy, balanced diet (Kairey et al., 2018). Qualitative studies indicate different reasons for portion sizes, such as parents typically serving what they have learned to be appropriate for their child (Kairey et al., 2018). This is often based less on recommendations and more on habit, intuition, and knowledge of their child's appetite (Acolatse et al., 2023; Philippe et al., 2021). Interestingly, this may result in the portion sizes that parents serve to their children mirroring those that parents serve to themselves at mealtimes (Johnson et al., 2014). Together, the evidence suggests that household norms and habits strongly shape portion size decisions. Considering the variety of factors that influence how parents portion meal items, it remains unclear whether these factors apply to portion sizes of the entire meal, or to individual components of the meal, such as vegetables. Given children's consistently low vegetable intake and dislike, the factors influencing how parents serve vegetables may differ from those guiding the protein or carbohydrate components of meals.

The way vegetables are served and presented within a meal has further been shown to either facilitate or hinder children's intake. When vegetables are served alongside more palatable foods (e.g. chips [French fries] and chicken nuggets), greater vegetable waste is

typically observed at the end of the meal (Ishdorj, Capps Jr, Storey, & Murano, 2015). In contrast, when vegetables are served on their own (e.g. as a starter), children tend to consume more (Chawner, Birtill, Cockroft, & Hetherington, 2024; Spill, Birch, Roe, & Rolls, 2010). Similarly, if competing food options (foods differing in palatability) are available, children may choose the food that is better liked or adds variety to the meal (Chawner, Blundell-Birtill, & Hetherington, 2022). Furthermore, increasing portion sizes of non-vegetable main meal items has been shown to reduce vegetable intake (Savage, Fisher, Marini, & Birch, 2012). Yet, if the portion sizes of these non-vegetable items are reduced and substituted with larger quantities of vegetables, children's vegetable consumption can be increased (Leahy, Birch, Fisher, & Rolls, 2008; Roe, Sanchez, Smethers, Keller, & Rolls, 2022). Importantly, to be eaten alongside other food items, vegetables need to be included as part of the main plate. When vegetables are served in large portions as side dishes, overall vegetable intake decreases (Kral, Kabay, Roe, & Rolls, 2010). These findings suggest that for the average child, when vegetables are not perceived as an integral part of the meal, are less visually prominent, or are less palatable than other foods, they may be eaten in smaller quantities, resulting in leftovers. Neuwald et al. (2024) recently illustrated that children who more frequently switched between meal items had greater overall intake, indicating potential behavioural mechanisms underlying these dietary patterns (which is likely underpinned further by avoidance and approach eating traits).

The current study used a portion size selection task to examine how meal, child, and parental factors influence parents' decisions to serve different vegetable portion sizes at mealtimes. Previous portion size tasks have investigated both self-serving of individual foods or composite meals (McCrickerd & Forde, 2016; Pink & Cheon, 2021) and parent and child selection of meal portion sizes (Potter *et al.*, 2018). These computer-based meal servings have been found to correlate with real world portion sizes (Cox *et al.*, 2021). However, no research to date has applied these tasks to parent portioning of individual meal components. The present study therefore addressed two overarching aims: 1) to explore predictors of parents' selection of vegetable portion sizes across different meals, specifically as a function of the foods served, perceived child food preferences, anticipated leftovers, child eating traits, and parent feeding goals and practices; and 2) to examine predictors of parents' perception of their child's vegetable leftovers across meals. .

2 Methods

2.1 Participants

Four-hundred-seven parents of 4-8-year-old children were recruited via Prolific (an online research participant pool) to participate in this study. This age group was selected as there are currently no official guidelines in the UK for portion sizes to be served to children under 4 years old. Additionally, 9–10-year-olds were excluded as these children are close to transitioning to different portion size recommendations at 11 years (Department for Education, 2025) and may already eat much larger portions than younger children (4-8 years). The sample size was determined with a power analysis, indicating that 336 participants would be required to detect a small-medium effect size ($f^2 = 0.05$) using multiple regression with an interaction term, with alpha = 0.05 and power = 0.90. We therefore aimed to recruit 400 participants to account for participants with varying diets (e.g. vegetarian, halal, etc.). All participants were parents living in the UK and had at least one child aged 4 to 8 years. Parents reporting for their children were not excluded based on any other parameters, including dietary requirements or allergies.

Participant gender was equally split between children (female=203, 49.9%, male=204, 50.1%), with slightly more female parents included in the sample (female=235, 57.7%, male=171, 42%, prefer not to say=1, 0.2%). Most of the sample was of white-British ethnicity (75.2%). Full sample characteristics are reported in **Table 1**. Parents consented to participate after reviewing the Participant Information Sheet though a web page. They were then compensated by payment of £2.25 for a median of 13 minutes taken to complete the survey tasks. Ethical approval for this study was granted by the University of Essex, Department of Psychology Research Ethics Panel: ETH2425-0361.

Table 1. Characteristics of the sample.

Characteristic	N (N=407)	%	Characteristic	N (N=407)	%
Age of child in years			***Child dietary requirements***		
4	70	17.2	No relevant dietary requirements*	369	90.7
5	112	27.5	Other (including Halal or Kosher)	21	5.2
6	83	20.4	Other (including vegetarian, vegan, pescatarian)	17	4.2

7	82	20.1			
8	60	14.7			
Education level of parent			***Household income (before tax)***		
Secondary school	27	6.6	Up to £24,999	38	9.3
Further education (A-levels, BTEC, etc.)	76	18.7	£25,000 to £49,999	124	30.5
Undergraduate degree (College or university)	184	45.2	£50,000 to £74,999	121	29.7
Professional qualification (vocational training/licence)	31	7.6	£75,000 to £99,999	76	18.7
Postgraduate degree	89	21.9	£100,000	44	10.8
			Prefer not to say	4	1
Child ethnicity			***Parent ethnicity***		
White/Caucasian	287	70.5	White/Caucasian	306	75.2
Black/Black British	50	12.3	Black/Black British	53	13
Asian/Asian British	21	5.2	Asian/Asian British	26	6.4
Any mixed heritage	48	11.8	Any mixed heritage	19	4.7
Other	1	0.2	Other	3	0.7
Questionnaire subscale	**Mean ± SD**	**Range**	**Questionnaire subscale**	**Mean ± SD**	**Range**
CEBQ: Food fussiness	3.03 ± 0.86	1-5	CFPQ: Encourage balance and variety	4.39 ± 0.5	2-5
CEBQ: Enjoyment of food	3.72 ± 0.80	1-5	CFPQ: Modelling	4.28 ± 0.68	1.75-5
FMG: Avoiding stress	4.21 ± 0.68	1-5	CFPQ: Pressure	3.16 ± 0.93	1-5
FMG: Serving healthy foods	4.66 ± 0.48	1.67-5	CFPQ: Restriction for health	3.61 ± 0.91	1-5
			CFPQ: Restriction for weight control	2.09 ± 0.9	1-4.88

*Where dairy or gluten free, these children are classified under dietary requirements as “no relevant dietary requirements” because the foods used in this study did not include these food groups/ingredients. Additionally, allergies were measured yet none were reported for the foods used in the study. CEBQ = Child Eating Behaviour Questionnaire, FMG = Family Mealtime Goals Questionnaire, CFPQ = Comprehensive Feeding Practices Questionnaire.

