



## Adolescents' food choice patterns at school: A data driven approach

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### ABSTRACT

Diet quality is critical during adolescence, given the nutritional requirements and developmental changes. Foods that adolescents choose at school can contribute a considerable proportion to their dietary intake. This study's aim was to examine adolescents' food choice patterns in secondary school. Food selection data across an academic year for students (11-18 years) attending a secondary school in England were examined. Food choice profiles for students ( $n = 857$ ) were derived, and cluster analysis was performed to determine food choice patterns. Associations between cluster membership and characteristics (sex, year group, free school meal status) were examined. Five clusters were differentiated based on adolescents' selection of foods and beverages. Clusters were characterised by dominant items: 'sandwich combo fans' ( $n = 340$ ), 'break time snackers' ( $n = 196$ ), 'traybake enthusiasts' ( $n = 161$ ), 'pizza lovers' ( $n = 147$ ) and 'healthy lunchers' ( $n = 13$ ). The preponderance of a few items across clusters, specifically cookies and traybakes was notable, as was the relative size of the clusters. Significant associations were found between cluster membership and year group, free school meal status and sex, all with small effect sizes ( $\eta^2 = 0.19, 0.18$  and  $0.13$ , respectively). This study provides important insights into adolescents' food choice patterns during the school day, specifically the general dominance of cookies and traybakes, as well as the very small number of 'healthy lunchers'. Findings point to future work to examine the relative popularity of items, as well as targeted interventions to support adolescents' dietary health.

### 1. Introduction

Overweight and obesity prevalence in adolescents is of global concern. A meta-analysis of studies across 154 countries reported significantly higher obesity prevalence in children and adolescence during 2012-2023 (11.3%) compared to 2000-2011 (7.1%) (Zhang et al., 2024). The Health Survey for England 2022 reported over a quarter (28%) of 11-15-year-olds are living with overweight, including obesity (NHS Digital, 2024). Adolescent obesity, driven by a positive energy balance, can be exacerbated by multiple individual, societal and community-level influences, including at school (Kansra et al., 2021). Further, diet and physical activity have been highlighted as important modifiable factors to lower the risk in young people (Mahumud et al., 2021).

The relevance of diet on adolescents' health outcomes is acknowledged, including with respect to physical health, psychosocial functioning, and school functioning (Wu et al., 2019). Unhealthy dietary behaviours (Moore Heslin & McNulty, 2023) and living with obesity (Horesh et al., 2021) can also increase susceptibility to disease later in life, with for example, atherosclerosis development observed and

accelerated into adulthood (McGill et al., 2002). Further, poor dietary patterns established in adolescence can track into adulthood (Appannah et al., 2021), impacting long term health outcomes (Moore Heslin & McNulty, 2023). To this end, adolescence presents an opportune time to support the formation and establishment of healthy dietary behaviours (Patton et al., 2016), particularly given that it is a nutritionally vulnerable life stage, marked by considerable developmental changes, and with elevated nutritional requirements, where special attention is needed, given its implication for later adult health (Das et al., 2017).

Adolescents' diets are typically characterised by frequent intakes of sugar sweetened beverages and low fruit and vegetable consumption (Beal et al., 2019). Moreover, the UK's National Diet and Nutrition Survey indicates that a minority of 11-18 year olds meet recommendations for fruit and vegetables, and fibre (9% and 4%, respectively), and most exceed the recommended limit for free sugars and saturated fat (95% and 84% of 11-18 year olds, respectively) (Office for Health Improvement & Disparities, 2025).

Pivotal to supporting adolescents' dietary health is understanding their food choice. This is a complex and multifaceted domain, where food decisions are constructed individually based on interrelated

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concepts that are themselves dynamic (Sobal et al., 2014). Schools provide an important setting to try to better understand adolescents' food choice. Further, with students attending school for 190 days out of a year (Long, 2023), where they can consume one or potentially two meals (with breakfast), as well as snacks, foods chosen within a school setting can provide an important contribution to their daily diet. Previous research has examined students' selections of food and beverages (Ensaiff et al., 2013; Lambert et al., 2005), adolescents' beverage choice patterns (Ensaiff et al., 2016) and school lunch patterns in primary school (François et al., 2025). This study aimed to investigate adolescents' food choice in a school environment and to explore food choice patterns, including across student characteristics.

