

Changes in food patterns over a 10-year period in the UK adult population; findings from the National Diet and Nutrition Survey

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Abstract

The prevalence of overweight and obesity in adults is increasing worldwide. Food portion size (PS) is an important environmental determinant of energy intake (EI) and may contribute to the obesity epidemic. However, UK evidence on the typical PS of commonly consumed foods in adults and how these may have changed over time is limited. Using combined data from Years 1-4 (2008/9-2011/12) and Years 9-11 (2016/17-2018/19) of the National Diet and Nutrition Survey (NDNS), this study examined trends in the PS of commonly consumed food groups over the last decade among UK adults. Significant increases in both consumption frequency and PS were observed for pasta, rice & pizza, eggs, oils & spreads, vegetables, fruits, nuts & seeds, and low-calorie carbonated/soft drinks (all $p \leq 0.005$). In contrast, bread, potato & potato products, condiments, and fruit juice & smoothies showed significant decreases in both frequency and PS (all $p \leq 0.032$). Divergent patterns were also evident: red meat showed increased frequency but reduced PS, while white meat and fish increased in frequency without significant changes in PS. Changes in PS alone were identified for milk and milk products, processed meat, alcoholic drinks, and total beverages.

Although fibre intake increased, recommendations are still not being met. There was no clear evidence that overweight or obese individuals consumed greater PS than those with normal weight. These findings highlight changes in food patterns among UK adults over the past decade and the importance of continued monitoring.

Keywords: Food portion sizes: Obesity: Energy intake: Energy density: Trends

Abbreviations

ANCOVA	Analysis of Covariance
BMR	Basal Metabolic Rate
BMI	Body Mass Index
CHO	Carbohydrates
DINO	Diet In Nutrients Out
EE	Energy Expenditure
EI	Energy Intake
EER	Estimated Energy Requirement
IQR	Interquartile Range
LRNI	Lower Reference Nutrient Intake

NDNS	National Dietary Nutrition Survey
PAL	Physical Activity Level
PS	Portion Size
RNI	Reference Nutrient Intake
RP	Rolling Programme
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
WC	Waist Circumference
WHR	Waist-Hip Ratio
WHO	World Health Organisation

Introduction

Overweight and obesity continue to increase worldwide, with prevalence having risen markedly since 1975⁽¹⁾. Adult obesity is defined as having a Body Mass Index (BMI) of 30kg/m² or above. According to the World Health Organisation (WHO) estimates, 43% of adults were living with overweight and 16% with obesity in 2022, highlighting the ongoing global burden of excess adiposity⁽²⁾. In England, Health Survey for England 2022 data indicate that 29% of adults were living with obesity, with prevalence 28% in men and 30% in women⁽³⁾. The UK also remains among the higher-burden countries in the WHO European Region for adult overweight/obesity⁽⁴⁾. Marked inequalities persist with adult obesity prevalence in England was 36% in the most deprived areas compared with 22% in the least deprived, demonstrating a substantial socioeconomic gradient⁽³⁾ that is consistently associated with disproportionately higher obesity-attributable morbidity and mortality in deprived populations⁽⁵⁾.

Food portion size (PS) is the food amount served for instant consumption in a single-eating event⁽⁶⁾, and is an important determinant of energy intake (EI)⁽⁷⁾. Consistent consumption of larger-than-appropriate PS contributes to sedentary behaviour and high EI⁽⁸⁻¹¹⁾. Both have been linked to an increase in obesity prevalence⁽⁹⁾ and have altered the food environment^(12,13), leading to non-communicable diseases such as cardiovascular disease, type 2 diabetes, and several cancer types⁽¹⁴⁾, as well as psychosocial diseases such as depression and anxiety disorders⁽¹⁵⁾. Although there is no direct evidence linking PS to obesity, both the energy density (ED) of commonly consumed foods and their consumption frequency have risen over recent decades^(9,16).

Since the 1970s, a fivefold increase in the ‘standard’ food PS has been noted in the USA⁽¹⁴⁾, and this has also been shown worldwide over the last 40 years⁽¹⁷⁾, via the introduction of larger-sized portions in popular and energy-dense foods, such as white bread products, macaroni⁽¹⁸⁾, pre-packed snacks^(19,20), cakes, popcorn⁽²¹⁾, soft drinks^(20,22), and alcoholic drinks⁽²³⁾.

Much of the previous research has used nationally representative surveys to investigate trends in the PS at the population level. In Australia, it was shown that the PS of discretionary food products, such as pizza, cakes, ice cream, sausages and other processed meats have increased over 17 years, whereas products such as pastries, snack foods and chips have decreased⁽²⁴⁾. An Irish survey of commonly consumed foods and beverages by adults aged 18-64 over 10 years, indicated significant increases in the PS of five foods (milk, white slice bread, wholemeal/brown bread, all cooked meat, roasted poultry) and significant decreases in three foods (potatoes, chips/wedges, sliced ham). No significant changes occurred over time in five foods (yoghurt, cheese, butter/spreads, processed potato products, ham/bacon)⁽²⁵⁾.

The UK Government campaigns for healthy eating and calorie reduction via the *Eatwell Guide* (current food-based dietary guidelines)⁽²⁶⁾. However, guidance on the appropriate PS of each food group and key foods within food groups is limited⁽²⁷⁾ and arguably outdated^(16,28), compounding consumers’ confusion on appropriate food PS⁽²⁹⁾. Furthermore, over 20 years, the UK National Diet and Nutrition Survey (NDNS) has revealed inconsistent trends in PS⁽³⁰⁾.

There is limited data on typical PS of commonly consumed foods among adults over the past decade, making it difficult to assess food over- or under-consumption and its impact on dietary adequacy and weight status. This is particularly relevant given the current prevalence of obesity rates in the UK. Further research on changing food consumption patterns is needed to guide current government dietary policies.

Using nationally representative data from the NDNS, this study primarily aims to identify trends in the PS of commonly consumed food groups over the last 10 years among the UK adult population. The key objectives are: to examine differences in PS consumption according to gender and weight status; to identify changes in the frequency of consumption of key food groups, and to examine associations between energy-dense foods and measures of adiposity. The hypothesis is that as obesity rates have increased over time, food PS has increased in the UK adult population, especially in the overweight/obese population.

Materials and methods

Survey design and sample size

Data from the NDNS were obtained from the UK Data Archive, University of Essex. The NDNS of adults aged 18-65 is part of a Rolling Programme (RP), which is a continuous cross-sectional survey collecting detailed, quantitative information from a representative sample of the UK population on food consumption, nutrient intake and nutritional status of the general population aged from 1.5 years up and living in private households⁽³¹⁾. Sample households were randomly selected from the Primary Sampling Units of the Postcode Address File, where one adult and one child were randomly chosen^(32,33).