2.2 Design

This study used a cross-sectional, repeated measures 3x3 experimental design. The first independent variable with three levels was the main macronutrient parts of the meal (Meal Combination: Chips and chicken nuggets, Pasta and meatballs, Rice and oily fish [sardines]). The second independent variable with three levels was the type of vegetable within the meal (carrots, peas, spinach). Two dependent variables were measured; 1) Parent served vegetable portion sizes (in grams), 2) Parent anticipation of child vegetable leftovers (in grams). Data were also collected for children's perceived liking for all foods, the portion sizes of protein and carbohydrate foods that parents would serve to children, children's familiarity with the study (target) foods, child eating traits, parental feeding practices and parental mealtime goals, all of which were used as predictor variables in the analyses.

As this was an online study, precautions were taken to ensure data quality and reduce the likelihood of bots in the data. Firstly, participants were only recruited using the Prolific platform and the survey link was not shared through generic advertising or social media. Secondly, open-ended responses to survey questions were screened, the duration of survey completion was monitored, and response consistency checks were performed (i.e. to ensure that responses did not follow a particular pattern, responses to questionnaire subscales were not random, nor were the same responses provided to each subsequent question). Five participants were removed due to duplicate entries (n=412 – 5). No further data were removed due to potential bots or low data quality.

The study and hypotheses were preregistered on Open Science Framework (OSF-https://osf.io/jteq5/overview?view_only=5e314d475ea144859b2feeb66c981561).

2.3 Materials

2.3.1 Food pictures

Nine food items were used throughout the experiment. Each food item was chosen to provide a range of palatability, familiarity and foods that were either commonly eaten or not eaten enough according to dietary guidelines and recommendations. This range of characteristics was chosen to examine how these differences between foods impact the portion sizes parents served to their children. Nutritional information for each food is provided in **Table 2**. Each food was pictured on an empty white plate using a digital camera, tripod, and light box, increasing the portion size of the food for each picture (pictures are open access on OSF). To imitate parent serving, the portion sizes increased in varying increments. For vegetable and carbohydrate items, 22 portion sizes were pictured from 0-

123g (vegetables) in increments of 3-8g. However, for protein items, which were larger individual units than the vegetable and carbohydrate items, 11, 12, and 15 portion sizes were pictured for chicken dippers, sardines, and meatballs respectively. Each portion size increase for protein foods was half of one unit (e.g. half of a meatball) and therefore between ~10-15g. Portion size increases were made in similar increments but not exact weights for three reasons: 1) due to food units naturally differing in size and weight, 2) to reflect parental servings at home, as these are often not in exact increments on the plate, and 3) so that in the serving size task, parents could not select the middle portion as 100% of the recommended portion size. Maximum portion sizes aimed to allow parents to serve up to 200% of the upper boundary of the recommended portion size (Department for Education, 2025) for each food. The exception was for chips (French fries), as 200% of the portion size did not comfortably fit on 1/3 of the plate. This maximum portion was to allow for parents to serve larger portion sizes than recommended if this reflected their usual serving behaviours.

Once individual food items were pictured in varying portion sizes, three food items (one from each food group: protein, carbohydrate, and vegetables) were selected together to make an entire meal. Overall, nine meals were used; three base meal combinations (chicken dippers and chips, meatballs and pasta, and sardines and rice) with one vegetable item added at a time to each meal (carrots, peas, and spinach).

Table 2. Food items used and their nutritional information.

Food item	***UK national recomm-ended portion size (g)****	***Serving range (g) – Task 1***	***Starting weight (g) – Task 2***	***Energy content range (kcal)***	***Energy density (kcal/g)***	**Carboh ydrate /100g (g)**	***Protein/ 100g (g)***	***Fats /100g (g)***
Chicken dippers/ nuggets	50-70	0-144	66	0-373	2.59	22	13	13
Meatballs	50-75	0-157	77	0-485.1	3.09	2	14.2	18.8
Sardines (tinned)	55-80	0-155	74	0-325.5	2.10	0	22	13.6
Chips (French fries)	70-100	0-123	102	0-226.3	1.84	31.8	3.7	3.9
Pasta	45-65[$]	0-123	63	0-203	1.65	35	5	0.5
Rice	35-55[$]	0-123	57	0-159.9	1.30	28	2.7	0.3

Carrots	40-60	0-123	58	0-43.1	0.35	8.2	0.8	0.2
Peas	40-60	0-123	60	0-103.3	0.84	15.6	5.4	0.2
Spinach	40-60	0-123	58	0-28.3	0.23	3.8	2.9	0.3

*UK national recommended portion sizes for children aged 4-10 years old from the Department for Education (https://www.gov.uk/government/publications/school-food-standards-resources-for-schools/portion-sizes-and-food-groups#primary-4-to-10-years-old).

[$]Recommended portion sizes are dried and do not reflect cooked weights.

Apart from the "UK national recommended portion size" column, all values are provided for this study and reflect cooked values.