## 2. Methods

### 2.1. Study population and food choice data

This study relates to a secondary school with students, aged 11-18 years, in Northern England. At the school, a fifth of students were eligible for free school meals (FSM). FSM is a means-tested support for students whose families are in receipt of certain benefits (Department for Education, 2024), and is often used as a proxy measure of socio-economic disadvantage (Office for National Statistics, 2022). The school's FSM profile was above the national average (at the time) (Department for Education, 2018). A smaller proportion (10%) of students in the school were from minority ethnic origins, compared to the national average (Department for Education, 2018), and less than 5% had English as an additional language. The school was in an urban area, with a moderate number of hot food takeaway outlets in the locality, and the school had a stay on site policy. In England, school food standards (The Requirements, 2014) restrict the provision of food and beverages in schools – and as is typical in secondary schools, there was a canteen on site for students to use. Catering in the school was provided by a catering company. Break and lunchtimes were 20 and 30 min, respectively, and were staggered; breakfast was also available for students.

Detailed discussions were held with the school management about the study and what participation would entail. Following agreement from the school and parental informed consent, anonymised food choice data for the academic year 2017-2018 were collected. These data comprised all foods and beverages selected by students at the school canteen. The canteen utilised a 3-week menu cycle, and students chose from various food and beverage items. Different daily specials (a meat/fish-based meal and a vegetarian meal) were available; these meals typically formed the backbone of menu cycles for secondary schools in England, contributing to meeting nutrient-based standards (previously in place). Alongside the daily specials, there were other savoury options (e.g. pasta, pizza, sandwiches), a daily dessert (e.g. pudding and custard) and other sweet items such as cookies and traybakes. At the till, catering staff keyed in students' food and beverage selections, with payment made directly from the student's system account.

### 2.2. Food categories

All selections were grouped into five main categories (i.e. main foods, desserts, break and morning snacks, beverages and miscellaneous) and their respective subcategories. Categorisation was according to food type, availability, previous literature, as well as discussion within the team. For example, break and morning snacks were available (and predominantly selected) during the morning (rather than at lunchtime), and desserts included cookies and traybakes, fruit, and other desserts. All main categories of items (except 'miscellaneous' which comprised occasional items, e.g. sachets of sauce) were subdivided; for example, beverages had five subcategories, i.e. water (unflavoured bottled water), juice-based drinks, milk-based drinks, pure juice, and plain milk. Likewise, main foods were subdivided into six subcategories, i.e. daily specials, sandwiches (including baguettes, paninis, wraps),

pasta (e.g. pasta with sauce), pizza (e.g. slice of meat pizza), jacket potatoes (e.g. with cheese, beans, tuna), and salads (e.g. cold pasta salad). Break and morning snacks included pastries and sweet snacks (e.g. doughnuts) and savoury snacks (e.g. bacon rolls).

### 2.3. Data analysis

The dataset was analysed using IBM SPSS statistics software (IBM Corp, Armonk, NY, USA). Initially, data were checked for missing values and inconsistencies (such as missing year groups, transactions outside school hours, one-off items); these were deleted and amounted to 1.6 % of the raw dataset. Students who made selections on less than ten days across the academic year were deemed to have limited use of the canteen and were excluded for the analysis (67 students); this threshold of ten days had been used previously in other work (Ensaiff et al., 2016). A food choice profile was developed for each student, which comprised their frequency selections for each subcategory (as a percentage of their total selections).

Dietary pattern analysis is an approach to examine populations' diets and assesses diet as a whole, rather than focussing on individual nutrients (Hu, 2002). Widely known methods include data-driven approaches such as cluster analysis (Greve et al., 2015), which has been used previously to determine dietary patterns among young adolescents (Araújo et al., 2015). Cluster analysis has also been used to determine beverage choice patterns in secondary school, with findings highlighting how students' beverage choices can substantially contribute to their sugar intake (Ensaiff et al., 2016).

In this study, k – means cluster analysis was conducted to divide students into mutually exclusive groups based on their food choice profiles; individuals within clusters would have greater similarity to each other, than to individuals in other clusters. The optimal number of clusters was judged to be five (informed by an inspection of the scree plot, preliminary hierarchical cluster analysis and a dendrogram of the clustering, as well as discussion within the team) and cluster analysis was conducted to differentiate five clusters of students. For each cluster, students' mean selections across food subcategories were assessed, and clusters were defined by their dominant subcategories.

Chi square tests were conducted to assess the associations between cluster membership and students' demographic characteristics, specifically sex, year group (proxy indicator for age), and free school meal (FSM) status (receipt of free school meals). Significance was determined at  $p < 0.05$  and the strength of the associations was established using effect sizes ( $\phi$ ), according to guidelines (Cohen, 1977). Ethical approval for the study was granted by the University of Leeds Faculty Research Ethics Committee.

