

Comparing dietary quality of provided lunches and lunchboxes in Early Childhood Education and Care Settings in England: A cross-sectional analysis

Amy Turner

ix23655@bristol.ac.uk

University of Bristol <https://orcid.org/0009-0007-9940-7642>

Rachel Maishman

University of Bristol

Marie Murphy

University of Birmingham

Genevieve Buckland

University of Bristol

Ruth Kipping

University of Bristol

Alice Porter

University of Bristol

Research Article

Keywords: Dietary quality, Nutrition, Early Childhood, Nurseries, Food waste

Posted Date: August 3rd, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10550047/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: The authors declare no competing interests.

Comparing dietary quality of provided lunches and lunchboxes in Early Childhood Education and Care Settings in England: A cross-sectional analysis

Amy Turner^{1,2}, Rachel Maishman³, Marie Murphy⁴, Genevieve Buckland⁵, Ruth Kipping¹, Alice Porter^{1,6}.

¹Centre for Public Health, Population Health Sciences, Bristol Medical School, University of Bristol, UK.

²National Institute for Health and Care Research (NIHR) School for Public Health Research (SPHR).

³Bristol Trials Centre, Bristol Medical School, University of Bristol, UK

⁴Institute of Applied Health Research, University of Birmingham, UK.

⁵Centre for Academic Child Health, Population Health Sciences, Bristol Medical School, University of Bristol, UK

⁶NIHR Bristol Biomedical Research Centre, University Hospitals Bristol and Weston NHS Foundation Trust and University of Bristol, UK.

Corresponding author: Amy Turner

amy.turner@bristol.ac.uk

Augustine's Courtyard, Orchard Lane, Bristol, BS1 5DS

Abstract

Objective:

The majority of early years children (0 to-5 years) attend Early Childhood Education and Care settings (ECECs) in England. This study aims to explore the dietary quality of lunches served, consumed, and wasted in English ECECs, and compare how this differs between ECEC provided lunches and lunchboxes from home, and across deprivation levels.

Design:

A cross-sectional secondary data analysis of baseline dietary data from the NAPSACC UK study. Dietary quality was measured using a bespoke ECEC Dietary Score (EDS).

Setting:

Diet data was collected from ECECs in three areas in England.

Participants:

357 children (mean age 3.5 years) from 38 ECECs.

Results:

52% (n=184) of children received ECEC provided lunches and 30% (n=108) were from areas of high deprivation. Lunchboxes had poorer dietary quality than ECEC provided lunches (median EDS (IQR) for ECECs: 5.0 (4.0, 6.0), lunchboxes: 4.0 (3.0, 5.0). Consumed lunches were more aligned with dietary recommendations than served lunches, both had low adherence to free sugars (all lunches served=8%, consumed=16%). Lunchboxes from the most deprived areas contained poorer dietary quality than lunchboxes in the least deprived areas (adjusted mean difference 0.9 (95% CI 0.2, 1.6) p=0.009). The largest proportion of food waste was for fruit and vegetables (median 19.6g, 25.5%).

Conclusions:

Dietary quality was higher in ECEC provided lunches than lunchboxes, although both contained excess energy, free sugars, saturated fat, and sodium, and were deficient in fibre. A widespread reduction in High Fat, Sugar or Salt (HFSS) foods served to early years children in ECECs is needed.

Keywords

Dietary quality, Nutrition, Early Childhood, Nurseries, Food waste.

Acknowledgements: We would like to acknowledge the parents and nursery staff involved in the initial development of the study. Additionally, we would like to thank the NAPSACC UK study team and all the participants, without whom this study would not have been possible.

Financial Support: This study is funded by the National Institute for Health and Care Research (NIHR) School for Public Health Research (SPHR) (Grant Reference Number NIHR 204000). The views expressed are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care. The NAP SACC UK study is funded by the UK National Institute for Health and Care Research (NIHR) Public Health Research Programme (12/75/51). The overall NAP SACC UK Trial which the data for this study is based on was designed and delivered in collaboration with the Bristol Trials Centre (BTC), a UKCRC Registered Clinical Trials Unit which is in receipt of NIHR CTU Support Funding.

Conflict of Interest: None

Authorship: AT: conceptualization, methodology, formal analysis, project administration, writing – original draft. RM: methodology, formal analysis, writing – review & editing. RK: conceptualization, funding acquisition, supervision, writing – review & editing. GB: methodology, writing – review & editing. MM: conceptualization, supervision, writing – review & editing. AP: conceptualization, supervision, writing – review & editing.

Ethical Standards Disclosure: This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the Ethical Committee at the University of Bristol (REF:6373). Written informed consent was obtained from all parent/carers of subjects.

Introduction

Globally, over 35 million children under the age of five are living with overweight⁽¹⁾. Childhood obesity is a widespread public health concern across England, as in 2024/25, 10.5% children aged 4 to-5-years were living with obesity and 13% with overweight. Children living in the most deprived areas are twice as likely to be living with obesity, and rates of overweight and obesity are highest among children from Black African (15%) and other Black ethnic groups (14.5%) compared to other ethnic groups in England⁽²⁾. Unhealthy dietary patterns in childhood, characterised by energy-dense nutrient-poor foods, often high in saturated fat, salt, and sugar and low in fibre, have been linked to increased risk of overweight and obesity in childhood⁽³⁾. Establishing healthy dietary patterns during childhood is associated with long-term protective effects against cardiovascular disease and better cognitive outcomes in later life^(4, 5). Despite this, recent evidence indicates that young children (aged 2 to-10 years) in the UK do not typically meet dietary recommendations for fruit and vegetables, exceed recommendations for sugar-sweetened beverages, and rarely meet nutritional recommendations for free sugars, fibre, zinc, and vitamin C⁽⁶⁾. Poor diet quality has also been reported in adolescence and adulthood in the UK, emphasising the need for early intervention to prevent overweight and obesity starting in early childhood^(6, 7).

In England, the majority (64%) of children aged 0 to-4 years attended Early Childhood Education and Care settings (ECECs) in 2024, where they spent on average 24 hours a week⁽⁸⁾. The Government in England has invested an additional £2 billion to expand funded childcare hours with 70,000 new places^(9, 10), reducing costs of childcare for parents and encouraging a return to work. The scheme provides up to 30 hours of free childcare a week for children from four months old; however, funding for food provision is not included⁽¹⁰⁾. This could therefore result in an increase in settings' reliance on food brought from home via lunchboxes and/or increased charges to parents for ECEC provided food⁽¹¹⁾. Furthermore, funding changes to childcare provision may have a

disproportionate impact in the most deprived areas, where ECECs already face chronic underfunding, and children have poorer dietary intakes^(12, 13).

Previous studies in England have reported that food provided in ECECs largely did not comply to fat, saturated fat, and sugar recommendations for early years children⁽¹⁴⁾. Moreover, recent evidence indicates that lunchboxes brought to ECECs contained more energy and higher proportions of ultra-processed foods (UPF), foods High in Fat, Sugar, or Salt (HFSS), and non-core foods than ECEC provided foods^(15, 16). Additionally, high UPF content and poorer dietary quality in lunchboxes was observed more frequently in more deprived areas^(15, 17). The recent changes to ECEC funding may therefore exacerbate the existing poor dietary quality in both ECEC provided lunches and lunchboxes.