For this research project, two independent cross-sectional NDNS datasets were used to represent two different time points: Years 1-4 (2008/09–2011/12) and Years 9-11 (2016/17–2018/19). The sample sizes were n=2506 adults in Years 1-4 (n=1250 males, n=1256 females) and n=1880 adults in Years 9-11 (n=935 males, n=945 females). As the two samples are independent and unpaired, comparisons reflect population-level changes rather than individual-level trends. NDNS participants completed a four-day food diary, and an interview providing information on eating and drinking habits, anthropometric measurements, socio-demographic characteristics of the household, medication use and supplement intake.

Ethical approval for Years 1-4 (2008/09–2011/12) was obtained from the Oxfordshire A Research Ethics Committee (Reference 07/H0604/113)⁽³²⁾. For Years 9-11 (2016/17–2018/19), ethical approval was obtained from the Cambridge South NRES Committee (Reference 13/EE/0016)⁽³⁴⁾. Each laboratory obtained approval from the respected Research and Development Committee where required (NatCen Social Research, National Institute of Health Research Cambridge Biomedical Research Centre)^(32,34).

Dietary intake data

Food intake data were collected using estimated food diaries for four consecutive days, beginning at any point during the week, representing a daily average of the days assessed. Participants were asked to record all food and drink consumed inside and out-of-home, including the brand name and, if applicable, the preparation method, and to describe food PS using household measures and weights from packaging. Photographic aids were also used to estimate accurate recording^(32,33). Once completed, food diaries were checked with interviewers for completeness, missing values, and improved recording, and were collected no later than three days after the last day of recording^(34,35).

The food records were coded using Diet In Nutrients Out (DINO) software⁽³⁶⁾, incorporating Public Health England's NDNS Nutrient Databank, Food Standards Agency Portion Sizes, and manufacturer data where applicable⁽³⁴⁾. Nutrient intakes were calculated for each participant based on the Lower Reference Nutrient Intake (LRNI) and Reference Nutrient Intake (RNI) dietary reference values for gender and age⁽³⁷⁾.

Food group analysis

Every food item in the dietary record was assigned to one of 60 individual food group codes, and each code was assigned to one of 155 subsidiary food groups⁽³⁸⁾. For the purpose of the current project, an internal protocol was used to create a working database from the main NDNS food file⁽³⁹⁾, where 60 food groups were recoded into 24 core food groups for analysis. During the recoding process, food items that were not considered to contribute meaningfully to habitual, everyday intake were excluded from the core food group to improve clarity of the aggregated groups. The data were subsequently aggregated and restructured to investigate the mean PS, EI, and frequency of key food group consumption at both time points during the recording period. Total EI was divided by the number of days' dietary intake recorded to calculate the average EI from foods. The contribution of dietary supplements and artificial sweeteners were excluded from the current analysis.

Anthropometric measurements

In NDNS at both time points, weight was measured to the nearest 0.1kg on a variety of weighing scales; Soehnle, Seca 850, Seca 870, or Tanita THD-305. To measure height to the nearest 0.1cm, a portable Leicester height stadiometer was used. At the midpoint between the iliac crest and the lower rib, WC was measured to the nearest 0.1cm^(32,40). BMI was calculated using Quetelet's formula (kg/m^2), weight status (defined as normal-weight, ≥ 18.5 - 24.99kg/m^2 ; and overweight/obese, 18.5 - $\geq 40\text{kg/m}^2$), waist circumference (WC) ($>102\text{cm}$ for men; $>88\text{cm}$ for women, for substantially increased risk of metabolic complications and abdominal obesity), and waist-hip ratio (WHR) ($\geq 0.90\text{cm}$ for men; $\geq 0.85\text{cm}$ for women, for substantially increased risk of metabolic complications, an indicator of serious health conditions) were described using WHO standards cut-offs⁽⁴¹⁾.

Misreporting

For the current project, misreporting was identified by examining the % difference between reported EI and estimated energy expenditure, known as the % estimated energy requirement (EER)⁽⁴²⁻⁴⁴⁾, calculated via the following equation: $(\text{EI}-\text{EER})/\text{EER} \times 100$ ⁽⁴⁶⁾. EER was calculated by multiplying the estimated Basal Metabolic Rate (BMR; according to sex and

age [Oxford equations]]⁽⁴²⁾, by an estimated Physical Activity Level (PAL) of 1.63, based on average UK adult energy requirements⁽⁴⁶⁾. Participants who reported $\leq 30\%$ of their total EER were considered to be ‘under-reporters’, while those who reported $\geq 30\%$ were considered to be ‘over-reporters’. Participants who reported between -30% to $+30\%$ of their EER were considered to be ‘accurate reporters’⁽⁴⁷⁾.

Statistical analysis

Data were statistically analysed using the Statistical Package for Social Sciences (SPSS) tool (version 27, manufacturer IBM, USA). Study weights were used in analyses accounting for sampling and non-response errors. Both combined datasets were rescaled to produce representative results⁽⁴⁸⁾. The Kolmogorov-Smirnov test was used to determine the data’s normality. Normally distributed data are presented as means and standard deviations (SD). Skewed data are presented as median and interquartile range (IQR). Independent t-tests were used to assess the differences in energy contribution of each food group over the 10 years, accounting for sex. Chi-square tests were used to compare categorical data. %EER and EI:EER were compared between time points by independent t-test. Analysis of covariance (ANCOVA), to improve precision and enhance the statistical power, was conducted to test for associations between food PS intake and consumption frequency adjusting for sex, age and misreporting (%EER). Partial correlations adjusted for sex, age, and misreporting were used to determine associations between PS of energy-dense foods, fruits and vegetables, and markers of adiposity (BMI, WC and WHR). The statistical significance was set at the 5% level ($p < 0.05$) and the confidence interval at 95%.

Results

General characteristics

Anthropometry

Table 1 summarises participant characteristics, indicating a statistically significant reduction in overall BMI (26.44kg/m^2 vs. 26.17kg/m^2 , $p=0.003$) and between the sexes (males: 26.92kg/m^2 vs. 26.88kg/m^2 , $p=0.039$; females: 25.76kg/m^2 vs. 25.45kg/m^2 , $p=0.028$) in the 10-year period. The women in Years 9-11 were significantly taller (162.3cm vs. 163cm , $p=0.004$) than their counterparts in Years 1-4. WC significantly decreased over the decade overall (91.10cm vs. 89.74cm , $p=0.001$) and in females (85.05cm vs. 83.25cm , $p=0.003$). No other significant difference was identified. Values refer to Years 1-4 and 9-11, respectively.