2.3.2 Food tasks.

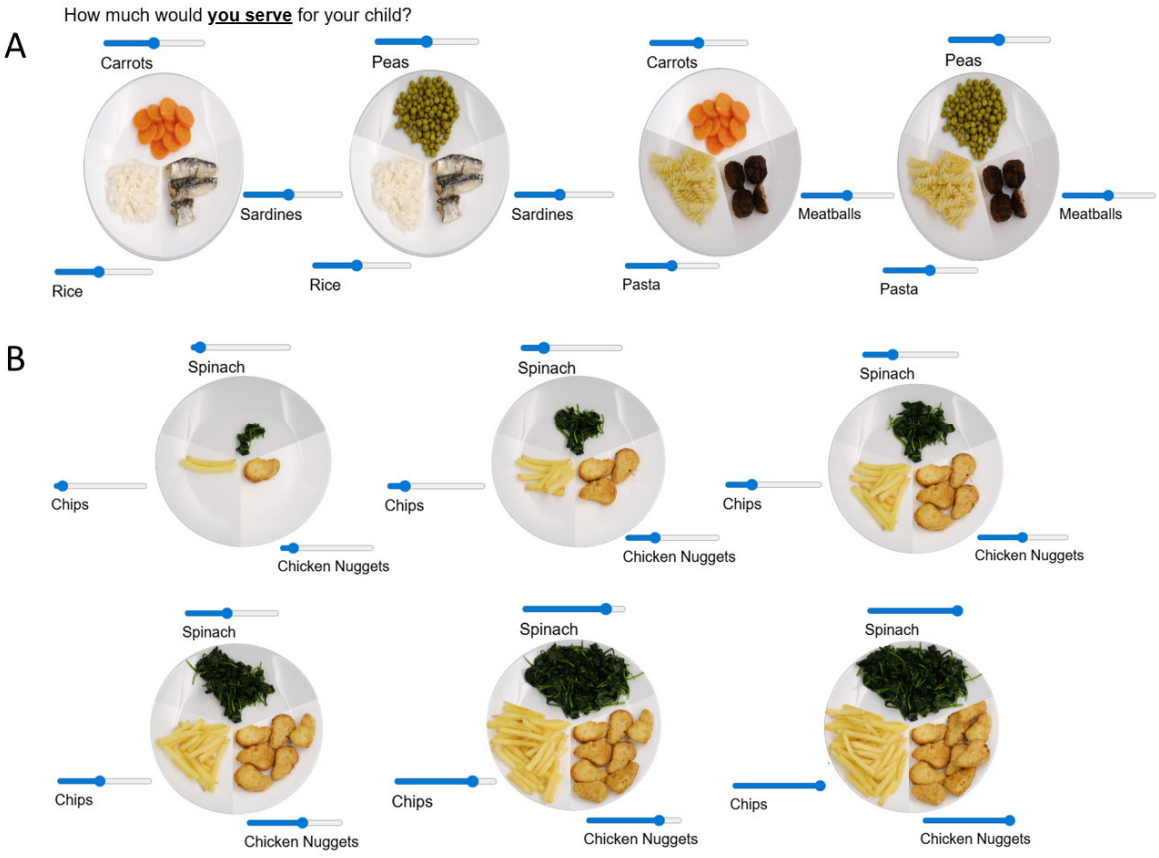
Two experimental tasks were conducted using the same nine meals: Task 1) parent served portion sizes of meals; and Task 2) anticipated food leftovers after children are served a meal with nationally recommended portion sizes. For Task 1, parents were asked to imagine they had cooked an evening meal with the foods presented and indicate how much of each food item they would serve to their child at a typical evening mealtime (full instructions for all tasks are provided in **supplementary material A**). Parents were also instructed that they could imagine the food is presented nicely, with their child's favourite dip or sauce included. Additionally, if the child followed a specific diet (e.g. halal, vegetarian), parents were instructed to imagine appropriate substitutes for foods that they would not usually serve. Parents were then presented with each meal individually, with each food starting at the smallest portion size. The smallest portion size was chosen to replicate the way that parents serve meals in the real world, starting with an empty plate and serving each food in turn. Randomising the starting portions of each food may have influenced portion decisions, especially where a larger amount is presented than would usually be served. Additionally, the task did not start with a completely empty plate for easier task comprehension and so that parents understood that there was food available on the plates. Parents could then use three sliders to adjust the portion sizes of all three foods within the meal (see **Figure 1**). It was ensured by varying the portion size increments (see section 2.3.1) that the recommended portion size for this age group was not directly in the middle of possible responses to reduce the likelihood of parents selecting the middle portion size for each item.

In Task 2 (leftovers task), parents were provided with the same nine meals, but this time the starting portion size of each of the three foods within the meal was the national recommended portion size. Parents were asked to imagine they had cooked the meal and

served it to their child. Then, using the sliders parents indicated how much of each food item would be left on their child's plate at the end of a typical evening mealtime (full task instructions provided in **supplementary material A**). Similar to the parent-serving task, parents used sliders to adjust portion sizes, however for this task the portion selected indicated anticipated amount of leftovers for each food. The national recommended portion size was chosen over parents' actual portion sizes (task 1 decisions) to ensure that all children started with the same portion size. This allowed differences in leftovers to reflect individual differences in children's eating, rather than differences in parent portioning decisions.

The experimental tasks were both conducted using Qualtrics and coded using JavaScript.

Figure 1. A: Example meal combinations used in the study tasks. **B:** Example of serving size sliders for a particular meal, with portion sizes of individual items increasing.



2.3.3 Demographics

Parents responded to questions asking their child's age, gender and ethnicity and whether their child follows a specific diet (e.g. Kosher, Halal, Vegetarian, etc.), then about their own age, gender, ethnicity, education level and household income (before tax).

2.3.4 Food liking and familiarity

Parents were instructed to indicate how much they perceive their child to like each individual food (nine foods) on a 100-point VAS scale (my child dislikes this food --> my child likes this food). Parents also indicated how familiar their child was with each food (How often does your child eat each of the following food items?) reported using a 5-point Likert scale: Never, Rarely [once per month], Sometimes [once every 2 weeks], Often [at least once per week], Every day.

2.3.5 Survey items

Information on children's eating traits was collected using the Children's Eating Behaviour Questionnaire (CEBQ: Wardle, Guthrie, Sanderson, & Rapoport, 2001), including the subscales food fussiness (α = 0.89, Average Variance Extracted [AVE] = 0.66) and enjoyment of food (α = 0.89, AVE = 0.75).To assess parent feeding practices, the Comprehensive Feeding Practices Questionnaire (CFPQ: Musher-Eizenman & Holub, 2007) was administered, including the subscales - encourage balance and variety (α = 0.60, AVE = 0.52), modelling (α = 0.81, AVE = 0.65), pressure (α = 0.74, AVE = 0.52), restriction for health (α = 0.76, AVE = 0.54) and restriction for weight control (α = 0.88, AVE = 0.63). Lastly, parent mealtime goals for avoiding stress (α = 0.71, AVE = 0.57) and serving healthy foods (α = 0.86, AVE = 0.83) were measured with the Family Mealtime Goals Questionnaire (FMGQ: Snuggs, Houston-Price, & Harvey, 2019). All subscales had acceptable reliability. As per scale instructions, subscales were calculated as an average response of their corresponding items.

In addition to these validated measures, parents were asked two portion size knowledge questions, including how much they agree (100-point Visual Analogue Scale) that children require different portion sizes depending on their age (to capture parental portion size attitudes), and whether parents were familiar with ("yes", "no" or "not sure") the Change4Life "me sized meals" campaign (to briefly assess awareness of national portion size campaigns and recommendations). This was the last salient national campaign for children's portion sizes in the UK, ending in 2021.

2.4 Procedure

Parents read an information sheet and signed an online consent form before answering the demographic questions. Next, parents completed Task 1, in which they indicated how much of each food they would serve to their child at mealtimes, for nine different meals. All meals were presented in a randomised order. Immediately after, parents completed Task 2, anticipating their child's typical food leftovers after being served each meal with nationally recommended portion sizes. The same nine meals were used. Again, meals were presented to parents in a randomised order. Parents were then asked to indicate their child's liking for, and familiarity with, each of the nine food items used. Lastly, the CEBQ, CFPQ, FMGQ, and portion size knowledge questions were presented and answered in a randomised order. Participants were then debriefed and offered the opportunity to share their thoughts about the tasks using an open-ended question.

2.5 Statistical analyses

Descriptive statistics were performed on all data. Although some outliers exist in portion sizes observed (see results sections 3.1.2 and 3.1.3), all data were retained in the analyses as they were all real possibilities of what may be served in the home. For example, serving larger than recommended portions may reflect a lack of portion size knowledge or a child with an avid appetite, whereas serving small portions (or none of an item) may indicate strong disliking from an individual child. These individual variations in the data were therefore captured in the main analyses.