## 3. Results

The final dataset comprised over two hundred thousand selections (267,958), and corresponded to 104 different food and beverage items, selected by 857 students, across 187 school days. Just under fifteen hundred items (1,433) were selected every day. Almost three quarters of selections were foods (73.5%) with the remainder, beverages (26.5%). Of all subcategories, cookies and traybakes had the highest mean daily uptake (355 per day), followed by savoury snacks (249 per day). Water (146 per day) and juice-based drinks (140 per day) were the beverages with the highest daily selection rates. There were slightly more female students (51.8%), although males made more selections (51.4%). Over a quarter of students using the canteen were registered for FSM (27.1%) and made proportionately more selections overall (29.8%) than other students. There was a general trend of younger students using the canteen more, with for example 11-12 year olds making more than a quarter (29.6%) of all selections, compared to older students, 14-15 years old, with fewer purchases (15.5%).

### 3.1. Food choice patterns

Cluster analysis derived five distinct clusters, and these were defined by their dominant subcategories, i.e. ‘sandwich combo fans’, ‘break time snackers’, ‘traybake enthusiasts’, ‘pizza lovers’ and ‘healthy lunchers’. Table 1 presents the characteristics of adolescents within each cluster, in terms of year group, FSM and sex, as well as their mean selections (as a % of selections made). Fig. 1 presents the patterns for the five clusters for the main categories and subcategories.

The largest cluster was *sandwich combo fans*, comprising two fifths (39.7%) of students, and with a high selection of beverages (mean selection of 31.8%, i.e. for students in this cluster, beverages comprised almost a third of selections made), cookies and traybakes (22.4%) and main foods (mostly sandwiches (12.8%)). This was followed by *break time snackers* (22.9%) who chose savoury snacks (mean selection 43.7%), and *traybake enthusiasts* (18.8%) whose selections were dominated by cookies and traybakes (mean selection 54.3%). Pizzas (with a

**Table 1**  
Demographic characteristics of adolescents (n = 857) and their mean selection of foods and beverages at school, across clusters.

	Sandwich combo fans n = 340 (39.7%)	Break time snackers n = 196 (22.9%)	Traybake enthusiasts n = 161 (18.8%)	Pizza lovers n = 147 (17.2%)	Healthy lunchers n = 13 (1.5%)
<b>Characteristics (%) by cluster</b>					
<b>Year group</b>					
Year 7	35.9	16.8	13.7	22.4	23.1
Year 8	17.4	13.8	26.1	22.4	15.4
Year 9	17.6	15.8	21.1	27.2	7.7
Year 10	13.5	16.8	18.6	17.7	30.8
Year 11	11.8	23.5	20.5	8.2	0.0
Year 12	3.2	8.7	0.0	0.7	7.7
Year 13	0.6	4.6	0.0	1.4	15.4
<b>Sex</b>					
Female	47.6	50.5	52.8	63.9	30.8
Male	52.4	49.5	47.2	36.1	69.2
<b>FSM eligibility</b>					
	36.2	18.9	23.0	20.4	38.5
<b>Mean selection of food and beverage categories (%) by cluster</b>					
<b>Beverages</b>	31.8	19.5	20.0	22.3	15.2
Water	12.8	9.0	8.3	8.6	6.7
Juice-based	10.6	6.1	5.8	9.7	5.1
Milk-based	6.2	3.3	5.1	2.8	3.0
Pure juice	2.2	0.9	0.8	1.2	0.4
Plain milk	0.1	0.0	0.0	0.0	0.0
<b>Desserts</b>	23.5	14.3	54.8	26.7	12.2
Cookies & traybakes	22.4	13.5	54.3	25.8	10.5
Fruit	0.6	0.5	0.3	0.5	0.9
Other desserts	0.5	0.3	0.2	0.4	0.9
<b>Main Foods</b>	31.3	19.2	19.0	42.6	63.1
Pizza	6.0	7.6	5.4	30.7	3.2
Pasta	4.5	2.0	4.6	2.2	0.9
Sandwiches	12.8	5.0	6.0	5.2	3.1
Daily Specials	2.7	2.4	1.3	2.6	49.1
Salads	4.4	1.5	1.1	1.0	0.7
Jacket Potatoes	1.0	0.7	0.6	0.9	6.1
<b>Break &amp; Morning snacks</b>	12.5	44.9	5.9	7.9	7.7
Savoury snacks	9.9	43.7	4.1	6.3	6.2
Pastries & sweet snacks	2.6	1.1	1.9	1.6	1.5
<b>Miscellaneous</b>	0.9	2.2	0.3	0.5	1.8
<b>Total selections n (%)</b>	116,900 (43.6%)	68,838 (25.7%)	37,279 (13.9%)	43,198 (16.1%)	1,743 (0.7%)

mean selection 30.7%) prevailed as the main category for the next cluster, *pizza lovers* (17.2%). The smallest cluster was *healthy lunchers* (1.5%) where half of selections were the daily specials (mean selection 49.1%), only popular among healthy lunchers.