Dietary characteristics

The EI, overall (1809kcal vs. 1763kcal, $p=0.044$) and in males was significantly decreased (2075kcal vs. 1989kcal, $p=0.011$) (Table 1). Carbohydrate (CHO) intake presented a significant decrease overall (60.9g vs. 60.4g, $p<0.0001$) and in both sexes (males: 60.5% vs. 60.1%, $p=0.011$; females, 61.2% vs. 60.5%, $p<0.0001$) over the decade. A significant reduction overall and in both sexes was observed in total (19.8% vs. 18.1%, $p<0.0001$; males: 19.3% vs. 17.5%; $p<0.0001$; females: 20.3% vs. 18.7%, $p<0.0001$) and free sugars (13.5% vs. 11.2%, $p<0.0001$; males: 16.9% vs. 13.1%, $p<0.0001$; females: 11.5% vs. 9.9%, $p<0.0001$). Fibre intake showed a significant increase overall (17.4g vs. 18.4g, $p<0.0001$) and in both sexes (males: 18.8g vs. 19.5g, $p<0.0001$; females: 16.4g vs. 17.0g, $p<0.0001$). Protein intake increased significantly overall (20.3g vs. 20.5g, $p<0.0001$) and in males (20.2g vs. 20.6g, $p=0.036$) while remaining the same in females (20.4g vs. 20.4g, $p=0.014$) over the decade. The fat consumption overall (18.6g vs. 19.0g, $p<0.0001$) and in females presented a significant increase (18.4g vs. 19.0g, $p<0.0001$). No other differences were observed in dietary characteristics over the 10 years.

Misreporting

No change over time was noted in the EER or %EER among the sample overall or in either males or females (Table 1). No difference in EI:EER between the time points in the overall sample or in females was observed. However, EI:EER was significantly higher among the males in Years 1-4 compared with Years 9-11 (0.73 vs. 0.69, $p=0.001$), suggesting greater misreporting of EI in Years 9-11 among males. The overall percentage of the sample size identified as under-reporters was similar between time points (48.1% vs. 51.3%) and among females (50.9% vs. 51%), while a higher % of males were considered to be accurate reporters in Years 1-4 compared to Years 9-11 (53.6% vs 46.8%; $p=0.007$, respectively). Misreporters were included in the total sample to retain the sample size.

Comparison of food groups percentage consumption

Table 2 illustrates the percentage difference in food group consumption between both time points in the overall sample. The highest increase trend was noted in the consumption of nuts & seeds (20.5%), condiments (14.7%), eggs (11%), low-calories carbonated & soft drinks (8%), and pasta, rice & pizza (7.6%). In contrast, a notable decrease was noted in the consumption of carbonated & soft drinks (-12.9%), breakfast cereals (-8.7%), red meat (-8.6%), processed meat (-7.1%) and alcoholic drinks (-5.3%). Milk and milk products showed no difference over the decade.

Comparison of consumption frequency and portion size of food groups

When one-way ANCOVA adjusted for age, sex and %EER was applied, several statistically significant changes in both daily frequency of consumption and PS were observed between Years 1-4 and Years 9-11 (Table 3). Among the analysed food groups, significant increases were observed for pasta, rice and pizza (frequency: 0.51 ± 0.31 vs 0.60 ± 0.40 times/day, $p < 0.001$; PS: 79.1g vs 87.5g/day, $p = 0.003$), eggs (frequency: 0.44 ± 0.29 vs 0.53 ± 0.34 times/day, $p = 0.001$; PS: 28.5g vs 31.0g/day, $p = 0.001$), oils and spreads (frequency: 1.22 ± 0.76 vs 1.77 ± 1.07 times/day, $p = 0.001$; PS: 11.7g vs 12.9g/day, $p = 0.001$), vegetables (frequency: 3.12 ± 2.15 to 4.05 ± 2.88 , $p = 0.001$; PS: 149.1g to 168.6g/day, $p = 0.001$), fruits (frequency: 1.39 ± 1.13 to 1.77 ± 1.59 times/day, $p = 0.001$; PS: 93.1g to 105.9g/day, $p = 0.005$), nuts and seeds (frequency: 0.64 ± 0.67 to 1.10 ± 1.43 times/day, $p = 0.001$; PS: 8.2g vs 11.0 g/day, $p = 0.001$), and low-calorie carbonated/soft drinks (frequency: 1.40 ± 1.50 vs 1.78 ± 1.79 times/day, $p = 0.001$; PS: 200.0g to 267.1g/day, $p = 0.001$). In contrast, significant decreases in both frequency and PS were found for bread (frequency: 1.23 ± 0.58 vs 1.10 ± 0.57 times/day, $p = 0.001$; PS: 81.0g vs 73.6g/day, $p = 0.001$), potato & potato products (frequency: 0.65 ± 0.30 vs 0.61 ± 0.32 times/day, $p = 0.001$; PS: 90.0g to 78.8 g/day, $p = 0.001$), condiments (frequency: 1.85 ± 1.77 vs 1.58 ± 1.47 times/day, $p = 0.001$; PS: 13.0g vs 9.0g/day, $p = 0.001$), and fruit juice & smoothies (frequency: 0.66 ± 0.52 vs 0.62 ± 0.49 times/day, $p = 0.032$; PS: 87.5g to 62.5g/day, $p = 0.001$).

Several food groups displayed different trends, characterised by a significant increase in consumption frequency alongside a simultaneous reduction in PS. These included pasta, rice & pizza (frequency: 0.51 ± 0.31 vs. 0.60 ± 0.40 times/day, $p < 0.001$; PS: 79.1g vs. 87.5g, $p = 0.003$), red meat (frequency: 0.46 ± 0.25 vs. 0.49 ± 0.25 times/day, $p = 0.012$; PS: 50.0g vs. 43.8g, $p = 0.001$), and white meat (0.54 ± 0.35 vs. 0.61 ± 0.38 times/day, $p = 0.001$; PS: 56.3g vs. 52.2g, $p = 0.144$). A further group of foods demonstrated a significant increase in consumption frequency without a corresponding change in PS, including sugar & chocolate confectionery (0.62 ± 0.52 vs 0.75 ± 0.58 times/day, $p = 0.001$), savoury snacks (0.50 ± 0.32 vs 0.55 ± 0.37 times/day, $p = 0.001$), white meat (0.54 ± 0.35 to 0.61 ± 0.38 , $p = 0.001$) and fish (0.49 ± 0.37 vs 0.56 ± 0.39 , $p = 0.001$), and in PS only for milk & milk products (172.9g vs 172.0g/day, $p = 0.042$), processed meat (46.0g vs 39.7g/day, $p = 0.001$), alcoholic drinks (256.3g vs 200.0g/day, $p = 0.001$), and beverages (1022.3g vs 1234.8g/day, $p = 0.001$).

Differences in portion size of food groups according to weight status

Table 4 presents the differences in average daily PS of food groups in both time points stratified by weight status, using one-way ANCOVA adjusted for age, sex and %EER. Among normal-weight adults, a significant increase in PS over time was observed for pasta, rice & pizza (84.7g vs. 89.3g, $p=0.020$), vegetables (152.1g vs. 176.9g, $p=0.001$), beverages (986.7g vs. 1254.1g, $p=0.001$), nuts & seeds (7.7g vs. 12.0g, $p=0.001$), and oils & spreads, (12.1g vs 13.2, $p=0.019$). Contrary, a significant decrease was observed for bread (80.1g vs. 74.7g, $p=0.001$), processed meat (43.3g vs. 35.6g, $p=0.001$), red meat (46.9g vs. 39.4g, $p=0.001$), potato & potato products (85.5g vs. 71.3g, $p=0.001$), condiments (15.0g vs. 10.0g, $p=0.001$), fruit juice & smoothies (100.0g vs. 50.0g, $p=0.001$), and alcoholic drinks (210.3g vs. 185.2g, $p=0.001$). No significant changes were observed in the other food groups.