Two primary analyses were then conducted in line with overarching aims 1 and 2: 1) to examine predictors of parent vegetable portion sizes across meals, and 2) to explore predictors of anticipated child vegetable leftovers after each meal. For both models, hierarchical regression analyses were conducted for all meals whilst controlling for the base meal combination (i.e. specific protein and carbohydrate pairings) and the vegetable type within the meal (block 1, **Tables** 3 and 4). This was to examine whether the meal combinations themselves altered parental portion sizes and anticipation of vegetable leftovers.

For the parent served vegetable portion size model, food-related factors (e.g. liking for each food, vegetable familiarity, amount of each food type anticipated to be leftover) were added to the model in block 2. In block 3, child eating traits and parental feeding practices and goals were added to the model. In the second analysis, another hierarchical model was conducted to examine anticipated amount of vegetable leftovers. Food-related and child specific factors were added to this model in block 2. All models were then adjusted with

cluster robust standard errors to account for repeated measurements. Sensitivity analyses were further performed removing parents of children with special diets (e.g. halal, vegetarian, etc.); however, outcomes were not different from the models with all participants included. All analyses were conducted in R Studio v4.2.3.

3 Results

3.1 Descriptive statistics

3.1.1 Parent perceived child food liking and familiarity

Parents rated their children's perceived liking for each food on a 100-point VAS scale. Most foods were more liked than disliked (chicken [*M*=87, *SD*=19], meatballs [*M*=75, *SD*=25], chips [*M*=86, *SD*=19], pasta [*M*=86, *SD*=19], rice [*M*=76, *SD*=22], carrots [*M*=68, *SD*=30], peas [*M*=58, *SD*=31]), although vegetable items were typically less liked than protein and carbohydrate foods. Specifically, spinach [*M*=31, *SD*=29] and sardines [*M*=30, *SD*=34] were much less liked than the other food items presented (also see figure in **supplementary material B**).

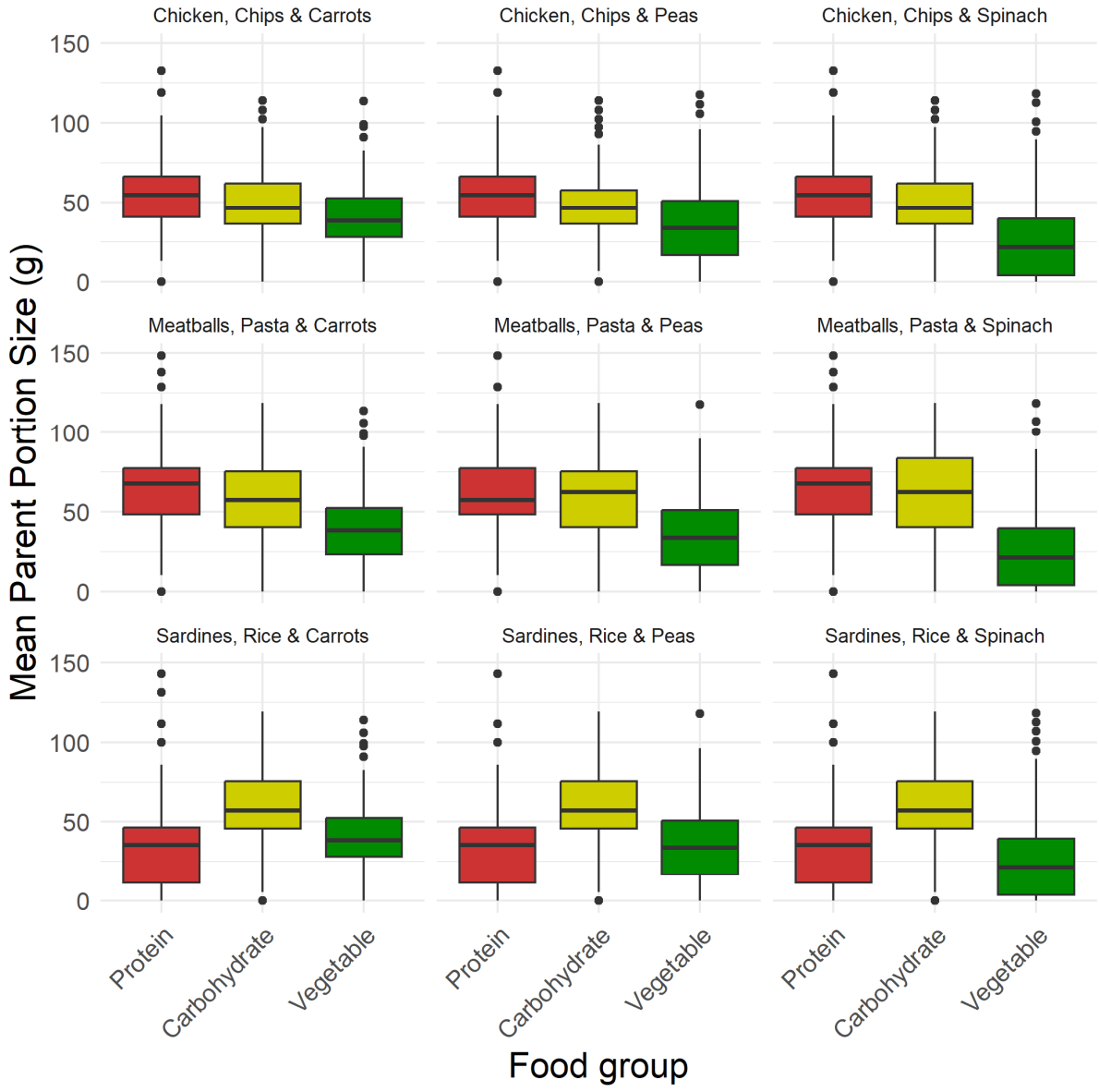
Parents also reported familiarity for each food. Based on modal values, most foods were consumed often (at least once per-week): pasta n=317, chips n=265, rice n=265, carrots n=263, chicken n=237, peas n=214. Meatballs (n=162) were consumed sometimes (once every 2 weeks), with spinach being reported as eaten both rarely (once per-month) (spinach n=131) and never (spinach n=127). Similarly, sardines (n=200) were most reported to never be eaten.