Food waste is an important factor related to food provision and dietary consumption in education settings, with one study reporting 45% of foods and beverages served were wasted in school settings⁽¹⁸⁾. The proportion of food wasted was found to be higher in young children (aged 5 to 6) than older children in educational settings and therefore has relevance for ECECs⁽¹⁸⁾. Furthermore, specific food groups such as meat/animal proteins contribute towards negative environmental impacts, whilst disproportionately driving up the cost of meals⁽¹⁹⁾. Therefore, it is important to identify what types of foods are wasted in ECECs to develop effective interventions that have economic and environmental benefits.

Our recent (2025) scoping review of food policy, practice, and provision in UK ECECs identified the need for more research to investigate the dietary quality of food provided to early years children in ECEC settings⁽²⁰⁾. Additionally, a recent (2026) study investigating ECEC lunch provision in Sheffield, England, identified the need for more nationally representative research of lunch provision in English ECECs⁽¹⁴⁾. Thus, this study aims to explore the dietary quality of lunches served, consumed and wasted in English ECECs. Secondly, the study aims to compare how dietary quality differs between food provided by ECECs and food brought from home via lunchboxes. Thirdly, this study aims to investigate how dietary quality provision varies across levels of deprivation.

Methods

Study design and sample

This study was a cross-sectional secondary data analysis of baseline data collected for the NAPSACC UK multicentre cluster randomised controlled trial (data collection period 2022-2025), that aimed to improve policies, practice, and the nutrition and physical activity environment in UK ECECs through self-assessment and targeted assistance⁽²¹⁾. Follow-up data were excluded from this

study due to exposure to the nutrition intervention, and data collected from Scottish ECECs were excluded due to government-funded meal provision in Scottish ECECs resulting in <5% lunches from lunchboxes. Details of the study design and dataset were pre-registered on Open Science Framework (DOI: <https://doi.org/10.17605/OSF.IO/B2GWN>).

NAPSACC UK recruited day nurseries, private nurseries, maintained nurseries, nursery classes attached to primary schools, and pre-schools from Somerset (South West), Swindon (South West), and Sandwell (Midlands) local government areas in England. Children were eligible for inclusion in the trial if they were: (i) at least 2 years old at the time of data collection; (ii) not attending primary school; (iii) attending the ECEC setting at least 12 (full year attendance) or 15 (term time attendance) hours per week; (iv) and consumed lunch at the ECEC at least once a week.

Diet assessment

In brief, diet data was collected in the NAPSACC UK study using the Remote Food Photography Method (RFPM). This method gives direct estimation of portion sizes of food and drinks through visual comparison of photographs taken during data collection to standard portion size photographs. Photographs⁽²²⁾ were sent to Pennington Biomedical Research Centre (PBRC) for processing and estimation of nutrient composition. For full data collection procedures see NAPSACC UK publication⁽²¹⁾.

Nutrition and diet outcomes

Nutritional composition of lunches served and consumed from ECEC provided lunches and lunchboxes were the primary outcomes in this study. Nutrients included in analyses were energy (kcal), carbohydrates (g), free sugars (g), fat (g), saturated fat (g), protein (g), AOAC fibre (g), and sodium (mg).

Dietary quality was measured using the bespoke ECEC Dietary Score (EDS), created for this study to measure dietary quality of mealtimes for early years children (2 to-6 years). The EDS was developed by adapting the framework of the Eatwell Guide (EWG) scoring used previously to assess individual adherence to the EWG food and nutrient recommendations for adults, and later modified for children^(23, 24). The EDS is made up of ten nutrient and food group categories: fat, saturated fat, free sugars, fibre, sodium, fruit and vegetables, dairy and plain, fortified plant-based alternatives, protein sources, and drinks (Table S1). EDS categories were examined separately as binary variables (meeting food group/nutrient thresholds or not), and as a continuous variable (summary EDS score with one point for each EDS category met, range 0 (lowest) to 10 (highest) to determine the overall dietary quality of lunches. The thresholds were calculated to reflect recommendations for a lunch, which are based on 30% of the Government Dietary Reference

Values (DRVs) or daily portions. Full detail of the EDS derivation can be found in Supplementary materials 1.

Food waste across food groups was presented as amount of food wasted (g) and percentage of lunch wasted per food group (fruit & vegetables, starchy carbohydrates, dairy and plain, fortified plant-based alternatives, and proteins) for ECEC provided lunches and lunchboxes. Children with no consumption were excluded from analyses of waste data to ensure waste variables accurately reflect the distribution of food groups wasted.

Covariates

Child-level deprivation was derived from the child's postcode using the Index of Multiple Deprivation (IMD) or ECEC setting average IMD if child IMD was missing⁽²⁵⁾. IMD was coded as a continuous variable and as a categorical variable (high deprivation (IMD deciles 1-3), moderate deprivation (deciles 4-7), and low deprivation (deciles 8-10)).

Potential confounders adjusted for in the analyses included child IMD; Body Mass Index (BMI) (kg/m^2) converted to centiles (z-BMI) using the UK 1990 growth reference charts⁽²⁶⁾ (classified as healthy weight ($\text{zBMI} < 1.04$; $1.04 = 85^{\text{th}}$ centile) or unhealthy weight ($\text{zBMI} \geq 1.04$)); child age (months); ECEC setting size (number of children attending setting); and ECEC setting type (nursery attached to school, nursery not attached to school, pre-school attached to school, preschool not attached to school).

Statistical analysis

Descriptive analyses were carried out on served, consumed, and wasted nutrient and food group data both across all lunches and separately for ECEC provided lunches and lunchboxes. Total amounts of each nutrient were calculated per child lunch and were presented descriptively (median and IQR) and as a percentage of the government recommendations for children aged 2 to-6 years (30% DRV to reflect recommendations for a lunchtime⁽²⁷⁾) (Table S4). Additionally, the mean and standard deviation (SD) of summed EDS were summarised across deprivation categories (high, moderate, low).

Dietary quality was compared between ECEC provided lunches and lunchboxes using unadjusted and adjusted multilevel linear regression models, with lunch provision type (ECEC provided/lunchbox) as the exposure variable and ECEC setting as a random effect to account for clustering. In all analyses, ECEC provided lunches served as the reference group. Adjusted models included potential confounders as fixed effects. Analyses were performed for total nutrient values (energy, fat, saturated fat, free sugars, fibre, sodium, and protein) served and consumed, total EDS

scores of lunches served and consumed, and for total waste per food group. Additionally, compliance to EDS categories between ECEC provided lunches and lunchboxes were compared using unadjusted and adjusted multilevel logistic regression models.

EDS scores were compared across deprivation categories using multilevel linear regression, adjusted for potential confounders as fixed effects and ECEC setting as a random effect. All analyses were performed using StataNow 19 MP.

Results

A total of 357 children aged 2 to 5 years from 38 ECEC settings within three local government areas in England were included in the analysis. Table 1 outlines demographic characteristics of the children and ECEC settings. Participating children were an average age of 3.5 years old (SD 0.7), and a quarter were living with overweight or obesity. Approximately half of the children received ECEC provided lunches (n=184, 52%). Thirty percent of children (n=108) were from areas of high deprivation.

Table 1. Demographic characteristics of children and ECECs

	Mean (SD) or n (%) Total n=357
Child IMD^a	
High (1-3)	108 (30%)
Moderate (4-7)	172 (48%)
Low (8-10)	77 (22%)
Child Age (years)	3.5 (0.7)
Child zBMI Score	0.41 (0.85)
Child Weight Category^b	
Normal	253 (76%)
Overweight or obese	81 (24%)
Child Ethnicity	
White British	272 (76%)
White Other	21 (6%)
Black, Black British, Black Caribbean, Black African	8 (2%)
Asian, Asian British	26 (7%)
Mixed	19 (5%)
Other	5 (1%)
ECEC Lunch Type	
ECEC Provided	184 (52%)
Lunchboxes	173 (48%)
ECEC Type	
Nursery attached to school	42 (12%)
Nursery not attached to school	169 (47%)
Pre-school ^c attached to school	59 (17%)
Pre-school ^c not attached to school	86 (24%)

^aIndex of Multiple Deprivation (IMD) deciles indicating area levels of deprivation, 1 indicating the highest deprivation and 10 the least. ^bCalculated using the UK 1990 growth reference charts⁽²⁶⁾. ^c'Pre-school' refers to ECECs with a more structured educational component, typically children aged 2 to-5 years.