Among adults with overweight/obesity, a significant increase noted for pasta, rice & pizza (75.0g vs. 86.1g, $p=0.001$), eggs (29.3g vs. 33.5g, $p=0.011$), vegetables (146.2g vs. 168.0g, $p=0.001$), oils & spreads (11.5g vs 12.9g, $p=0.001$), fruits (93.5g vs. 105.6g, $p=0.009$), sugar & chocolate confectionery (19.2g vs. 21.5g, $p=0.005$), beverages (1064.3g vs. 1225.6g, $p=0.001$),), nuts & seeds (8.0g vs. 9.7g, $p=0.009$), and low-calorie carbonated & soft drinks (200.0g vs. 324.4g, $p=0.001$). A decrease in PS was observed for bread (81.7g vs. 72.5g, $p=0.001$), processed meat (48.8g vs. 43.1g, $p=0.022$), red meat (52.5g vs. 48.0g, $p=0.016$), potato & potato products (95.0g vs. 84.8g, $p=0.001$), fruit juice & smoothies (78.6g vs. 71.0g, $p=0.045$), and condiments (12.1g vs. 8.0g, $p=0.001$). No other significant changes were observed.

Associations between energy dense, fruit and vegetable food groups and measures of adiposity over a 10-year period in the NDNS

Partial correlations (r-values) were performed to examine the relationships between average intakes (g) of energy-dense and healthy food groups and measures of adiposity (BMI, WC and WHR), while controlling for sex, age, and misreporting (Table 5). Although several correlations reached statistical significance ($p<0.05$), all associations were small in magnitude, indicating weak relationships between food group intakes and adiposity outcomes. Among energy-dense food groups, carbonated and soft drinks showed the most consistent positive associations with adiposity, particularly for central measures. Positive correlations with WC were observed in both time points (Years 1-4: $r=0.072$, $p=0.020$; Years 9-11: $r=0.157$, $p<0.001$), and with WHR in Years 9-11 ($r=0.153$, $p=0.003$), but not in Years

1-4 ($r=0.033$, $p=0.292$). Sugar & chocolate confectionery intake was positively associated with BMI ($r=0.125$, $p<0.001$) and WC ($r=0.157$, $p<0.001$) only in Years 9-11, whereas no significant associations were observed in Years 1-4 (BMI: $r=0.017$, $p=0.507$; WC: $r=0.006$, $p=0.823$; WHR: $r=-0.045$, $p=0.110$). Buns, cakes, pastries & biscuits were positively associated with BMI ($r=0.057$, $p=0.008$) and WC ($r=0.073$, $p=0.003$) only in Years 1-4, with no significant associations in Years 9-11 (BMI: $r=0.053$, $p=0.081$; WC: $r=0.030$, $p=0.400$). Oils & spreads showed a small positive association with BMI in Years 1-4 ($r=0.044$, $p=0.026$), but not in Years 9-11 ($r=0.035$, $p=0.203$), and no significant associations with WC (Years 1-4: $r=0.033$, $p=0.135$; Years 9-11: $r=0.038$, $p=0.240$) or WHR (Years 1-4: $r=0.024$, $p=0.274$; WHR Years 9-11: $r=0.032$, $p=0.313$). No significant associations were observed for savoury snacks across any adiposity measures or time points. Using fruit and vegetable as diet quality markers, fruit intake was inversely associated with adiposity, particularly WHR. Fruit intake was negatively correlated with WHR in both Years 1-4 ($r=-0.069$, $p=0.005$) and Years 9-11 ($r=-0.100$, $p=0.004$), with additional inverse associations observed for BMI in Years 1-4 ($r=-0.056$, $p=0.011$) and WC in Years 9-11 ($r=-0.094$, $p=0.007$). Vegetable intake was not significantly associated with BMI (Years 1-4: $r=-0.008$, $p=0.668$; BMI Years 9-11: $r=0.042$, $p=0.120$) or WC (Years 1-4: $r=-0.038$, $p=0.124$; WC Years 9-11: $r=-0.053$, $p=0.099$); however, it was inversely correlated with WHR in both time points (Years 1-4: $r=-0.071$, $p=0.001$; Years 9-11: $r=-0.064$, $p=0.044$).

Discussion

The current study examined decade-long changes in the prevalence, frequency of consumption, and PS of food group consumption among UK adults aged 18-65 years using NDNS data. Overall, shifts in food patterns were heterogeneous across food groups, with notable divergence between the proportion of consumers, consumption frequency and PS. The proportion of consumers increased for pasta, rice & pizza, eggs, oils & spreads, white meat, vegetables, fruits, condiments, savoury snacks, sugar & chocolate confectionery, beverages, nuts & seeds, low-calorie carbonated & soft drinks, and condiments. Whereas it decreased for bread, breakfast cereals, buns, cakes, pastries & biscuits, processed meat, red meat, fish, potato & potato products, fruit juice & smoothies, alcoholic drinks, and carbonated & soft drinks.

When food groups were considered in relation to the Eatwell Guide, changes in consumption frequency across core food groups were mixed rather than uniform over time. Frequency

increased for fruits and vegetables, but decreased for bread and potato and potato products, while no clear change was evident for milk and milk products. Discretionary food groups also showed variable trends, with increased frequency for sugar & chocolate confectionery and savoury snacks, but decreases for condiments and fruit juice & smoothies. Changes in PS were similarly heterogeneous, with reductions observed for processed meat, condiments, and alcoholic drinks, alongside increases for fruits, vegetables, beverages, nuts & seeds, and low-calorie carbonated & soft drinks. Overall, these findings suggest inconsistent alignment with food-based dietary guidelines in the adult population⁽⁴⁹⁾.

These findings partly contrast with findings from other European populations. For example, a Norwegian study reported increased dairy consumption alongside reductions in fruit and vegetable intake, trends not consistently observed in the present analysis⁽⁵⁰⁾. Furthermore, a Danish cohort and cross-sectional study reported a decreased frequency of white bread and potato consumption⁽⁵¹⁾. Adults in the United States generally exhibit higher frequencies of consumption across most food groups compared with populations in Brazil and other countries, except for staple foods such as rice, beans, and legumes⁽⁵²⁾. These discrepancies likely reflect differences in food environments, cultural dietary norms, and national nutrition policies.

In line with these findings, changes in PS were heterogeneous across food groups over the decade, with reductions observed for several energy-dense foods, including processed meat, red meat, potato and potato products, and condiments. Only a limited number of food groups, including pasta, rice & pizza, eggs, vegetables, beverages, nuts & seeds, fruits, and low-calorie carbonated & soft drinks, showed increases in PS. The increase in consumption of low-calorie carbonated & soft drinks may reflect reformulation and consumer response following the introduction of the UK Soft Drinks Industry Levy^(53,54), suggesting that fiscal policies may influence PS and product choice beyond sugar-sweetened beverages alone.