3.1.2 Task 1 - Portion sizes selected by parents

The average vegetable portion size selected by parents for their children across the nine meals (*M* = 34.9g, *SD* = 19.9) was less than the lower boundary for one national recommended portion of vegetables (40g) for 4-8-year-old children. Large variations were observed between individual vegetables, with parents indicating larger portion sizes for carrots (*M* = 40.5g, *SD* = 24.3), compared with peas (*M* = 35.8g, *SD* = 24.0) and spinach (*M* = 28.3g, *SD* = 25.2). For protein items, the mean portion sizes of chicken dippers (*M* = 56.2g, *SD* = 24.6) and meatballs (*M* = 65.1g, *SD* = 31.9) were within national recommended portion sizes for the age range, however the average portion size of sardines (*M* = 34.3g, *SD* = 27.9) was 21g less than the lower bound for recommended portion sizes. Lastly, carbohydrate item portion sizes were typically smaller than one recommended portion, with

chips (*M* = 50.0g, *SD* = 22.6) being served in smaller portions than both pasta (*M* = 63.2g, *SD* = 25.2) and rice (*M* = 62.0g, *SD* = 24.2). Parent portion sizes for all foods within each separate meal combination are provided in **Figure 2.**

Figure 2. Parent portion sizes (g) for all foods within each of nine meal combinations.

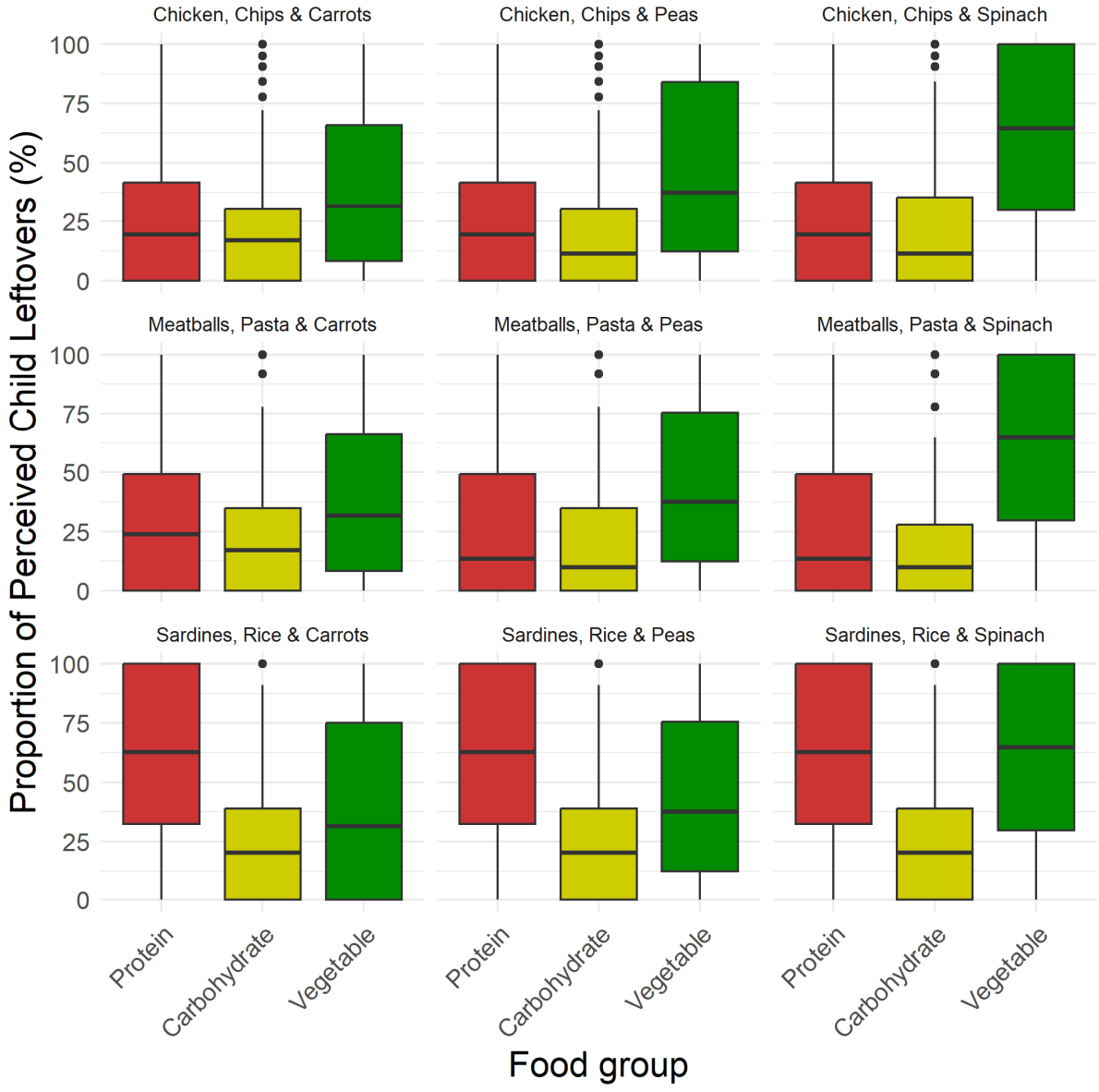


3.1.3 Task 2 - Perceived child leftovers

When served a portion of ~60g of vegetables within a meal (starting weights provided in **Table 2**), parents estimated their children would leave on average almost half of the vegetables served (*M* = 27.6g, *SD* = 16.9). Estimated leftovers was highest for spinach (*M* = 31.5g, *SD* = 18.4), followed by peas (*M* = 27.8g, *SD* = 21.5), and carrots (*M* = 23.5g, *SD* = 20.8). Protein items including chicken dippers (*M* = 16.6g, *SD* = 20.6) and meatballs (*M* = 22.4g, *SD* = 25.2) were perceived by parents to be least likely to be leftover, while parents

perceived that children would largely leave most of the sardines (*M* = 44.4g, *SD* = 27.7) served to them. Lastly, parents expected fewer leftovers on average for each carbohydrate item, chips (*M* = 22.0g, *SD* = 24.7), pasta (*M* = 12.6g, *SD* = 15.5) and rice (*M* = 14.9g, *SD* = 15.8). Parent perceived child leftovers for all foods within each separate meal combination are provided in **Figure 3.**

Figure 3. Parent perceived child leftovers (as a percentage of the portion served) for all foods within each of nine meal combinations.



3.1.4 Parental awareness of portion sizes requirements for children

Parents typically agreed (100-point VAS) that meal portion sizes need to be adjusted for the child's age (*M* = 84.7, *SD* = 17.3). Average portion sizes for foods within a meal were

predicted by child age (β = 2.69, p < 0.001) and the food group of the item, specifically vegetables (β = -12.7, p = 0.017). There was a significant interaction between child age and vegetables as a predictor of portion sizes (β = -1.84, p = 0.04). These findings suggest that parents served more protein and carbohydrate foods for older children, yet vegetable serving sizes were relatively stable across age groups (see figure in **supplementary material C**). Additionally, parents were mostly unfamiliar with recent UK national child portion size campaigns, such as the Change4Life me sized meals (unfamiliar = 335, not sure = 20, familiar = 52).

3.2 Primary analyses

3.2.1 Children's vegetable portion sizes served by parents

Aspects of the meal itself, children's eating traits and parental feeding practices were examined for their predictive value on parent portion sizes of vegetables within meals. The food types themselves were added to the model in block 1, followed by food-related factors in block 2 and child and parental factors added to the model in block 3 (**Table 3**). In block 1, it was found that the foods in the meal significantly predicted parent vegetable portion sizes. For example, fewer vegetables were served in the pasta and meatballs meal compared with the chicken dippers and chips meal, and fewer vegetables were served when the vegetable item was peas or spinach, compared with carrots. However, in blocks 2 and 3, these meal items were no longer significant, meaning that the variance explained by the meal items was better explained by other factors.