Nutrient content

Served

Table 2 presents the nutrient content of served and consumed lunches. Children were served lunches with significantly higher energy in lunchboxes compared to ECEC provided lunches (median (IQR): 522.3kcal (410.7, 671.9) in lunchboxes versus 418.9kcal (332.4, 529.2) in ECEC provided lunches; adjusted mean difference (aMD) 119.9kcal (58.9, 181.0), $p<0.001$). Findings from the adjusted models provided strong evidence ($p<0.05$) that served lunchboxes had higher carbohydrates, free sugars, fat, saturated fat, and sodium, and lower fibre than in served lunches provided by ECEC, however no difference was observed in amount of protein served.

Consumed

Differences in nutrient content between lunchboxes and ECEC provided lunches were less evident for consumed lunches, with strong evidence of differences only observed for free sugars, saturated fat, and fibre (Table 2). Additionally, aMD for consumed lunches were smaller than those for served for all nutrients except protein, suggesting that there was greater similarity in nutrients consumed between lunchboxes and ECEC provided lunches than for nutrients served.

Table 2. Total served nutrient content for all lunches, ECEC provided lunches and lunchboxes

	DRV per lunch (30%)	All lunches (n=357)		Lunchbox (n=173)		ECEC provided (n=184)		Adjusted mean difference (95% CI), p-value
		Median	IQR	Median	IQR	Median	IQR	
Served								
Energy (kcal)	371.4	466.1	(362.9, 585.6)	522.3	(410.7, 671.9)	418.9	(332.4, 529.2)	119.9 (58.9, 181.0), <0.001
Carbohydrates (g)	49.6	62.3	(45.4, 82.3)	71.7	(53.9, 86.4)	53.4	(41.2, 71.2)	12.1 (2.2, 22.1), 0.02
Free sugars (g)	5.0	20.9	(13.5, 30.4)	27.7	(19.2, 41.6)	15.7	(9.1, 23.9)	15.1 (10.4, 19.8), <0.001
Fat (g)	16.8	18.3	(11.4, 24.7)	21.2	(14.6, 28.9)	14.1	(9.0, 21.0)	7.5 (4.6, 10.4), <0.001
Saturated Fat (g)	5.3	6.7	(4.1, 10.8)	8.1	(5.0, 13.0)	5.4	(3.5, 8.5)	3.8 (2.4, 5.2), <0.001
Protein (g)	5.1	16.1	(11.8, 20.7)	15.8	(11.9, 19.8)	16.6	(11.5, 22.6)	-1.0 (-3.5, 1.4), 0.40
Fibre (g)	5.0	5	(3.7, 7.0)	4.8	(3.3, 6.1)	5.5	(4.1, 7.7)	-1.8 (-2.8, -0.9), <0.001
Sodium (mg)	300	530.1	(330.7, 758.7)	680.2	(487.4, 841.6)	400.8	(221.6, 619.4)	159.0 (68.0, 250.0), 0.001
Consumed								
Energy (kcal)	371.4	336.6	(219.8, 454.9)	381.7	(244.3, 470.3)	324.8	(196.4, 442.9)	14.8 (-44.9, 74.4), 0.63
Carbohydrates (g)	49.6	43	(29.1, 61.1)	46.4	(32.7, 62.8)	41.9	(24.0, 58.4)	-0.3 (2.2, 10.2), 0.96
Free sugars (g)	5.0	14.9	(8.0, 24.2)	18.4	(11.7, 29.4)	12.2	(5.5, 20.0)	6.2 (4.6, 10.4), 0.002
Fat (g)	16.8	12.1	(6.9, 19.4)	13.7	(8.4, 20.3)	10.1	(4.9, 18.0)	2.6 (-0.3, 5.4), 0.08
Saturated Fat (g)	5.3	4.6	(2.6, 8.1)	5.2	(3.3, 8.6)	4	(1.6, 6.8)	1.6 (0.3, 2.9), 0.02
Protein (g)	5.1	11.1	(7.2, 16.5)	11.1	(7.7, 15.4)	11.2	(6.8, 17.7)	-2.1 (-4.4, 0.2), 0.07
Fibre (g)	5.0	3.2	(1.7, 5.0)	2.9	(1.6, 4.6)	3.7	(1.8, 5.5)	-1.4 (-2.4, -0.5), 0.002
Sodium (mg)	300	371.7	(194.3, 559.7)	448.6	(298.1, 663.8)	289.6	(134.5, 460.3)	75.7 (-6.6, 158.0), 0.07

Abbreviations: DRV = Dietary Reference Values; ECEC = Early Childhood Education and Care; IQR = interquartile range; CI = confidence interval. Models adjusted for IMD, zBMI, age, size of ECEC, ECEC type, and random effects of ECEC setting

Adherence to nutrition recommendations

Served

Figure 1a presents the median deviance from adjusted daily recommendations (calculated as the amount excess to daily recommendations expressed as a percentage of the daily recommendations) for served nutrients. Both served ECEC provided lunches and lunchboxes exceeded recommendations for energy, carbohydrates, free sugars, saturated fat, protein, and sodium, ranging from 112.7% to 559.0% over the recommendations (Figure 1a). Served lunchboxes exceeded recommendations by a greater amount than ECEC provided lunches. This was most notable for free sugars, as ECEC provided lunches contained over three times the recommendation (317.7%), whereas lunchboxes exceeded recommendations by over five times (559.0%). Served lunchboxes also contained excess fat and were deficient in fibre, in contrast to ECEC provided lunches that met the minimum recommendations for fibre (Figure 1a and Table S3a).

Consumed

Overall, consumed lunches generally had a greater adherence to nutrient recommendations than served lunches (Figure 1b and Tables S3a & S3b). Similar to served lunches, consumed lunchboxes exceeded nutrient recommendations by greater proportions than consumed ECEC lunches. However, both consumed lunches provided by ECEC and lunchboxes exceeded recommendations for free sugars and protein and were deficient in fibre (Figure 1b and Table S3b).

Figure 1a. Percentage deviance from nutrient recommendation (30% DRV) met for served ECEC provided lunches and lunchboxes.