The mean selection of beverages varied across clusters, ranging from 31.8% in *sandwich combo fans* to 15.2% in *healthy lunchers*. Among beverages, water featured strongly in four clusters, accounting for mean selections of 6.7-12.8%, overall. Juice-based drinks were also important, particularly in *sandwich combo fans* and *pizza lovers* with a mean selection of 10.6% and 9.7%, respectively.

Cookies and traybakes were the most selected subcategory for *traybake enthusiasts* (mean selection 54.3%) and for *sandwich combo fans* (mean selection 22.4%). Cookies and traybakes were also popular with *pizza lovers* (second only to pizzas themselves), *break time snackers* (second only to savoury snacks) and *healthy lunchers* (second only to daily specials).

### 3.2. Demographic characteristics of students in food choice clusters

Different year groups tended to dominate different clusters, e.g. year 7 (11-12 year olds) made up over a third of *sandwich combo fans* (35.9%), Year 8 students (12-13 year olds) were the largest group in the *traybake enthusiasts* (26.1%), and year 9 (13-14 year olds) comprised over a quarter (27.2%) of *pizza lovers*. Many *break time snackers* (23.5%) were in year 11 (15-16 year olds), and *healthy lunchers*, the smallest group, had a notable number of year 10 students (14-15 year olds) (30.8%). Interestingly, there were no *traybake enthusiasts* among older students in years 12 and 13 (16-18 years). When considering sex, similar proportions were in clusters, except for *pizza lovers*, where the majority were female (63.9%), and *healthy lunchers* where most were male (69.2%). The proportion of students registered for FSM was highest in *healthy lunchers* (38.5%) and *sandwich combo fans* (36.2%).

The distribution of year groups, sex, and FSM status across the five clusters is presented in Fig. 2. Overall cluster membership and year group were significantly associated, with a small effect size ( $X^2(24, 857) = 124.6, p < 0.001, \phi_c = 0.19$ ). For *break time snackers*, a clear trend was observed where the proportion in this cluster increased with age, i.e. 15.5% of 11-12 year olds (year 7) progressively increasing to 60.0% of 17-18 year olds (year 13) – and the association between membership of *break time snackers* and age was significant with a medium effect size ( $X^2(6, 857) = 54.2, p < 0.001, \phi_c = 0.25$ ). Conversely, for *sandwich combo fans*, the proportion of students decreased with age, i.e. 57.3% of year 7 to 13.3% of year 13 (although Year 12 was an exception to this trend) – with a significant moderate association between membership of *sandwich combo fans* and year group ( $X^2(6, 857) = 40.8, p < 0.001, \phi_c = 0.22$ ). For associations between year group and membership of all other clusters, effect sizes were smaller (*traybake enthusiasts* ( $X^2(6, 857) = 30.1, p < 0.001, \phi_c = 0.19$ ), *healthy lunchers* ( $X^2(6, 857) = 19.5, p = 0.003, \phi_c = 0.15$ ), *pizza lovers* ( $X^2(6, 857) = 17.5, p = 0.008, \phi_c = 0.14$ )).

Sex and cluster membership were significantly associated, ( $X^2(4, 857) = 13.5, p = 0.009, \phi_c = 0.13$ ), with a small effect size. Weak associations were found between sex and membership of *pizza lovers* ( $X^2(1, 857) = 10.5, p = 0.001, \phi = 0.11$ ) which had more females (63.9%), and with *sandwich combo fans* ( $X^2(1, 857) = 3.91, p = 0.048, \phi = 0.07$ ) which had more males (52.4%).

There was a significant association between FSM status and cluster membership ( $X^2(4, 857) = 26.5, p < 0.001, \phi_c = 0.18$ ), with significant weak associations between FSM status and membership for *sandwich combo fans* ( $X^2(1, 857) = 23.7, p < 0.001, \phi = 0.17$ ) with more than a third (36.2%) registered for FSM, and *break time snackers* ( $X^2(1, 857) = 8.64, p = 0.003, \phi = 0.10$ ), where less than a fifth were registered for FSM.