In block 2, parents anticipating vegetable and protein items being leftover resulted in reduced portion sizes of vegetables. Additionally, parents who perceived their child to like the vegetables served more on the plate . However, vegetable familiarity and liking of protein and carbohydrate items on the plate did not significantly predict parent vegetable serving sizes.

In block 3, it was found that on average, male children were served 3g more vegetables than females. Parents also served larger portions of vegetables if they reported holding healthy eating goals, however parents served fewer vegetables if their goals were aligned with avoiding stress at mealtimes. Neither child age, eating traits (including CEBQ enjoyment of food and food fussiness), nor parental feeding practices (CFPQ restriction for health and weight, modelling, pressure to eat and encouraging balance and variety) were significant predictors of parents' vegetable portion sizes and so were not included in the final model. No interaction effects were observed.

The overall model explained ~42% of the variance in parental portion sizes of vegetables within different meals.

Table 3. Hierarchical regression models examining predictors of Task 1 parent vegetable portion sizes across different meals.

	Task 1 - Parental portion sizes of vegetables (g)														
	Block 1					**Block 2**					**Block 3**				
Predictors	*Estimates*	*std. Error*	*CI*	*t-value*	*p-value*	*Estimates*	*std. Error*	*CI*	*t-value*	*p-value*	*Estimates*	*std. Error*	*CI*	*t-value*	*p-value*
(Intercept)	40.68	1.17	38.39, 42.98	34.7	**<0.001**	33.15	5.50	22.38, 43.93	6.02	**<0.001**	35.27	9.97	15.75, 54.78	3.54	**<0.001**
Meal	(Reference: chips and chicken dippers)														
Meal [meatballs & pasta]	-1.0	0.43	-1.85, -0.16	-2.32	**0.020**	-0.47	0.66	-1.76, 0.82	-0.72	0.474	-0.66	0.65	-1.93, 0.61	-1.02	0.309
Meal [sardines & rice]	0.43	0.39	-0.34, 1.2	1.11	0.269	0.89	1.45	-1.96, 3.74	0.61	0.541	0.01	1.38	-2.69, 2.71	0.01	0.996
Vegetable type	(Reference: carrots)														
Vegetable type [peas]	-4.67	0.89	-6.4, -2.93	-5.26	**<0.001**	-0.27	0.76	-1.76, 1.21	-0.36	0.717	-0.51	0.77	-2.01, 0.99	-0.67	0.506
Vegetable type [spinach]	-12.23	1.07	-14.34, -10.13	-11.4	**<0.001**	0.53	1.31	-2.04, 3.1	0.40	0.687	-0.24	1.30	-2.78, 2.31	-0.18	0.856
Vegetable familiarity						1.23	0.94	-0.6, 3.07	1.31	0.189	1.05	0.91	-0.73, 2.84	1.15	0.249
Anticipated vegetable leftovers						-0.47	0.05	-0.57, -0.37	-9.06	**<0.001**	-0.45	0.05	-0.55, -0.35	-8.85	**<0.001**

Protein liking		-0.04	0.02	-0.08, 0.01	-1.68	0.092	-0.05	0.02	-0.09, -0.01	-2.28	**0.023**
Carbohydrate liking		0.04	0.03	-0.01, 0.09	1.42	0.155	0.03	0.03	-0.02, 0.08	1.19	0.234
Anticipated protein leftovers		-0.07	0.03	-0.12, -0.02	-2.52	**0.012**	-0.07	0.03	-0.12, -0.01	-2.42	**0.016**
Anticipated carbohydrate leftovers		0.09	0.04	0.02, 0.17	2.44	**0.015**	0.09	0.04	0.01, 0.16	2.32	**0.020**
Perceived vegetable liking		0.20	0.04	0.13, 0.27	5.53	**<0.001**	0.19	0.04	0.12, 0.26	5.28	**<0.001**
Child gender [Male]							3.19	1.43	0.4, 5.98	2.23	**0.026**
CEBQ: Food fussiness							-1.35	1.08	-3.46, 0.76	-1.25	0.211
FMG: Stress							-3.01	1.28	-5.52, -0.5	-2.35	**0.019**
FMG: Health							3.36	1.51	0.41, 6.31	2.23	**0.026**
Meal observations	3663	3663					3663				
R^2 / R^2 adjusted	0.041 / 0.040	0.405 / 0.403					0.419 / 0.417				
F	$F(4,3658) = 39.29$, $p <$ **0.001**	$F(11,3651) = 225.6$, $p <$ **0.001**					$F(15,3647) = 175.5$, $p <$ **0.001**				

Note: Positive estimates indicate larger vegetable portion sizes (g) by parents.

3.2.2 Parent perceived vegetable leftovers

Next, factors predicting the amounts of anticipated vegetable leftovers were explored. Like the model in section 3.2.1, a hierarchical regression analysis was conducted. Block 1 shows the model when only accounting for the specific food types and in block 2, food and child-related factors were added to the model (**Table 4**).

Vegetable type and meal combination were again significant in block 1, suggesting that meal combinations affect the amount of vegetables children are anticipated to leave on their plate. However, these effects were no longer significant in block 2, except for spinach. In real terms, when spinach was served there were more leftover vegetables compared to meals with carrots (block 1). However, when controlling for vegetable liking (block 2), serving spinach predicted fewer leftover vegetables compared to meals with carrots. This is likely because spinach was much more disliked than carrots, yet the amount anticipated to be leftover did not linearly reflect the higher level of dislike.

When examining anticipated amount of vegetable leftovers (block 2), children who were more familiar with the vegetable item and who had increased vegetable liking were expected by parents to leave fewer vegetables on the plate. Additionally, if children were perceived to have higher liking for protein and carbohydrate foods in the meal, parents anticipated that their child would have more vegetable leftovers. Similarly, if parents expect children to leave more protein and carbohydrate foods, they also anticipated more vegetable leftovers.

Children reported as being more food fussy (CEBQ) were also anticipated by parents to have more vegetable leftovers. Food fussiness was found to interact with the amount of protein items leftover. Children with lower food fussiness who also left less protein were expected by parents to leave fewer vegetables on the plate compared to children with higher food fussiness. However, as children were expected to leave more of the protein item, the effect of low and high food fussiness on the amount of vegetables leftover was reduced.

Additionally, child age, gender and enjoyment of food (CEBQ) did not significantly predict vegetable leftovers across meals. The final model explained ~57% of the variance in anticipated amount of vegetables leftover at the end of a meal.

Table 4. Hierarchical regression models examining predictors of parent perceived vegetable leftovers across different meals.