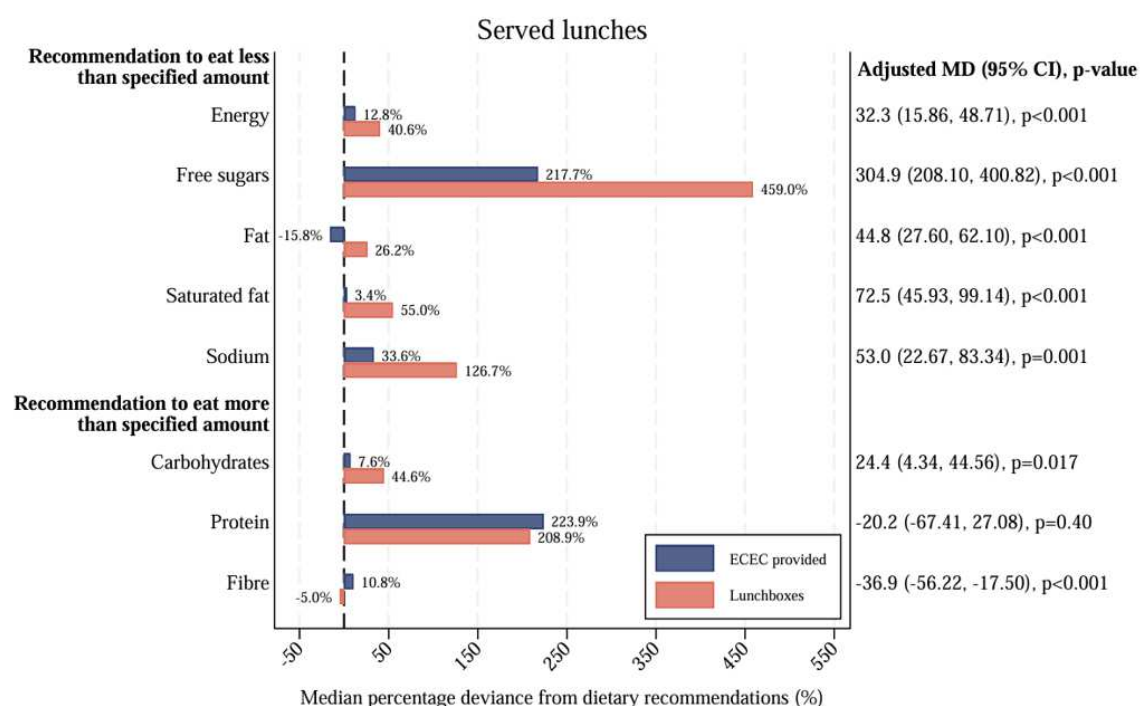
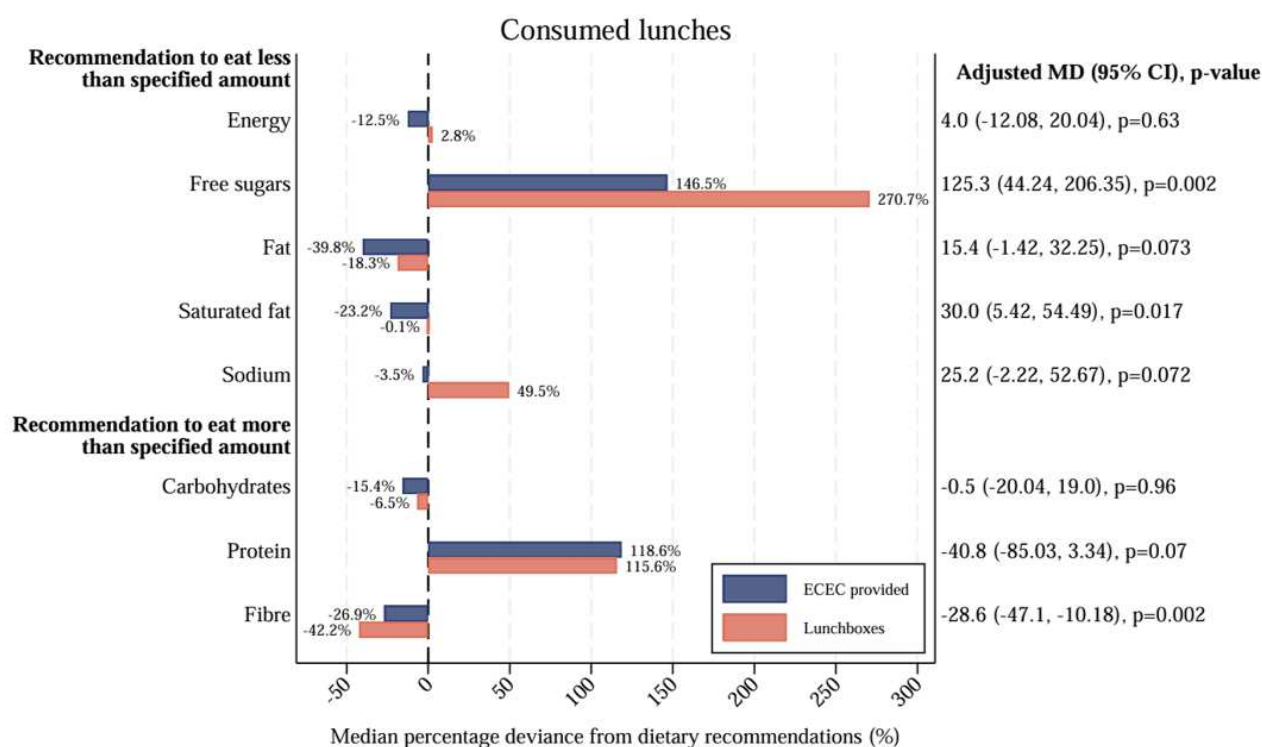


Figure 1b. Percentage deviance from nutrient recommendation (30% DRV) met for consumed ECEC provided lunches and lunchboxes.



Dietary quality – compliance to ECEC recommendations

Served

Figures 2a and 2b present the proportion of children meeting nutrient and food group recommendations for served and consumed lunches, used to derive the EDS. Descriptive analysis showed that lunchboxes had lower compliance to recommendations than ECEC provided lunches in all cases except fruit & vegetables, starchy carbohydrates, and dairy. The highest level of compliance for served ECEC provided lunches and lunchboxes was observed for drinks (85% and 73%, respectively). The lowest compliance was observed for free sugars and sodium (8% and 21% across all lunches). Furthermore, compliance to the dairy food group recommendation was low (26%) in ECEC provided lunches, but less so in lunchboxes (65%). Served lunchboxes were less likely to meet dietary recommendations for fat (aOR 0.30(0.13, 0.71), p=0.006), saturated fat (aOR 0.30(0.14, 0.64), p=0.002), fibre (aOR 0.30(0.12, 0.73), p=0.008), sodium (aOR 0.31(0.12, 0.83), p=0.02) and proteins (aOR 0.08(0.03, 0.23), p<0.001) compared to served lunches provided by ECECs (Figure 2a and Table S4a).

Consumed

Overall, there was greater compliance to free sugars, fat, saturated fat, sodium, and drinks recommendations for consumed lunches compared to served (Figure 2b). Although compliance to the free sugar recommendation was low across all lunches, compliance was double for consumed (16%) compared to served (8%) across all lunches. This was particularly notable for lunchboxes, with 1% compliance for served and 9% for consumed, although still low. Consumed lunchboxes were less likely to meet recommendations for proteins (aOR 0.15(0.06, 0.36), $p<0.001$) and drinks (aOR 0.25 (0.07, 0.9), $p=0.034$) compared to consumed ECEC provided lunches. However, consumed lunchboxes were more likely to meet dairy recommendations than ECEC lunches (aOR 3.78 (1.59, 8.99), $p=0.003$) (Figure 2b and Table S4b).

Figure 2a. Proportion of children meeting recommendations for nutrients and food groups in ECEC provided lunches and lunchboxes (served); the adjusted odds ratios (95% CI) are presented for the comparisons of lunchboxes and ECEC provided lunches.