An Australian study reported increased PS consumption of processed foods, which decreased in the present study. However, Australian participants were older overall, and the study methodology differed, as the dietary intake was measured with different methods⁽²⁴⁾. An Irish study supports the findings of this research only regarding the decreased consumption of potato and potato products and processed meat. Notably, it did not account for under-reporting, and the PS was accounted for, regardless of the quantification method used⁽²⁵⁾.

This study partially contradicts the evidence from the USA, where most foods' PS consumption increased consistently over time^(55,56). For instance, while the daily PS of foods such as French fries reportedly increased in the USA, the present study found a significant decrease in PS for potato & potato products. Beverage PS consumption has increased in both the USA and the present study. Such differences may partly reflect variation in dietary assessment methods and differences in eating location and food source patterns⁽⁵⁵⁾. Moreover, while the USA study focused on widely consumed food patterns in a wider age range⁽⁵⁶⁾, this study explored all food groups in the UK adult population. Other USA studies have indicated decreased sugar-sweetened beverage consumption, which aligns with the current study findings⁽⁵⁷⁻⁶⁰⁾.

Between 1987 and 2006, PS increased in savoury foods, sugar and chocolate products, and fast foods, while it decreased in others, such as potatoes/chips, desserts, yoghurts, ice creams, breaded chicken and some fruits and vegetables^(28,30,61). Findings of 2000/1 and 2008/9 NDNS surveys support these trends, as PS varied with some foods increasing, some decreasing, and others remaining constant⁽⁶²⁾. However, the 2008/9 NDNS data (Year 1, RP) had a smaller sample size than the 2000/1 survey. Increased consumption of cereal, grain, and meat is indicated in the National Food Surveys (1949-2005)⁽⁶³⁾. However, it is not reflected in the present study, possibly due to evolving food trends. Data from the UK National Survey of Health and Development noted an increased PS of fruits and vegetables and decreased whole milk, butter, and red meat intake in both sexes⁽⁶⁴⁾. The British Birth Study identified PS trends similar to the current study, with increases in bread (wholemeal, granary), fish, fruits, vegetables, and semi-skimmed milk. Decreases were noted in white bread, whole milk, fats and oils, meat and meat products, coffee, sugar, preserves, and alcoholic drinks⁽⁶⁵⁾. Some studies focused on PS changes based on manufacturer weights or examining food groups^(14,51,66,67). In contrast, others examined specific food changes rather than those contributing most to EI using dietary data^(55,68) or combining both^(63,64). Three were cohort studies^(51,64,65) with repeated dietary measurements from the same individuals. Overall, the mixed direction of changes observed across studies, including the present one, might be due to the population's ageing, food trends, and changes in food availability over time.

In line with earlier studies^(24,25), this study discovered a 60.4% decrease in CHO consumption over the decade, yet consumption remains greater than the recommendations. Although total

and free sugar intake has decreased over the decade⁽⁶⁹⁾, the population continues to consume higher amounts than is recommended primarily because of processed foods⁽⁷⁰⁾. Although fibre intake has increased, mainly due to veganism⁽⁷¹⁾, it remains below the recommended 30g/day⁽⁷²⁾. Fat intake has increased by 19% but remained below the recommendations, similar to previous research^(24,25). Protein consumption has risen by 20.5%, exceeding recommendations⁽⁷³⁾. Lifestyle changes⁽⁷⁴⁾, sustainability⁽⁷⁵⁾, increased need for quick protein sources⁽⁷⁶⁾, and alternative protein options^(77,78) have been attributed to this.

The current study identified modest associations between energy-dense food group intakes and measures of adiposity, with patterns differing between the two NDNS survey periods. While overweight and obesity remain highly prevalent among UK adults, diet-adiposity relationships were generally weak. Contrary to the study hypothesis that overweight/obese individuals would consume larger portions compared to their normal-weight counterparts, the observed differences were not consistent across food groups. These findings contrast with previous research showing obese individuals self-reporting larger PS^(8,79,80) and that obesity is associated with increased consumption of various foods and food groups^(77,81). Previous research also indicates that high-energy and processed/ultra-processed foods are linked with adiposity and, thus, weight gain and obesity^(69,82-85). Temporal variation in associations was evident, with sugar & chocolate confectionery intake positively associated with BMI in Years 9-11, and oils & spreads associated with BMI in Years 1-4. Stronger associations were observed for central adiposity, with carbonated & soft drink intake positively related to WC and WHR in Years 9-11. In contrast, fruit intake was inversely associated with several adiposity measures, while vegetable intake showed an inverse association with WHR only. Although statistically significant, the effect sizes were small, suggesting limited clinical relevance. As misreporters were retained, these associations might have been weakened, given that obese individuals tend to under-report their intake⁽⁸⁶⁾.

This study has several public health implications, particularly for developing strategies to combat obesity in the UK. Limiting multi-buy deals⁽⁸⁷⁾ and junk food advertising policies⁽⁸⁸⁾ were announced in 2020, however, while restrictions on multi-buy deals came into effect on 1 October 2025⁽⁸⁷⁾ in England, implementation of junk food advertising restrictions came into effect on 5 January 2026⁽⁸⁹⁾. Evidence supports the benefits of fat reduction content in foods, extending beyond the sugar levy⁽⁷⁰⁾, as observed successfully in international measures, such as energy-dense foods taxation⁽⁹⁰⁻⁹²⁾. Introducing mandatory calorie labelling in UK restaurants^(93,94) promotes lower-calorie options⁽⁹⁵⁾. A UK study indicated that a 20% fat

reduction in manufactured and out-of-home foods could reduce overweight and obesity rates by 1.5% and 5.3%, respectively, and prevent type 2 diabetes over twenty years⁽⁹⁶⁾.

Despite the obstacles presented by culturally different eating habits, governments and organisations worldwide must collaborate to provide transparent technical regulations and standards, including labelling, packaging, and marketing⁽⁹⁷⁾. Front-of-pack nutrition labels help educate the public about healthy eating⁽⁹⁸⁾ despite claims that they are a marketing tool rather than a public health strategy⁽⁹⁹⁾. Notably, nutrition labels are not required to include PS information^(97,100-102).

The NDNS is the only survey providing nationally representative data on food consumption and nutrient intake in the UK, monitoring and investigating dietary trends. Data collection through food diaries is a comprehensive method that helps minimise missing information^(31,32). However, misreporting in self-reported dietary methods remains an issue that requires further investigation⁽¹⁰³⁾. EI may be underestimated due to PS estimates or food composition assumptions being measured in household measures⁽¹⁰⁴⁾. In addition, public health campaigns raising awareness of healthy eating may lead to under-reporting of high fat foods⁽¹⁰⁵⁾.