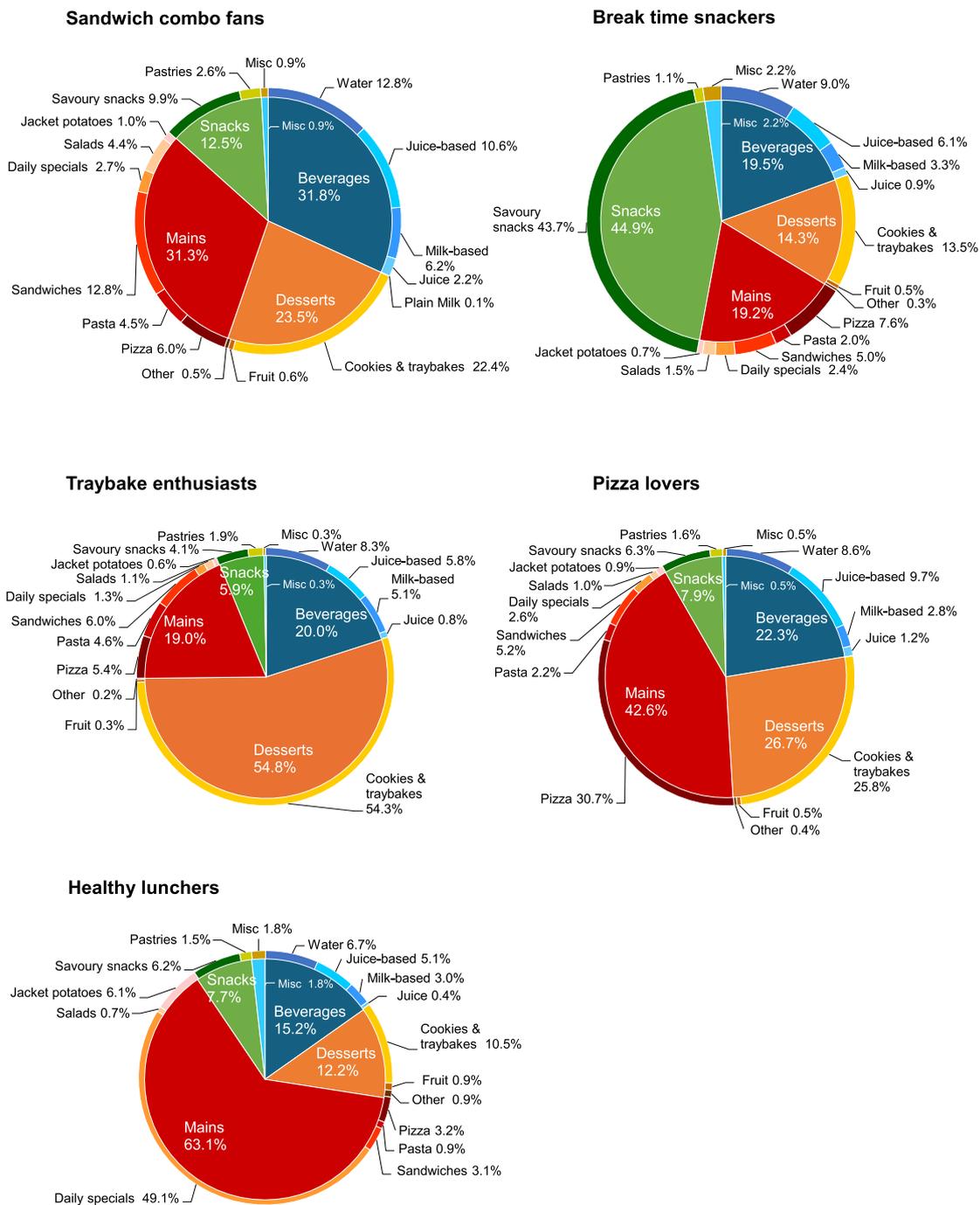


Fig. 1. Mean selections for foods and beverages at school, across clusters: sandwich combo fans, break time snackers, traybake enthusiasts, pizza lovers, and healthy lunchers. (Break & morning snacks category has been shortened to snacks; main foods category has been shortened to mains; pastries & sweet snacks subcategory has been shortened to pastries; other desserts subcategory has been shortened to other; pure juice subcategory has been shortened to juice).

4. Discussion

In this study, food choice patterns were determined for adolescents based on their selections across the school day, for a full academic year. Cluster analysis differentiated five mutually exclusive groups with distinct patterns: sandwich combo fans, break time snackers, traybake enthusiasts, pizza lovers and healthy lunchers. The largest cluster, sandwich combo fans, accounted for two-fifths of all students, with high selection of sandwiches, beverages, and cookies and traybakes. Conversely, the smallest cluster was healthy lunchers, where selections were dominated by the daily specials.