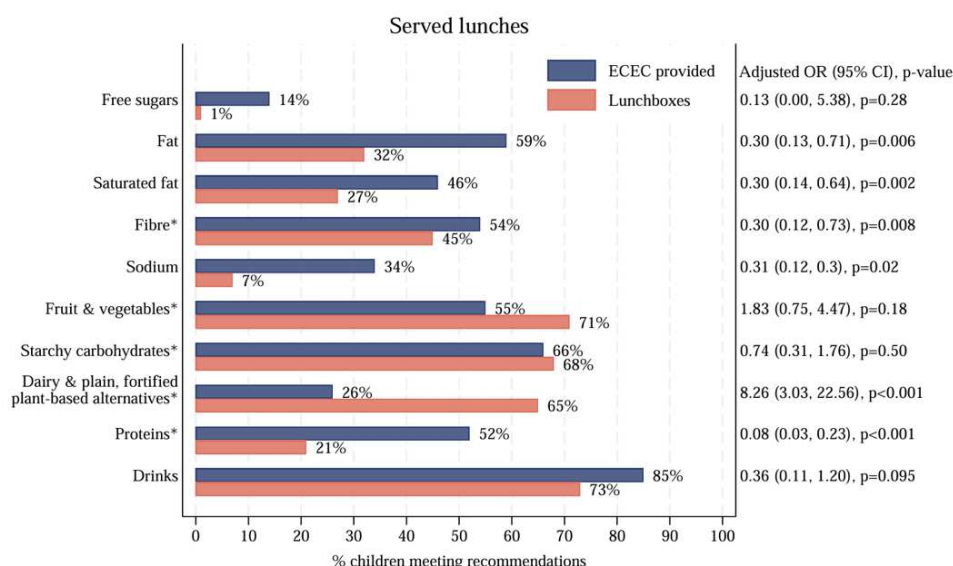
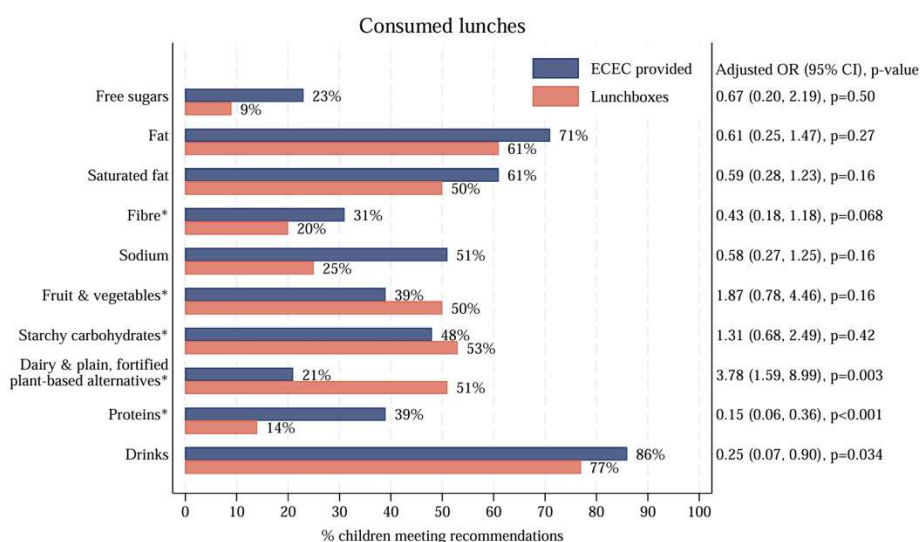


Figure 2b. Proportion of children meeting recommendations for nutrients and food groups in ECEC provided lunches and lunchboxes (consumed); the adjusted odds ratios (95% CI) are presented for the comparisons of lunchboxes and ECEC provided lunches.



Dietary quality across deprivation levels

Dietary quality was measured using the EDS. Table 3 presents the median (IQR) EDS for both served and consumed ECEC provided lunches and lunchboxes across the deprivation categories, and the results from the adjusted linear regression models. ECEC provided lunches were of higher dietary quality than lunchboxes for both served and consumed lunches (median (IQR): EDS score 5.0 (4.0, 6.0) for served and consumed ECEC provided lunches vs 4.0 (3.9, 5.0) for served and consumed lunchboxes) (Table 3). Dietary quality varied significantly across deprivation levels for served lunchboxes, with higher EDS scores observed in served lunchboxes of children from areas of low deprivation compared to high deprivation (aMD 0.9 (95% CI 0.23 to 1.55), $p=0.009$). No significant differences were seen in the quality of served ECEC provided lunches or in the quality of consumed lunches (both ECEC provided and lunchboxes) across deprivation levels. **Table 3.** Median (IQR) summed EDS scores across deprivation categories (high, moderate, and low) for (a) served and (b) consumed lunches.

Table 3. Median (IQR) summed EDS scores across deprivation categories (high, moderate, and low) for (a) served and (b) consumed lunches.

	Served		Consumed	
	Median (IQR)	aMD (95% CI), p-value	Median (IQR)	aMD (95% CI), p-value
<i>ECEC provided</i>				
Overall	5.0 (4.0, 6.0)	-	5.0 (4.0, 6.0)	-
High Deprivation	5.0 (4.0, 6.0)	<i>Reference category</i>	4.0 (4.0, 5.0)	<i>Reference category</i>
Moderate Deprivation	5.0 (4.0, 6.0)	0.1 (-0.5, 0.69), 0.69	5.0 (4.0, 6.0)	0.3 (-0.3, 0.8), 0.37
Low Deprivation	6.0 (4.0, 7.0)	0.2 (-0.5, 1.0), 0.59	5.0 (4.0, 7.0)	0.6 (-0.2, 1.3), 0.13
<i>Lunchboxes</i>				
Overall	4.0 (3.0, 5.0)	-	4.0 (3.0, 5.0)	-
High Deprivation	4.0 (3.0, 5.0)	<i>Reference category</i>	4.0 (3.0, 5.0)	<i>Reference category</i>
Moderate Deprivation	4.0 (3.0, 5.0)	0.4 (-0.1, 0.9), 0.12	4.0 (3.0, 5.0)	-0.0 (-0.5, 0.5), 0.88
Low Deprivation	4.0 (3.0, 5.0)	0.9 (0.2, 1.6), 0.009	4.0 (3.0, 5.0)	0.4 (-0.2, 1.0), 0.17

Abbreviations: EDS = ECEC Dietary Score; IQR = interquartile range; MD = mean difference; ECEC = Early Childhood Education Care.

Food waste

Table 4 presents the quantity and percentage of food wasted across different food groups. The largest quantity and percentage of wasted food was found for the fruit and vegetables food group for both ECEC provided lunches and lunchboxes. Additionally, more of the starchy carbohydrates ($p<0.001$) and proteins ($p<0.001$) food groups were wasted in ECEC provided lunches compared to lunchboxes.

Table 4. Quantity of food groups wasted (g) (adjusted for participants with 0g served) of all lunches, ECEC provided lunches and lunchboxes, and as a proportion of the food group wasted (%).