The study included all the participants for the statistical analysis, as misreporters' exclusion may introduce selection and unknown bias⁽¹⁰⁵⁾. Weekend days were overrepresented in the NDNS RP Years 1-4 combined data. This possibly weakened some expected relationships and introduced bias in reported food consumption and nutrition intake, as dietary patterns differ for sex and age groups⁽¹⁰⁷⁾. While the data was weighted, including the non-responses, bias reduction is not guaranteed, as the weighting is equivalent to replacing the non-respondents from a sub-group with respondents from the same sub-group^(104,108).

This study recoded the NDNS food groups into core food groups, making direct comparisons with other studies difficult. When disaggregated composite food codes, fruit and vegetable intake can increase by up to 11% and 29% respectively^(109,110). While beans and pulses are included in the protein food group in the Eatwell Guide, they are classified in the vegetable food group in the NDNS^(39,111). This may explain the increase in vegetable consumption. The recoded food groups combined diverse items, such as different types of processed meat, milk & milk products, or oils & spreads, which may mask important within-group variation in nutrient composition, processing level, and associated health impacts. In particular, food groups such as alcoholic drinks can vary widely in energy content, and PS, and changes in their consumption may have a disproportionate impact on total energy intake. Finally, age,

socioeconomic status, and geographic characteristics were not accounted for, for representative results and limiting the ability to identify specific trends.

These findings highlight changes in the UK adult population's consumption patterns across several commonly consumed food groups over the past decade. Some reductions in PS, including those for energy-dense foods such as processed meat, may represent favourable trends; however, the overall pattern of change was mixed. The findings also provide scope for policy interventions to increase fibre intake and reduce sugar consumption, particularly among overweight/obese individuals. Monitoring trends through nationally representative surveys remains critical to inform targeted health promotion campaigns and support healthier dietary patterns.

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Declaration of interests

No conflict of interest.

Authorship

This research was conducted as part of the dissertation module in the MSc Food Regulatory Affairs by Maria Papagiannaki, who helped formulate the research question, conducted the literature search, interpreted the findings and wrote the research. Dr Maeve Kerr formulated the research question and guided the research.

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Table 1: General and dietary characteristics of National Diet and Nutrition Survey of Years 1-4 (2008/9-2011/12) and Years 9-11 (2016/17-2018/19).

		Total sample			Males			Females		
		Years	1-4		Years	1-4		Years	1-4	
Years 9-11		Years 9-11			Years 9-11			Years 9-11		
(n=1880)		(n=2506)	P-		(n=1250)	P-		(n=1256)	P-	
			value*			value*				
Median	IQR	Median	IQR		Median	IQR		Median	IQR	
Median	IQR				Median	IQR		Median	IQR	
General characteristics										
Age (years)	42.00	43.00	0.480		41.87	43.63	0.427	42.00	43.00	0.840
	23.0	23.0			23.2	24.00		23.0	23.0	
Height (cm)	167.1	167.6	0.131		176.0	176.8	0.132	162.3	163.0	0.004
	13.7	13.9			9.4	9.3		8.1	8.1	
Weight (kg)	75.6	75.2	0.950		83.2	83.4	0.972	69.4	69.3	0.711
	23.7	23.7			21.0	21.7		20.5	20.6	
BMI (kg/m ²)	26.44	26.17	0.003		26.92	26.88	0.039	25.76	25.45	0.028
	6.9	6.5			5.8	5.8		8.2	7.1	
Normal weight (n, %)	889	705	0.135		377	299	0.215	512	405	0.251
	(38.1)	(39.9)			(32.3)	(34.1)		(43.9)	(45.5)	
Overweight/obese (n, %)	1444	1769			789	578		655	486	
	(61.9)	(61.1)			(67.7)	(65.9)		(56.1)	(54.5)	
WC (cm)	91.10	89.74	0.001		95.61	94.74	0.068	85.05	83.25	0.003
	20.1	20.2			17.0	18.1		18.7	19.7	
<102cm M, <88cm F	1088	837	0.029		588	437	0.321	500	400	0.018
(n, %)	(60.6)	(64.0)			(66.1)	(67.3)		(55.2)	(60.6)	
≥102cm M, ≥88cm F	708	471			302	212		406	260	

(n, %)	(39.4)	(36.0)		(33.9)	(32.7)		(44.8)	(39.4)	
WHR (cm) (n, %)	0.86	0.86	0.120	0.92	0.91	0.331	0.82	0.81	0.091
	0.1	0.1		0.1	0.1		0.1	0.1	
<0.90cm M, <0.85cm	929	681	0.368	346	264	0.288	583	427	0.490
F (n, %)	(53.3)	(54.0)		(39.8)	(41.4)		(66.7)	(66.5)	
≥0.90cm M, ≥0.85cm	814	589		523	374		291	215	
F (n, %)	(46.7)	(46.0)		(60.2)	(58.6)		(33.3)	(33.5)	
Dietary characteristics									
EI (kcal/d)	1809	1763	0.044	2075	1989	0.011	1568	1581	0.812
	62.7	720.1		794.1	776.5		598.4	591.6	
% CHO/d	60.9	60.4	<0.0001	60.5	60.1	0.011	61.2	60.5	<0.0001
	8.0	8.3		8.0	8.5		8.3	8.0	
% total sugars/d	19.8	18.1	<0.0001	19.3	17.5	<0.0001	20.3	18.7	<0.0001
	8.6	7.9		8.0	7.3		9.1	8.3	
% free sugars/d	13.5	11.2	<0.0001	16.9	13.1	<0.0001	11.5	9.9	<0.0001
	12.5	10.6		13.5	11.5		10.3	9.0	
AOAC fibre (g)	17.4	18.4	<0.0001	18.8	19.7	<0.0001	16.4	17.0	<0.0001
	8.5	9.9		8.6	10.3		7.7	9.0	
% protein/d	20.3	20.5	<0.0001	20.2	20.6	0.036	20.4	20.4	0.014
	5.8	6.0		5.8	5.8		5.9	6.3	
% fat/d	18.6	19.0	<0.0001	18.7	18.9	0.107	18.4	19.0	<0.0001
	5.3	5.1		5.0	4.9		5.6	5.4	
EER (kcal/d)	2475	2492	0.719	2889	2885	0.692	2245	2227	0.949
	630.7	635.3		404.1	451.1		303.1	331.6	
% EER/d	-28.9	-30.7	0.080	-27.1	-30.7	0.064	-30.4	-30.7	0.555
	27.9	27.4		28.2	27.5		28.1	27.0	
EI: EER	0.70	0.69	0.080	0.73	0.69	0.001	0.70	0.69	0.683

	0.28	0.28		0.28	0.27		0.28	0.27	
Misreporting									
Accurate reporter	1186 (50.8%)	839 (47.4%)	0.079	625 (53.6%)	410 (46.8%)	0.007	561 (48.1%)	428 (48.0%)	0.999
Under-reporter	1123 (48.1%)	908 (51.3%)		529 (45.4%)	453 (51.7%)		594 (50.9%)	454 (51.0%)	
Over-reporter	24 (1.0%)	23 (1.3%)		12 (1.0%)	14 (1.6%)		12 (1.0%)	9 (1.0%)	

BMI, body mass index; WC, waist circumference; WHR, waist-hip ratio; CHO, carbohydrates; EI, energy intake; EER, estimated energy requirements.