Most striking in the current study was the prominence of one

subcategory, cookies and traybakes, which made up a quarter of all selections made by adolescents. Cookies and traybakes also dominated the largest cluster, sandwich combo fans (accounting for more than a fifth of selections), and featured across all clusters, including its own cluster where more than half of selections were cookies and traybakes. This subcategory included items such as cookies, traybakes and muffins – and although their nutritional composition was beyond the scope of this analysis, these are typically sweet and sugar dense items. Their popularity is notable, particularly given the importance of improving students’ access to healthy and nutritious meals, and the School Food Standards (The Requirements, 2014), which intend to help students to develop healthy eating habits and restrict foods high in fat, salt, and

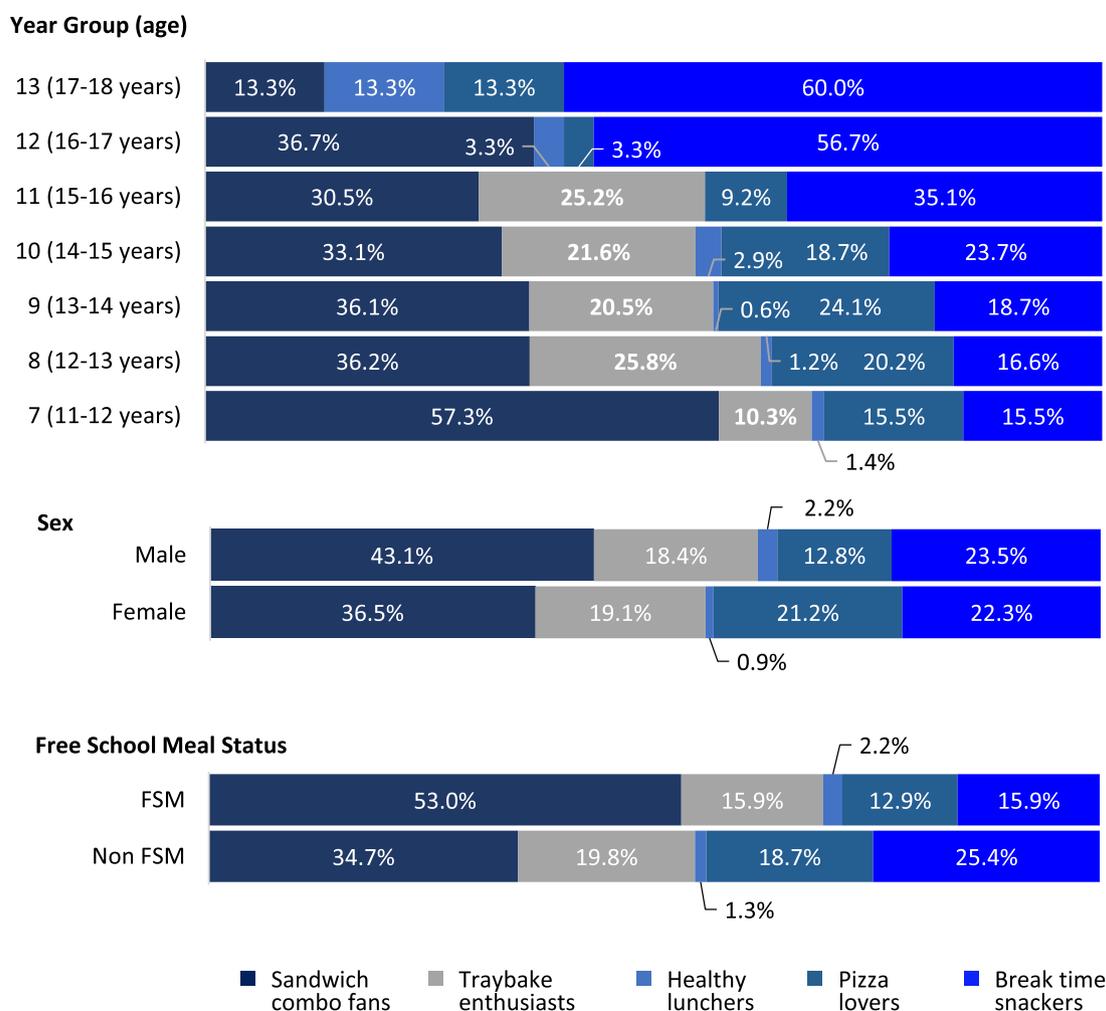


Fig. 2. Cluster membership of adolescents (n = 857) across year group, sex and free school meal status.

sugar (Department for Education, 2025).