	Food wasted	All lunches (n=357)		Lunchboxes (n=173)		ECEC provided lunches (n=184)		Adjusted MD (95% CI), p- value
		Median	IQR	Median	IQR	Median	IQR	
Fruit and Veg								
	Total grams	19.6	(0.0, 58.1)	21.5	(0.00, 70)	15.0	(0.0, 46.8)	0.1 (-0.3, 0.6), 0.51
	as a % of fruit and veg served	25.5	(0.0, 70.0)	26.7	(0.0, 66.3)	25.0	(0.0, 75.0)	-0.0 (-0.4, 0.3), 0.33
Starchy Carbohydrates								
	Total grams	5.3	(0.0, 37.8)	3.9	(0.0, 23.5)	8.3	(0.0, 45.0)	-0.7 (-1.1, -0.3), <0.001
	as a % of starchy carbohydrates served	10.0	(0.0, 50.0)	10.0	(0.0, 50.0)	9.5	(0.0, 50.0)	-0.1(-0.4, 0.2), 0.65
Dairy								
	Total grams	0.0	(0.0, 20.5)	0.0	(0.0, 20.7)	0.0	(0.0, 18.4)	-0.3 (-0.8, 0.2) 0.25
	as a % of dairy served	0	(0.0, 50.0)	0	(0.0, 50.0)	0	(0.0, 45.2)	0.4 (-0.2, 0.9), 0.20
Proteins								
	Total grams	1.0	(0.0, 33.9)	0.0	(0.0, 18.8)	4.5	(0.0, 72.0)	-1.4 (-2.0, -0.9), <0.001
	as a% of proteins served	2.8	(0.0, 64.6)	0	(0.0, 52.2)	4.0	(0.0, 80.0)	-0.0 (-0.48, 0.46), 0.96

Abbreviations: ECEC = Early Childhood Education and Care; MD = mean difference; CI = confidence interval; IQR = interquartile range.

Discussion

This is the first study, to the best of our knowledge, to comprehensively assess the dietary quality of lunches served, consumed, and wasted in ECECs across England. Overall, our analysis found that served lunches provided by ECECs and from lunchboxes generally had inadequate adherence to dietary recommendations. This is consistent with previous analyses that found lunches in English ECECs also contained excess carbohydrates, free sugars, protein, and sodium^(14, 28). Our findings also align with research from ECECs in the Netherlands that reported excess provision of energy, protein, and sodium⁽²⁹⁾. Together, this evidence indicates a need for widespread reduction in HFSS foods served to early years children in ECECs.

This study, alongside existing research, has consistently found that lunchboxes have poorer dietary quality (reflected by a lower EDS score) compared to ECEC provided food, with previous studies also reporting excess energy, fat, saturated fat, free sugars, and sodium in lunchboxes served in ECECs^(14, 17). Poor dietary quality of lunchboxes was also identified in primary and secondary

schools in England^(30, 31), highlighting the importance of optimising healthy food provision in educational settings rather than relying on food brought from home to meet children's dietary needs.

Our findings showed that consumed lunches often had greater adherence to dietary recommendations than served lunches, including for energy, starchy carbohydrates, fat, and saturated fat. This finding is consistent with a study that reported nutrient consumption had greater alignment to free sugars and saturated fat recommendations compared to served lunches⁽¹⁴⁾. The difference observed in energy consumed compared to energy served may be due to appetite self-regulation (ASR), an executive function developed in early childhood to maintain a 'healthy' energy balance⁽³²⁾. ASR, alongside biological satiation cues, contribute to appetite control and can ultimately prevent 'overconsumption' of energy^(33, 34). Self-regulating mechanisms could therefore explain why excess provision of energy did not result in excess consumption. Whilst evidence indicates that generally early years children can self-regulate consumption, excess provision of energy could lead to overconsumption, contributing to overweight and obesity risk, particularly for the 22% of young children who are avid eaters^(35, 36). Moreover, reducing the quantity of food served at lunchtime may be beneficial to ECECs and parents to decrease costs and food waste, and ensure food is more likely to align with dietary recommendations.

Excess provision of energy and other nutrients in lunches served by ECECs and in lunchboxes, could indicate that providers and parents are not utilising nutrition guidance available. This is supported by previous studies that reported low awareness and implementation of nutrition guidance in ECECs and for parents⁽³⁷⁻³⁹⁾. Furthermore, both parents and ECEC providers have cited reliance on best judgment estimates for portion sizes rather than weighing food items as recommended⁽³⁸⁾, a practice that is likely to contribute to overestimation of energy and nutrient provision⁽⁴⁰⁾. The recently published (2025) Early years foundation stage (EYFS) nutrition guidance includes some portion size recommendations⁽⁴¹⁾ which may promote better portion size practices in ECECs.

We found that all lunches exceeded recommendations for free sugars, with lunchboxes containing over five times the recommendation. The National Diet and Nutrition Survey (NDNS) reported greater compliance to the free sugar recommendation, reporting 27% of children aged 18 months to 3 years met the recommendation, compared to 8% and 23% (served and consumed) in our study⁽⁶⁾. The differences in compliance could be attributed to the data collection method, as the NDNS utilises a 24-hour dietary recall method, completed by parents/carers across four days, whereas our study used the RFPM to capture data for one meal occasion. 24-hour dietary recall can also be subject to bias resulting in an underestimation of sugar consumption⁽⁴²⁾. The NDNS reported notably lower compliance for children aged 4-to 10 years (8% compliance), indicating that

generally free sugar consumption in children in the UK does not meet recommendations⁽⁶⁾. The high free sugar consumption observed for children in England has concerning health implications, such as increased risk of overweight and obesity and dental caries⁽⁴³⁾. Additionally, the low compliance reinforces the need for Government strategies targeting HFSS foods in ECECs⁽⁴¹⁾, as well as broader public health initiatives such as restricting promotions of HFSS and the Soft Drinks Levy^(44, 45).

This study found limited evidence of differences in the dietary quality of ECEC provided lunches across deprivation levels, however there was evidence that served lunchboxes in the most deprived areas had lower dietary quality than lunchboxes in the least deprived areas. This was consistent with previous studies that found lunchboxes in the most deprived areas contained more free sugars and less fibre, and more commonly contained cakes and biscuits than lunchboxes in the least deprived areas^(15, 17). Although greater deprivation is generally associated with poorer dietary quality in children⁽¹³⁾, there is evidence of greater adherence to recommended feeding practices in ECECs in the most deprived areas⁽²⁰⁾. The limited evidence of differences found in this study highlights the importance of ECEC as a source of healthy food provision for early years children across all deprivation levels, and the impact of increasing lunchbox provision (due to childcare funding changes) could have on children's diets in the most deprived areas. Universal provision of ECEC lunches for all children could therefore help reduce health-related inequalities.

We found that the majority of food waste was from fruit and vegetables. This was similarly observed in previous research from preschools in the USA⁽¹⁸⁾. A cost analysis of foods in the UK identified that fruit and vegetables were the most expensive food group (£ per 100kcal), with bread and other starchy carbohydrates as the least expensive⁽⁴⁶⁾. ECECs and parents may therefore be inclined to decrease provision of fruit and vegetables to reduce waste and costs due to rising costs of living⁽⁴⁷⁾, and in doing so, cause a reduction in dietary quality.

Our analysis also identified that there was greater waste of starchy carbohydrates and proteins from lunchboxes than ECEC provided lunches. It is important to consider that this food waste may not ultimately be wasted, as leftover food could be returned in the lunchbox and consumed at a later time. This is likely, as we know that parents may pack surplus food in lunchboxes to cater to child preferences with anticipation that some will be returned⁽⁴⁸⁾, and rely on packaged foods, often energy-dense and UPF, that will not perish⁽⁴⁹⁾, contributing to the higher energy provision and lower dietary quality observed for lunchboxes.

Implications

Research

The poorer dietary quality observed for lunchboxes in comparison to ECEC provided lunches highlights a need for intervention to improve dietary quality in lunchboxes. However, interventions targeting ECECs and parents providing lunchboxes have shown limited success at improving nutritional outcomes^(21, 50). Future research should therefore explore how population level strategies such as universal meal provision could be effectively implemented in ECECs in England to improve dietary quality, focusing on ECECs in the most deprived areas to ensure future interventions and governmental strategies benefit children experiencing dietary inequalities. Future research should also investigate why there were differences in served and consumed lunches in ECECs and how this impacts food wasted.