	Task 2 - Parent Perceived Vegetable leftovers (g)									
	Block 1					**Block 2**				
Predictors	*Estimates*	*std. Error*	*CI*	*t-value*	*p-value*	*Estimates*	*std. Error*	*CI*	*t-value*	*p-value*
(Intercept)	23.91	1.01	21.94, 25.89	23.67	**<0.001**	20.49	3.68	13.29, 27.69	5.57	**<0.001**
Meal	(Reference: chips and chicken dippers)									
Meal [meatballs & pasta]	-0.53	0.27	-1.06, 0	-1.96	0.051	0.61	0.46	-0.3, 1.51	1.31	0.192
Meal [sardines & rice]	-0.69	0.30	-1.28, -0.11	-2.32	**0.020**	-0.03	0.86	-1.71, 1.65	-0.03	0.973
Vegetable type	(Reference: carrots)									
Vegetable type [peas]	4.26	0.71	2.86, 5.65	5.98	**<0.001**	0.20	0.55	-0.87, 1.27	0.37	0.714
Vegetable type [spinach]	8.04	0.89	6.29, 9.78	9.04	**<0.001**	-8.28	0.86	-9.97, -6.59	-9.60	**<0.001**
Vegetable familiarity						-2.80	0.63	-4.04, -1.57	-4.44	**<0.001**
Protein liking						0.13	0.02	0.09, 0.16	6.51	**<0.001**
Carbohydrate liking						0.09	0.02	0.05, 0.13	4.19	**<0.001**
Protein leftovers						0.50	0.07	0.37, 0.63	7.36	**<0.001**
Carbohydrate leftovers						0.20	0.07	0.06, 0.34	2.83	**0.005**
Vegetable liking						-0.34	0.02	-0.39, -0.3	-14.33	**<0.001**
CEBQ: Food fussiness						3.09	0.72	1.67, 4.5	4.27	**<0.001**

Protein leftovers*CEBQ: Food fussiness		-0.06	0.02	-0.1, -0.02	-3.13	**0.002**
Carbohydrate leftovers* CEBQ: Food fussiness		-0.01	0.02	-0.05, 0.02	-0.72	0.472
Meal observations	3663	3663				
R^2 / R^2 adjusted	0.026 / 0.025	0.568 / 0.567				
F	$F(4,3658) = 24.15$, $p <$ **0.001**	$F(13,3649) = 369.5$, $p <$ **0.001**				

Note: Negative estimate values indicate fewer vegetables leftover at the end of the meal.

4 Discussion

This study used a novel online portion-size selection task, allowing parents to adjust individual meal components, to examine predictors of: (1) vegetable portion sizes served to children and (2) anticipated vegetable leftovers across different meals. Results showed that parents' portion sizes were mainly influenced by their perception of the child's liking for specific vegetables and their expectations of leftovers. Avoiding mealtime stress predicted smaller portions, whereas healthy eating goals predicted larger vegetable portions. No other feeding practices had significant effects. Parent anticipated amount of vegetable leftovers were similarly linked to the child's food preferences but were also shaped by the overall meal context, such as the combination of foods, perceived liking and expected leftovers of non-vegetable items (protein and carbohydrates). These findings suggest that parents tend to serve larger vegetable portions when they believe their child likes and will consume them, while also acknowledging that the overall meal composition may influence their child's vegetable intake and leftovers.

Many factors appeared to converge in the parent portion size decision-making process. However, children's liking for vegetables and parents' anticipation of vegetable leftovers were central to this decision, with lower liking and higher amount of expected leftovers predicting smaller vegetable portions served. Cost is often perceived by parents as a barrier to serving healthy foods (e.g. Nepper & Chai, 2016) and where mitigation of food waste is important, parents may reduce portion sizes as a strategy (Blondin, Djang, Metayer, Anzman-Frasca, & Economos, 2015). Therefore, liking and potential for leftovers may be considerably more influential on parent vegetable portion size decisions than other mealtime goals or characteristics of the meal as a whole (Luesse et al., 2018). Previous research suggests that parental healthy eating goals and attitudes inform children's healthy diets (Lim et al., 2020; Romanos-Nanclares et al., 2018), however it does not necessarily follow that healthy eating goals also inform appropriate portion sizes. Most parents in the current study scored highly on healthy eating goals, yet whilst this predicted larger vegetable portions, for many parents it still resulted in serving smaller than recommended vegetable portion sizes (i.e. < 40-60g, see section 3.1.2). Furthermore, the only other parent mealtime goal that predicted vegetable portion sizes was the goal to avoid mealtime stress. The intention to avoid stress may reflect children's vegetable liking as a transactional behaviour at mealtimes. If children do not like a food (or want to eat it) but the parent is encouraging, pressuring, or negotiating its consumption, it is more likely to result in mealtime conflict or tensions (Alm & Olsen, 2017; Paugh & Izquierdo, 2009). Therefore, each factor taken together indicates that serving smaller portions of vegetables could allow parents to simultaneously serve vegetables on the plate (in line with healthy eating goals), encourage

small amounts of consumption, reduce leftovers (compared with larger portions) and avoid mealtime conflict (due to smaller portion size demands on the child) (Johnson, Goodell, Williams, Power, & Hughes, 2015). These factors may feed into the 'parent intuition' that is often reported when making decisions to serve food to children (Acolatse et al., 2023; Kairey et al., 2018), as parents potentially evaluate and balance these factors at mealtimes. In turn, parental portion size habits could form upon repeated servings of smaller vegetable portions in their children's meals acquiring normative, habitual status (Almiron-Roig, Navas-Carretero, Emery, & Martínez, 2018). Overall, these findings suggest that mealtime vegetable portioning decisions are highly influenced by child-related characteristics of individual food items (e.g. liking and potential for leftovers) and the parenting context (e.g. avoiding stress and achieving healthy eating goals), whilst being less influenced by the meal characteristics themselves.

The meal context may become more important when determining what the child is expected to eat and leave on their plate. Meal combination (e.g. pasta and meatballs versus rice and sardines), liking and anticipated leftovers for carbohydrate and protein items, all played a role in determining anticipated vegetable leftovers. Interestingly, if children were perceived to better like the carbohydrate and protein components of the meal, parents expected more vegetable leftovers. This indicates that the more palatable foods are expected to be eaten over the less palatable items, which are often vegetables. Thus, supporting the notion of 'competing' foods on the plate (Chawner, Blundell-Birtill, & Hetherington, 2022). However, when parents anticipated greater leftovers of non-vegetable items, they also expected more vegetable leftovers. This almost paradoxical finding (both higher liking and more leftovers of non-vegetable items are associated with more vegetable leftovers) could be explained by individual differences in eating traits (**Table 4**). Perhaps avid or happy eaters (Pickard et al., 2023), may eat more overall, including eating more vegetables, therefore leaving smaller amounts on the plate at the end of the meal. Although enjoyment of food did not directly predict vegetable leftovers in this study, this may be because the variance was already explained by vegetable, protein and carbohydrate liking and anticipated leftovers in the model. Alternatively, children with high food fussiness may not clear the plate and may only eat the better-liked foods, therefore not eating so much overall and leaving more vegetables. It is further possible that these factors affecting intake are embedded within specific meal combinations. For example, meals perceived as less palatable (e.g., sardines and rice) were associated with fewer expected vegetable leftovers compared to highly liked meals (e.g., chips and chicken dippers). Future research may investigate children's actual vegetable intake across different meal combinations with varying palatability, as well as investigate how children learn to eat vegetables in meals

through categorisation learning. For example, learning and understanding which foods are typically served together to create a meal (the category) that is acceptable to be eaten alongside vegetables (Mura Paroche, Caton, Vereijken, Weenen, & Houston-Price, 2017).