The popularity of sweet items with adolescents has been observed previously, including in school-based studies (Ensauff et al., 2013; Haney et al., 2022; Kelly et al., 2021; Park et al., 2023). One study across two UK secondary schools found desserts to be among the most popular items, selected on at least a fifth of days, second only to pizza and sandwiches (Ensauff et al., 2013). Other work conducted in secondary schools in the Midlands has reported how desserts, cakes and biscuits accounted for a sizeable proportion (up to a third) of total sales in the canteens (Pallan et al., 2024). In another study examining Irish adolescents' perception of the local school food environment, students highlighted sweet snacks as popular choices (Kelly et al., 2021). Further, analysis of national data for children aged 4-16 years old has indicated that, with increasing age, a greater proportion of children's school meals contain sweet snacks (Haney et al., 2022).

In the present study, over a fifth of students were *break time snackers*, predominantly selecting savoury snacks (mostly bacon rolls, potato wedges and toast). Interestingly, this was the cluster with the strongest association with age, with an increasing proportion of older students. Previous research on food choices in secondary schools in England reported that unhealthy snacking is common among adolescents (11-13 years), who may opt to skip or replace meals with snacks (Calvert et al., 2020). Adolescents' dietary quality has also been reported to decline with increasing snacking frequency (when considering snacks that are not low energy) (Llauradó et al., 2016). Further work to examine adolescents' dietary behaviours, including preferences for savoury snacks

and their nutritional composition is recommended.

The dominance of snacks and sweet treats in the present study may be related to their convenient and grab-and-go nature, compared to, for example, the daily specials. Another contributory factor may be the duration of break and lunchtimes, which were 20 and 30 min, respectively and staggered. Most secondary schools have morning breaks that last 20 min, and approximately half of schools have lunchtimes less than 45 min (Baines & Blatchford, 2019); interestingly, a reduction of 65 min per week overall has been noted since the mid-1990s (Baines & Blatchford, 2019). Lunchtime observations and interviews with canteen staff at three middle schools in Wales, revealed how students (11-14 years) preferred to select convenience foods, like cakes, over plated meals due to time constraints during lunch (Gilmour et al., 2021). Likewise, queues have been reported to be a barrier to students choosing meals at lunchtime, instead opting for 'on the go' items (Devine et al., 2023). One study involving young adolescents (11-13 year olds) reported how long queues deterred them from using the school canteen – and how long queues and limited food availability sometimes meant that they missed out on their desired options (Gilmour et al., 2020). Adolescents also explained how they might opt for foods based on wanting to queue with their peers (Gilmour et al., 2020). Other aspects of the dining environment, such as inadequate seating space, can also play a role. This emerged as an important issue for adolescents (13 – 18 years old) participating in youth-led panel discussions, where they explained how they might instead eat outside, standing up, or in some cases, skip lunch altogether (Bite Back, 2021).

Beverages featured across clusters, to varying degrees, with mean selections ranging from approximately 15% to just over double this. It is notable that, out of all beverages, water featured strongly in four of the five clusters, (with juice-based drinks highest for *pizza lovers*). Previous research at two secondary schools, reported a third of all items selected were beverages, with juice-based drinks being the most frequently chosen beverage (Ensaiff et al., 2016). The stronger presence of water in the present study (compared to previous work) may reflect ongoing efforts to improve the school food environment, and the revised school food standards (which became statutory in the interim, in 2015); these stipulate the provision of water, restrict beverages to 'healthier drinks' and limit the portion size and minimum proportion of juice in juice-based drinks (The Requirements, 2014). Other analysis of sales data from multiple secondary schools has shown beverages to account for a substantial proportion of all items sold, with plain water accounting for up to 15%, (school food standards) compliant beverages up to 19% and non-compliant drinks up to 21% (Pallan et al., 2024).

A key finding of this study is that *healthy lunchers*, who selected the daily specials, comprised less than 2% of the total sample. The small size of this cluster, and the low selection of daily specials by all other adolescents, should be examined further. This is particularly relevant given that daily specials may have a more nutritionally favourable profile than other main food options; daily specials historically formed the backbone of a menu cycle in secondary school and contributed to an average lunch meeting the nutrient targets of the previous nutrient-based standards in England (no longer in place) (Crawley, 2005). Interestingly, one report advised that, despite the availability of vegetable and salad options in the canteen, they are mostly ignored or disposed (Guys & St Thomas Charity, 2020). The small size of the *healthy lunchers* cluster also corresponds with another study of school food choice, where the daily specials made up less than 8.7% of food selected and were not as popular as other options, such as sandwiches, pizzas and pasta (Ensaiff et al., 2013). Further research to consider the greater representation of students registered for FSM among *healthy lunchers* and *sandwich combo fans* would be valuable. This could provide an important appreciation and understanding of students' perspectives and associated relevant factors, including school food policies and canteen practices, e.g. pricing of items relative to FSM allowance.