The introduction of the EYFS nutrition guidance for ECECs could be key in improving guidance adherence and dietary quality of lunches served in ECECs, although future research is needed to evaluate its effectiveness and explore barriers to implementation and compliance.

Policy

Our findings showing poor dietary quality, reflected by a lower EDS score, in lunchboxes from the most deprived areas emphasises the importance of lunches provided by ECECs as an opportunity to reduce health inequalities for children. Sources of grey literature have indicated that sending a lunchbox is often more cost-effective for parents than paying ECEC consumable fees⁽⁵¹⁾. The recent funding changes to ECECs, as well as the rising cost of food, will only exacerbate the costs to settings to provide lunches, potentially driving an increase in lunchboxes and thus a reduction in dietary quality provision in ECECs. Furthermore, the EYFS nutrition guidance provides limited information for ECECs on managing food brought in from home and does not provide specific guidance for parents⁽⁴¹⁾, indicating a need for more support for ECECs and parents to deliver lunchboxes that meet dietary requirements.

The need for greater adherence to dietary recommendations in ECECs and by parents was evident in these analyses. The recent EYFS nutrition guidance could promote better adherence in ECECs; however, the effectiveness is likely to be limited by factors such as lack of nutrition training in ECECs, funding, and staff shortages^(11, 20). Additionally, the guidance is not enforced or monitored by the Department for Education or ECEC inspectorates, which could contribute to the lack of adherence. Greater levels of enforcement, increased support and funding for ECECs would be beneficial to promote better guidance adherence.

Strengths and limitations

One main strength of this study was the creation of the EDS as a measure of dietary quality for meals served and consumed in ECECs. This score is, to the best of our knowledge, the first dietary

quality score to combine nutrient recommendations for early years children (aged 4 to-6 years) and food group recommendations from the EYFS nutrition guidance for ECECs. The EDS can be used in future research as a comprehensive measure of dietary quality for early years and can be adapted for international guidance to widen its impact. Another strength of this research is the inclusion of consumption and waste data in the analyses, which are under-studied in research and provide greater insight into how provision translates to consumption and waste. Additionally, the use of RFPM for data collection ensured nutrient estimations were subjected to limited bias and had high accuracy. The inclusion of three areas in England (Somerset, Swindon, Sandwell) with varying demographic and deprivation profiles is another strength of this study, as this more accurately captured the food served, consumed, and wasted in ECECs in England, in comparison to previous studies that have focused on a singular region of England^(14, 20).

This study also had several limitations. For example, the binary nature of the EDS reduced the sensitivity of the score, and the fixed weighting of each category may not accurately represent the importance of each category. Future versions of the EDS could improve the sensitivity and scope of the score by increasing the number of nutrient and food group categories and reducing the use of binary thresholds. Another limitation of the study was the exclusion of other mealtimes and snacks provided by ECECs, as lunchboxes may be more likely to include food for all mealtimes rather than just food for lunchtime, potentially resulting in an overestimation of lunchboxes relative to ECEC lunches. Additionally, the lower provision and consumption of dairy for ECEC provided lunches could be attributed to the exclusion of snacks or breakfast, which may be more likely to contain dairy products⁽⁵²⁾.

Conclusion

In conclusion, this study found that lunches served by ECECs and in lunchboxes generally did not meet most nutrient and food group recommendations. Consumed lunches were more aligned with recommendations, but still contained excess free sugars and protein, and were deficient in fibre. Additionally, the majority of food wasted was fruit and vegetables, contributing to the inadequate dietary quality intake. We found that lunchboxes had poorer dietary quality in comparison to ECEC provided lunches, with notably poorer quality in lunchboxes from the most deprived areas; this highlights the importance of ECEC provided lunches as a source of nutrition and emphasizes the risk that increasing reliance on lunchboxes may have on the diet of early years children. Future research should explore population level solutions such as universal meal provision for ECECs and the effectiveness of the EYFS nutrition guidance in improving the dietary quality of lunches in ECECs.

References

1. The Lancet (2025) Childhood obesity: a global health crisis. *The Lancet* 406, 1193.
2. Department of Health & Social Care (2025) *National Child Measurement Programme annual report, academic year 2024 to 2025*.
3. Liberali R, Kupek E Assis MAAd (2020) Dietary Patterns and Childhood Obesity Risk: A Systematic Review. *Childhood Obesity* 16, 70-85.
4. Ness AR, Maynard M, Frankel S *et al.* (2005) Diet in childhood and adult cardiovascular and all cause mortality: the Boyd Orr cohort. *Heart* 91, 894-898.
5. Tandon PS, Tovar A, Jayasuriya AT *et al.* (2016) The relationship between physical activity and diet and young children's cognitive development: A systematic review. *Prev Med Rep* 3, 379-390.
6. Office for Health Improvement & Disparities (2025) National Diet and Nutrition Survey 2019 to 2023: report <https://www.gov.uk/government/statistics/national-diet-and-nutrition-survey-2019-to-2023/national-diet-and-nutrition-survey-2019-to-2023-report#contents> (accessed 18 June 2026)
7. Emmett PM & Jones LR (2015) Diet, growth, and obesity development throughout childhood in the Avon Longitudinal Study of Parents and Children. *Nutr Rev* 73 Suppl 3, 175-206.
8. Department for Education (2025) Childcare and early years survey of parents. *Reporting year 2024*. <https://explore-education-statistics.service.gov.uk/find-statistics/childcare-and-early-years-survey-of-parents/2024> (accessed 18 June 2026)
9. Department for Education, S M B P (2024) Over £2 billion boost to secure expansion in early education. <https://www.gov.uk/government/news/over-2-billion-boost-to-secure-expansion-in-early-education> (accessed 18 June 2026)
10. UK Government (n.d) Free Childcare for Working Parents. <https://www.gov.uk/free-childcare-if-working/what-youll-get> (accessed 18 June 2026)
11. Warren E, Williams L Knai C (2022) The "Cinderella sector": The challenges of promoting food and nutrition for young children in early years' settings in England. *Ecology of Food & Nutrition* 61, 576-594.
12. National Day Nurseries Association (2021) Stop Underfunding- Start Building Futures England. https://ndna.org.uk/wp-content/uploads/2021/09/1258_NDNA_A4_Report_PDF_England_AW-1.pdf (accessed 18 June 2026)
13. Thomas F, Thomas C, Hooper L *et al.* (2019) Area deprivation, screen time and consumption of food and drink high in fat salt and sugar (HFSS) in young people: results from a cross-sectional study in the UK. *BMJ Open* 9, e027333.
14. Wall CJ & Pearce J (2026) Lunch Provision, Consumption and Plate Waste in Early Years Settings in Sheffield. *Maternal & Child Nutrition* 22, e70132.
15. Deb S, Harris M, Hawkins M *et al.* (2026) Dietary patterns and nutritional composition of packed lunches in early years education settings. *medRxiv*, 2026.2003.2003.26347536.
16. Maishman R, Toumpakari Z, Turner A *et al.* (2026) Lunches in UK early years education and care settings: cross-sectional analysis of food processing, provision and intake. *Res Sq.*
17. Pearce J & Wall CJ (2025) Packed Lunch Provision and Consumption in Early Years Settings in Sheffield: A Cross-Sectional Study. *Journal of Human Nutrition and Dietetics* 38, e70066.
18. Niaki SF, Moore CE, Chen TA *et al.* (2017) Younger Elementary School Students Waste More School Lunch Foods than Older Elementary School Students. *J Acad Nutr Diet* 117, 95-101.
19. Scherer L, Rueda O Smetana S (2023) Chapter 14 - Environmental impacts of meat and meat replacements. In *Meat and Meat Replacements*, pp. 365-397 [HL Meiselman and J Manuel Lorenzo, editors]: Woodhead Publishing.