Theoretical models of parent portion size decisions highlight numerous additional influencing factors, including location, day of the week, family members present, and food preferences (Acolatse et al., 2023). One omitted variable from the Acolatse *et al.* model is child and parent gender. The current study observed that parents served larger vegetable portions to male children than to female children, yet child gender was not associated with anticipated vegetable leftovers. This finding may be linked to parent perception of different energy requirements between genders, serving more of each food item to males, despite national portion size recommendations not differing between genders (Department for Education, 2025). Future behavioural research may examine the roles of child and parent gender as another important variable in determining portion sizes of vegetables and other meal items.

4.1 Implications and future research

This study offers several important implications for supporting vegetable portion sizes and intake at home mealtimes. First, as vegetable portion sizes were primarily driven by food and child characteristics (e.g. liking) rather than parent healthy eating goals, future studies could investigate ways to raise parental awareness of why they may serve smaller than recommended vegetable portions. Simply holding intentions to promote healthy eating may not translate into serving recommended vegetable portions if those decisions are shaped by concerns about acceptance or leftovers. Encouraging parents to think beyond individual foods and instead focus on the overall meal composition may be a helpful strategy. For example, routinely including vegetables as a standard part of certain meals (even breakfast – see McLeod & Haycraft, 2024) may increase children's acceptance over time, helping them learn that vegetables are a normal and expected component of meals.

Second, the reasons behind smaller vegetable portion sizes, such as perceived dislike, avoiding waste, or mealtime stress, could inform targeted interventions. For parents concerned about children disliking vegetables, promoting exposure strategies targeting liking, before adjusting portion sizes to target intake, may produce the desired increase in intake. For parents concerned about leftovers or waste, education strategies around reusing leftover food may be beneficial (de Souza et al., 2025). Each targeted strategy could explore how portion sizes and exposure strategies can be used together to encourage parallel improvements in liking and intake. Additionally, as parents often do not believe that increasing portions will be an effective strategy to increase their child's intake (Chawner,

Blundell-Birtill, & Hetherington, 2023), future interventions could aim to build parental confidence and set realistic expectations around gradual improvements in vegetable intake and portion sizes at mealtimes.

Lastly, given the large number of variables that may influence portion sizes, it remains unclear how much each variable contributes to the portion sizes of specific foods within meals, particularly across different food groups. Although food type is accounted for in existing portion size models (Acolatse et al., 2023), much of the supporting evidence stems from research comparing high and low energy dense snacks, rather than meal items that vary in palatability, macronutrient content, or typical meal combinations. In this study, food combinations were found to have a potential effect on parent vegetable portion sizes. Future research could further investigate how meal context and food combinations influence both portion size decisions and child consumption of specific items within meals that are commonly served at home. Additionally, portion decisions may vary not only by food group (e.g., proteins versus vegetables) but also by how parents evaluate factors such as liking and anticipated leftovers. For example, potential leftovers may be assessed differently depending on the cost or preparation time of a protein compared to a vegetable item. These findings highlight the need for more nuanced research into how parents make portion decisions within meals and across food types. Such findings could deepen our understanding of parents' motivations during mealtimes and support the development of more effective meal planning and feeding strategies aimed at encouraging children to eat more vegetables and reduce leftovers during meals.

4.2 Strengths and Limitations

A strength of the current study is that it employed a novel portion size task. Using multiple food meals rather than composite meals, a specific meal context could be investigated for differences in parent portion size decisions. Specifically, whether portion decisions are affected by how foods are combined on the plate. Given the online nature of the task, portion size estimations were provided for numerous meals, without increasing food waste or children having to eat multiple meals over several days. Using the same stimuli, we can further control for energy and food weights in the meals. However, the main limitation is that no eating behaviour or physical portioning of real foods was observed. For example, parents may need to feel the portions or use utensils to engage with their usual decision-making processes, rather than having only visual feedback for what is on the plate. Parents also usually only portion out one meal at a time for their child. There may be the limitation that parents would indicate serving the same amount of vegetables in each meal because

that is how much they chose for the last meal stimulus. When portioning at home, having a daily washout period between serving evening meals could have different effects for the role of memory in making portion size decisions. Therefore, replication at home mealtimes with individualised meals would be useful.

Furthermore, certain unmeasured variables may have influenced parents' decisions to serve a particular portion size. For example, if the meal was unusual for the family to serve to their child (e.g. sardines, rice and spinach), how acceptable the meal was to the parent or child (de Graaf *et al.*, 2005), the sensory qualities of the meal (Chaffee & Ross, 2023), and how much parents would serve themselves of the same foods. Additionally, parents may have been considering other goals or factors that are important to them, such as whether the food or portion size would make their child sated. Expected satiation from a meal is important for adult meal acceptability decisions (Brunstrom & Rogers, 2009), therefore parents may utilise expected satiation to serve foods to their child. Additionally, the study did not collect data on parent dietary requirements. Therefore, it is possible that parents following alternative diets (e.g. vegetarian) may have served vegetables to their children differently compared to other parents.

Lastly, it is possible that hungrier children or those with higher BMI may require larger portions. Similarly, pubertal development could influence typical eating habits related to portion sizes. However, the current study did not measure BMI due to the self-report nature of online studies (which would reduce accuracy of BMI), nor consider pubertal development beyond the age of the child. Whilst these factors and unmeasured growth patterns could have affected parents' portion sizes of foods, they are unlikely to influence the overall results due to the repeated measures design and accounting for correlated observations in the analyses.

In conclusion, this study presents the first quantitative evidence to examine parents' portion sizes of vegetables for their child within the context of different meal combinations. It was found that parent portion size decisions for vegetables within meals were most influenced by the child's expected liking and leftovers of the vegetable portion, along with the parent goals to avoid mealtime stress and to serve healthy foods, with only small influences of the meal combination. Whereas, how much the child was expected to leave on the plate was more strongly affected by the meal combination, liking for other foods on the plate and the expected amount of other foods leftover at the end of the meal. Parent vegetable portion sizes at mealtimes appear to be largely based on expectations surrounding individual items, rather than the meal as a whole, yet parents acknowledge the role of meal combinations in

determining what their child is likely to eat or leave on the plate and appeared to take account of competing foods.

Data availability

The data that support the findings of this study are available upon reasonable request from the corresponding author.

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Declarations of competing interests

I have nothing to declare.

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