General and dietary characteristics presented are Median and IQR (presented in one value the difference between third and first quartile).

*General and dietary characteristics are obtained from independent t-test; categories of BMI, WC and WHR, and misreporting are obtained from chi-square test, statistical significance presented in bold.

Misreporting is calculated by the % difference between reported energy intake (EI) and estimated energy requirements (EER) via the equation $(EI-EER)/EER \times 100^{(46)}$.

Table 2: Percentage consumption of food groups in adults 18-65 years old in Years 1-4 (2008/9-2011/12) and Years 9-11 (2016/17-2018/19) of the NDNS.

Food group	Years 1-4 N (%)	Years 9-11 N (%)	Percentage difference
Pasta, rice & pizza	1853 (73.9)	1533 (81.5)	7.6
Bread ^a	2436 (97.2)	1749 (93.1)	-4.1
Breakfast cereals ^b	1544 (61.6)	994 (52.9)	-8.7
Buns, cakes, pastries & biscuits	1965 (78.4)	1419 (75.5)	-2.9
Milk & milk products	2468 (98.5)	1852 (98.5)	0
Eggs	1373 (54.8)	1237 (65.8)	11
Oils & spreads ^c	2368 (94.5)	1830 (97.4)	2.9
Processed meat ^d	1975 (78.8)	1348 (71.7)	-7.1
Red meat	1702 (67.9)	1115 (59.3)	-8.6
White meat	1812 (72.3)	1420 (75.6)	3.3
Fish	1516 (60.5)	1079 (57.4)	-3.1
Vegetables	2448 (97.7)	1853 (98.6)	0.9
Potato & potato products	2256 (90.0)	1635 (87.0)	-3.0
Fruits	1946 (77.6)	1505 (80.0)	2.4
Condiments	1727	1571	14.7

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	(68.9)	(83.6)	
Savoury snacks	1225	955	1.9
	(48.9)	(50.8)	
Sugar & chocolate confectionery	1433	1098	1.2
	(57.2)	(58.4)	
Fruit juice & smoothies	1063	733	-3.2
	(42.4)	(39.0)	
Alcoholic drinks	1467	1000	-5.3
	(58.5)	(53.2)	
Beverages ^e	2464	1875	1.5
	(98.3)	(99.8)	
Nuts & seeds	536	787	20.5
	(21.4)	(41.9)	
Carbonated & soft drinks	1306	736	-12.9
	(52.1)	(39.2)	
Carbonated & soft drinks low calories	875	805	8
	(34.9)	(42.9)	
Soups, sauces, other beverages & condiments	2378	1865	4.3
	(94.9)	(99.2)	

^aBread types include: white, wholemeal, brown granary, wheatgerm and other breads.

^bCereal types include: high fibre breakfast and other breakfast cereals.

^cOils and spreads types include: butter, PUFA margarine/oils, low-fat spread margarine and not PUFA reduced fat spread.

^dProcessed meat types include: burgers and kebabs, sausages, meat pies and pastries and other meat and meat products.

^eBeverages include tea, coffee and water.

Table 3: Differences in frequency of consumption and portion size (g) per day among UK adults aged 18-65 years from Years 1-4 (2008/9-2011/12) vs Years 9-11 (2016/17-2018/19) of the NDNS.

Food group	Frequency				Portion size		
	consumption/day				consumption (g)/ day		
	Years	1-4	P-value*		Years	1-4	P-
	Years 9-11				Years 9-11		value*
	Mean $\pm$ SD	$\pm$ SD			Median IQR		
Pasta, rice & pizza	0.51 $\pm$ 0.31	0.60 $\pm$ 0.40	<0.001		79.1 83.9	87.5 92.1	0.003
Bread ^a	1.23 $\pm$ 0.58	1.10 $\pm$ 0.57	0.001		81.0 62.3	73.6 66.0	0.001
Breakfast cereals ^b	0.70 $\pm$ 0.41	0.69 $\pm$ 0.43	0.227		25.0 25.5	25.0 25.8	0.060
Buns, cakes, pastries & biscuits	0.92 $\pm$ 0.69	0.94 $\pm$ 0.67	0.193		37.0 49.0	34.0 47.9	0.278
Milk & milk products	3.61 $\pm$ 2.16	3.58 $\pm$ 2.25	0.524		172.9 179.1	172.0 190.9	0.042
Eggs	0.44 $\pm$ 0.29	0.53 $\pm$ 0.34	0.001		28.5 30.0	31.0 42.0	0.001
Oils & spreads ^c	1.22 $\pm$ 0.76	1.77 $\pm$ 1.07	0.001		11.7 12.7	12.9 13.3	0.001
Processed meat ^d	0.75 $\pm$ 0.46	0.71 $\pm$ 0.46	0.399		46.0 59.5	39.7 55.6	0.001
Red meat	0.46 $\pm$ 0.25	0.49 $\pm$ 0.25	0.012		50.0 56.2	43.8 48.5	0.001
White meat	0.54 $\pm$ 0.35	0.61 $\pm$ 0.38	0.001		56.3 61.8	52.2 60.9	0.144
Fish	0.49 $\pm$ 0.37	0.56 $\pm$ 0.39	0.001		40.3 41.9	40.0 41.2	0.876
Vegetables	3.12 $\pm$ 2.15	4.05 $\pm$ 2.88	0.001		149.1 128.5	168.6 163.1	0.001

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Potato & potato products	0.65 ± 0.30	0.61 ± 0.001	90.0	78.8	0.001
		0.32	80.3	77.2	
Fruits	1.39 ± 1.13	1.77 ± 0.001	93.1	105.9	0.005
		1.59	113.9	123.6	
Condiments	1.85 ± 1.77	1.58 ± 0.001	13.0	9.0	0.001
		1.47	17.8	13.9	
Savoury snacks	0.50 ± 0.32	0.55 ± 0.001	12.5	12.5	0.110
		0.37	12.7	13.6	
Sugar & chocolate confectionery	0.62 ± 0.52	0.75 ± 0.001	19.4	20.5	0.488
		0.58	25.0	28.8	
Fruit juice & smoothies	0.66 ± 0.52	0.62 ± 0.032	87.5	62.5	0.001
		0.49	101.5	118.0	
Alcoholic drinks	1.29 ± 1.33	1.27 ± 0.821	256.3	200.0	0.001
		1.12	491.2	375.6	
Beverages ^e	5.38 ± 3.07	5.22 ± 0.057	1022.3	1234.8	0.001
		2.61	752.0	959.7	
Nuts & seeds	0.64 ± 0.67	1.10 ± 0.001	8.2	11.0	0.001
		1.43	14.6	23.0	
Carbonated & soft drinks	1.04 ± 1.10	1.00 ± 0.234	162.5	150.0	0.958
		1.07	254.3	263.7	
Carbonated & soft drinks low calories	1.40 ± 1.50	1.78 ± 0.001	200.0	267.1	0.001
		1.79	330.0	453.8	
Soups, sauces, other beverages & condiments	1.60 ± 1.31	3.66 ± 0.001	41.1	34.1	0.001
		2.50	67.9	57.4	

Frequency consumption presented are Mean and SD, and PS consumption presented are Median and IQR (presented in one value the difference between third and first quartile).