20. Turner A, Porter A, Murphy M *et al.* (2025) Food Policy, Practice, and Provision in UK Early Childhood Education and Care: A Scoping Review. *Public Health Nutrition*, 1-35.
21. Kipping R, Anne Simpson S, Hannam K *et al.* (2026) Effectiveness of an environmental nutrition and physical activity intervention in early childhood education and care settings (NAPSACC UK): a multicentre cluster randomised controlled trial. *The Lancet Regional Health – Europe* 61.
22. Martin CK, Nicklas T, Gunturk B *et al.* (2014) Measuring food intake with digital photography. *J Hum Nutr Diet* 27 Suppl 1, 72-81.
23. Buckland G, Northstone K, Emmett PM *et al.* (2023) Adherence to UK dietary guidelines in school-aged children from the Avon Longitudinal Study of Parents and Children (ALSPAC) cohort. *British Journal of Nutrition* 130, 454-466.
24. Scheelbeek P, Green R, Papier K *et al.* (2020) Health impacts and environmental footprints of diets that meet the Eatwell Guide recommendations: analyses of multiple UK studies. *BMJ Open* 10, e037554.
25. Ministry of Housing CLG (2025) The English Indices of Deprivation 2025. https://assets.publishing.service.gov.uk/media/68ff547a49d08dd781b48351/ID_2025_Research_Report.pdf (accessed 04 November 2025)
26. Cole TJ, Freeman JV Preece MA (1995) Body mass index reference curves for the UK, 1990. *Arch Dis Child* 73, 25-29.
27. Porter A, Kipping R, Summerbell C *et al.* (2020) What guidance is there on portion size for feeding preschool-aged children (1 to 5 years) in the United Kingdom and Ireland? A systematic grey literature review. *Obes Rev* 21, e13021.
28. Parker M, Lloyd-Williams F, Weston G *et al.* (2011) Nursery nutrition in Liverpool: an exploration of practice and nutritional analysis of food provided. *Public Health Nutr* 14, 1867-1875.
29. Goldbohm RA, Rubingh CM, Lanting CI *et al.* (2016) Food Consumption and Nutrient Intake by Children Aged 10 to 48 Months Attending Day Care in The Netherlands. *Nutrients* 8, 428.
30. Haney E, Parnham JC, Chang K *et al.* (2023) Dietary quality of school meals and packed lunches: a national study of primary and secondary schoolchildren in the UK. *Public Health Nutr* 26, 425-436.
31. Stevens L, Nicholas J, Wood L *et al.* (2013) School lunches v. packed lunches: a comparison of secondary schools in England following the introduction of compulsory school food standards. *Public Health Nutrition* 16, 1037-1042.
32. Russell CG & Russell A (2025) Appetite self-regulation in childhood: A narrative review and conceptual model of processes and mechanisms with implications for research and practice. *Nutrition Reviews* 83, 1784-1799.
33. Blundell JE, Lawton CL Hill AJ (2008) Mechanisms of Appetite Control and their Abnormalities in Obese Patients. *Hormone Research* 39, 72-76.
34. Bridgett DJ, Hughes SO, Broussard M *et al.* (2026) The role of top-down appetite self-regulation in the development of healthy eating behaviors among children: a narrative review and socialization framework. *Appetite* 218, 108384.
35. Francis LA & Susman EJ (2009) Self-regulation and Rapid Weight Gain in Children From Age 3 to 12 Years. *Archives of Pediatrics & Adolescent Medicine* 163, 297-302.
36. Pickard A, Croker H, Edwards K *et al.* (2023) Identifying an avid eating profile in childhood: Associations with temperament, feeding practices and food insecurity. *Appetite* 191, 107050.
37. Porter A, Langford R, Summerbell C *et al.* (2023) A qualitative exploration of food portion size practices and awareness of food portion size guidance in first-time parents of one- to two-year-olds living in the UK. *BMC Public Health* 23, 1779.

38. Quirke-McFarlane S, Carstairs SA Cecil JE (2024) 'You just eyeball it': Parent and nursery staff perceptions and influences on child portion size: A reflexive thematic analysis. *Nutrition and Health*, 2601060241245255.
39. Warren E, Boadu P, Exley J *et al.* (2024) Knowledge and use of voluntary food and drink guidelines in English nurseries? Results from a nationally representative cross-sectional study. *Food Policy* 122.
40. Johnson SL, Hughes SO, Cui X *et al.* (2014) Portion sizes for children are predicted by parental characteristics and the amounts parents serve themselves¹²³⁴⁵. *The American Journal of Clinical Nutrition* 99, 763-770.
41. Department for Education (2025) Early Years Foundation Stage nutrition guidance https://assets.publishing.service.gov.uk/media/67f8e61c04146682e61bc84c/Nutrition_guidance_for_early_years_providers.pdf (accessed 18 June 2026)
42. Foster E & Bradley J (2018) Methodological considerations and future insights for 24-hour dietary recall assessment in children. *Nutrition Research* 51, 1-11.
43. Bleich SN & Vercammen KA (2018) The negative impact of sugar-sweetened beverages on children's health: an update of the literature. *BMC obesity* 5, 6.
44. Department of Health & Social Care (2023) Restricting promotions of products high in fat, sugar or salt by location and by volume price: implementation guidance. <https://www.gov.uk/government/publications/restricting-promotions-of-products-high-in-fat-sugar-or-salt-by-location-and-by-volume-price/restricting-promotions-of-products-high-in-fat-sugar-or-salt-by-location-and-by-volume-price-implementation-guidance> (accessed 18 June 2026)
45. HM Revenue & Customs (2024) Soft Drinks Industry Levy uprating. <https://www.gov.uk/government/publications/increasing-the-rates-of-the-soft-drinks-industry-levy/soft-drinks-industry-levy-uprating> (accessed 18 June 2026)
46. Hoenink JC, Garrott K, Jones NRV *et al.* (2024) Changes in UK price disparities between healthy and less healthy foods over 10 years: An updated analysis with insights in the context of inflationary increases in the cost-of-living from 2021. *Appetite* 197, 107290.
47. Francis-Devine B & UK Parliament (2026) High cost of living: Impact on households. <https://commonslibrary.parliament.uk/research-briefings/CBP-10100/> (accessed 18 June 2026)
48. Lalchandani NK, Miller C, Hume C *et al.* (2025) Family Perspectives on Packing a Low-Waste and Nutritious School Lunchbox. *Journal of Nutrition Education and Behavior* 57, 809-820.
49. Lalchandani NK, Hume C, Giles L *et al.* (2025) Sneak peek: food, waste and packaging characteristics of South Australian school children's lunchboxes. *Public Health Nutrition* 28, e52.
50. Nathan N, Janssen L, Sutherland R *et al.* (2019) The effectiveness of lunchbox interventions on improving the foods and beverages packed and consumed by children at centre-based care or school: a systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity* 16, 38.
51. Learner S (2026) Nursery top-up fees Guidance on additional charges 2026. <https://www.daynurseries.co.uk/advice/nursery-top-up-fees-are-they-legal#h-nurseries-charging-top-up-fees-look-set-to-increase> (accessed 18 June 2026)
52. Park SY, Zheng M, Lacy KE *et al.* (2025) On-site breakfast provision in early childhood education and care (ECEC) services in Australia: a multi-method investigation. *European Journal of Nutrition* 64, 78.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryMaterials1.docx](#)
- [SupplementaryMaterials2.docx](#)