A notable trend of older students visiting the canteen less than younger students was observed in the present study, alongside a shift towards more break time snacking with age. This was reflected in cluster membership, where more than half of year 12 and year 13 students in this study, were in the *break time snackers* cluster. The reasons behind these trends are unclear, however both may reflect older students opting for alternatives to school meals, such as bringing in their own food purchased on the way to school, or from home, or preferring to select snacks at break time (that they may also consume later). This corresponds with previous analysis of national data for 11-18 year olds, where the percentage of students consuming a school meal decreased with age (from more than three fifths for 11 year olds to less than a fifth for 18 year olds) (Taher et al., 2020). Further, differences with age may reflect changes in personal autonomy over food, e.g. older students moving from the more conventional lunch in the school canteen to selecting snacks at break time. This may reflect growing food autonomy, including from primary school, where, in one study with children (7-11 years), older children expressed that they exercised more control over their food choices (at school and home), whereas younger children's choices were influenced by their parents, e.g. setting rules on content of packed lunches (Warren et al., 2008). Other research highlighting differences with age includes a study with Australian adolescents, where selections of food items classified as healthier 'everyday' were selected more by older students than younger students (12-14 years) (Clinton-McHarg et al., 2021). To some extent, this aligns with the findings of the present study, where a larger proportion of older students were in the *healthy lunchers* cluster compared to younger students.

This study demonstrates the value of food choice data in examining

adolescents' food choice patterns. The duration of a complete academic year and the introduction of broad and narrow categories of foods and beverages, contributed to meaningful food choice patterns. This work adds to a growing body of research utilising food choice data from UK secondary schools, including work highlighting how students in receipt of FSM may be more likely to choose the more nutritionally valuable foods (Ensaiff et al., 2013), and work differentiating beverage choice patterns in UK adolescents (Ensaiff et al., 2016). Other research utilising food choice data has assessed the nutritional quality of food in nine Australian secondary schools (Clinton-McHarg et al., 2021).

Findings from the present study – specifically, the food choice patterns, the relative size of the clusters and the preponderance of certain items – point to further work, including with multiple schools and current data, and highlight the utility of food choice data. The nutritional composition of foods, alongside adolescents' perspectives and perceptions of their own selections within the school environment should be explored. In particular, the appeal of more nutritionally favourable mains, duration of breaks and the variety of foods and beverages in the school dining environment should be examined. This work should extend to other stakeholders, such as school and catering staff, to contribute to a comprehensive understanding and to identify facilitators to students' improved food choice.

#### 4.1. Limitations of the study

Consideration of this study's results should be within the context of the single school and academic year to which they relate. It is important to note the school's FSM profile (above the national average), the proportion of students from minority ethnic groups (below the national average), as well as the school food environment, including food provision by a catering company. Further studies to examine food choice patterns in other schools, including those with differing student populations and catering provision is recommended. Students' food choice profiles (and the subsequent cluster analysis) were based on categorisation by researchers; whilst this was according to food type, availability and previous literature, other categories may have been possible. The clusters were named by the researchers, which introduced an element of subjectivity. It is important to note that the data relate to selections rather than consumption; likewise, the extent to which food and beverages selected in the canteen were supplemented with other foods (e.g. from home or on the way into school, free drinking water), is unknown. There is also the possibility of errors when catering staff registered selections. The analysis was limited by the level of specificity in the data, e.g. daily specials also included those purchased as part of a bundle with the daily dessert and/or beverage (which constituted a very small minority, i.e. 0.3% and 0.6% respectively).

## 5. Conclusions

Cluster analysis of adolescents' food choices within a secondary school differentiated five patterns. Two fifths of students were in a cluster dominated by sandwiches, beverages and cookies and traybakes. Cookies and traybakes also featured in other clusters to varying degrees, including one cluster where it comprised over half of selections made. In contrast, *healthy lunchers*, who selected the daily specials were the smallest cluster of students. This study provides useful insights to food and beverage selections, and avenues for future research. Further work is needed to understand how adolescents select their foods within the school environment. In particular, the dominance of cookies and traybakes and the low selection of daily specials should be investigated further, to inform the design of interventions to support adolescents' better food choice in school.

#### CRediT authorship contribution statement

P. Mwithaga: Writing – review & editing, Writing – original draft,

Methodology, Formal analysis. **M. Holmes:** Writing – review & editing, Methodology. **H. Ensaff:** Writing – review & editing, Methodology, Conceptualization.

### Availability of data and materials

The authors do not have permission to share datasets.

### Ethics statement

This study was conducted following approval granted through the University of Leeds' Faculty Research Ethics.

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### Declaration of competing interest

None.

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