*P-value obtained from one-way ANCOVA adjusted for age, sex and misreporting; statistical significance presented in bold.

^aBread types include: white, wholemeal, brown granary, wheatgerm and other breads.

^bBreakfast cereal types include: high fibre breakfast and other breakfast cereals.

^cOils and spreads types include: butter, PUFA margarine/oils, low-fat spread margarine and not PUFA reduced fat spread.

^dProcessed meat types include: burgers and kebabs, sausages, meat pies and pastries and other meat and meat products.

^eBeverages include tea, coffee and water.

Table 4: Differences in portion size consumption (g) per day of food groups according to weight status between Years 1-4 (2008/9-2011/12) and Years 9-11 (2016/17-2018/19) of the NDNS.

Weight status/ Food groups (day consumption)	Normal weight					Overweight/obese				
	Years 1-4		Years 9-11			Years 1-4		Years 9-11		
	(n=889)		(n=705)			(n=1444)		(n=1065)		
	Median	IQR	Median	IQR	P-value	Median	IQR	Median	IQR	P-value
Pasta, rice & pizza	84.7	87.5	89.3	94.3	0.020	75.0	75.0	86.1	89.3	0.001
Bread ^a	80.1	65.9	74.7	72.4	0.001	81.7	65.0	72.5	62.0	0.001
Breakfast cereals ^b	25.0	25.0	25.0	29.9	0.276	25.0	25.0	25.0	23.3	0.178
Buns, cakes, pastries & biscuits	37.5	44.4	37.3	50.3	0.821	37.0	52.7	33.0	44.7	0.185
Milk & milk products	175.0	182.6	184.5	200.8	0.092	173.3	186.8	165.7	189.5	0.217
Eggs	28.5	30.4	29.1	39.1	0.174	29.3	30.0	33.5	43.3	0.011
Oils & spreads ^c	12.1	12.9	13.2	13.5	0.019	11.5	12.3	12.9	13.4	0.001
Processed meat ^d	43.3	57.2	35.6	48.1	0.001	48.8	60.2	43.1	57.3	0.002
Red meat	46.9	52.0	39.4	42.9	0.001	52.5	56.3	48.0	54.9	0.006
White meat	57.5	58.1	50.8	62.6	0.701	55.9	66.0	52.7	58.9	0.083
Fish	39.0	38.7	40.3	42.7	0.942	40.8	42.3	38.9	40.2	0.840
Vegetables	152.1	125.3	176.9	153.7	0.001	146.2	127.6	168.0	161.5	0.001
Potato & potato products	85.5	76.7	71.3	72.1	0.001	95.0	78.7	84.8	80.0	0.001
Fruits	90.4	124.5	108.1	132.8	0.261	93.5	110.0	105.6	119.3	0.009
Condiments	15.0	18.8	10.0	15.3	0.00	12.1	18.2	8.0	14.0	0.00

					1					1
Savoury snacks	12.5	12.8	12.5	14.9	0.89	12.5	12.5	12.5	12.5	0.02
Sugar & chocolate confectionery	20.3	28.1	19.6	28.9	0.05	19.2	23.4	21.5	29.0	0.00
Fruit juice & smoothies	100.0	130.4	50.0	96.7	0.00	78.6	107.2	71.0	123.7	0.04
Alcoholic drinks	210.3	451.4	185.2	266.8	0.00	293.7	518.1	238.6	489.5	0.06
Beverages ^e	986.7	822.2	1254.1	1091.1	0.00	1064.3	690.7	1225.6	877.1	0.00
Nuts & seeds	7.7	15.3	12.0	25.5	0.00	8.0	13.5	9.7	20.5	0.00
Carbonated & Soft Drinks	178.0	262.3	142.0	281.6	0.43	150.0	251.0	165.0	257.1	0.65
Carbonated & Soft Drinks Low Calories	199.4	403.6	178.1	349.3	0.07	200.0	308.5	324.4	478.7	0.00
Soups, Sauces, Other Beverages & Condiments	42.1	66.6	33.1	47.3	0.00	42.5	69.4	36.3	64.0	0.06

PS consumption presented are Median and IQR (presented in one value the difference between third and first quartile).

*P-value obtained from one-way ANCOVA adjusted for age and misreporting; statistical significance presented in bold.

^aBread types include: white, wholemeal, brown granary, wheatgerm and other breads.

^bBreakfast cereal types include: high fibre breakfast and other cereals.

^cOils and spreads types include: butter, PUFA margarine/oils, low-fat spread margarine and not PUFA reduced fat spread.

^dProcessed meat types include: burgers and kebabs, sausages, meat pies and pastries and other meat and meat products.

^eBeverages include tea, coffee and water.

Table 5: Partial correlations between intakes (g) of energy-dense food groups and fruits/vegetables and measure of adiposity (BMI, WC and WHR) between Years 1-4 (2008/9-2011/12) and Years 9-11 (2016/17-2018/19) of the NDNS.

	BMI (kg/m ²)				WC (cm)				WHR (cm)			
	Years 1-4		Years 9-11		Years 1-4		Years 9-11		Years 1-4		Years 9-11	
	R-value	P-value	R-value	P-value	R-value	P-value	R-value	P-value	R-value	P-value	R-value	P-value
Energy-dense food groups												
Savoury snacks	0.007	0.807	0.069	0.069	-0.038	0.124	0.086	0.053	0.026	0.404	0.012	0.792
Carbonated & soft drinks	0.036	0.179	0.077	0.078	0.072	0.020	0.157	<0.001	0.033	0.292	0.153	0.003
Buns, cakes, pastries & biscuits	0.057	0.008	0.053	0.081	0.073	0.003	0.030	0.400	0.005	0.825	0.007	0.853
Sugar & chocolate confectionery	0.017	0.507	0.125	<0.001	0.006	0.823	0.157	<0.001	-0.045	0.110	0.068	0.092
Oils & spreads	0.044	0.026	0.035	0.203	0.033	0.135	0.038	0.240	0.024	0.274	0.032	0.313
Fruits and vegetables												
Fruits	-0.056	0.011	-0.055	0.070	-0.028	0.197	-0.094	0.007	-0.069	0.005	-0.100	0.004
Vegetables	-0.008	0.668	-0.042	0.120	-0.038	0.124	-0.053	0.099	-0.071	0.001	-0.064	0.044

BMI, body mass index; WC, waist circumference; WHR, waist-hip ratio.

R-value and P-value obtained from partial correlation; adjusted for age, sex, and misreporting; statistical significance presented in bold.