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Dietary Approaches to Stop Hypertension (DASH) diet and associated socio-economic inequalities in the UK

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Abstract

The Dietary Approaches to Stop Hypertension (DASH) diet is an effective measure in the prevention and treatment of CVD. We evaluated recent trends in socio-economic differences in the DASH score in the UK population, using education, occupation and income as proxies of socio-economic position (SEP). We analysed data on 6416 subjects aged 18 years and older collected in the National Diet and Nutrition Survey (2008–2016). The DASH score was calculated using sex-specific quintiles of DASH items. Multiple linear regression and quantile regression models were used to evaluate the trend in DASH score according to SEP. The mean DASH score was 24 (SD 5). The estimated mean difference between people with no qualification and those having the highest level of education was −3·61 (95 % CI −4·00, −3·22) points. The mean difference between subjects engaged in routine occupations and those engaged in high managerial and professional occupations was −3·41 (95 % CI −3·89, −2·93) points and for those in the first fifth and last fifth of the household income distribution was −2·71 (95 % CI −3·15, −2·28) points. DASH score improved over time, and no significant differences in the trend were observed across SEP. The widest socio-economic differences emerged for consumption of fruit, vegetables, whole grains, nuts, seeds and legumes. Despite an overall increase in the DASH score, a persisting SEP gap was observed. This is an important limiting factor in reducing the high socio-economic inequality in CVD observed in the UK.

Key words: **Dietary Approaches to Stop Hypertension: Socio-economic inequalities: National Diet and Nutrition Survey**

CVD is a leading cause of morbidity and mortality worldwide[1]. The UK is among the countries with the highest incidence of CVD in Western Europe accounting for one in four premature deaths[2]. Recent trends in the UK show that, despite the overall decreasing CVD mortality rates, more favourable trends amongst the highest socio-economic groups have widened relative inequality[3]. The most deprived individuals are almost twice as likely to die from CVD than those having more resources[4].

Diet is a key modifiable risk factor for CVD and is among the contributing factors to socio-economic inequalities in CVD morbidity and mortality[1,5–7]. A poorer diet has long been reported in low socio-economic position (SEP) individuals, and thus, improving the diet of people of low SEP is of utmost importance to reduce the burden of disease[7–9]. The Dietary Approaches to Stop Hypertension (DASH) diet has been proved effective in lowering blood pressure in patients with CVD as well as to prevent risk factors for CVD in the general population[10]. The DASH diet is high in fruits and vegetables, moderate in low-fat dairy products and low in animal protein but with substantial amount of plant protein from legumes and nuts[11]. The cost of consuming such a diet, however, could be a barrier among people with low SEP[12–14].

In this study, we evaluated recent trends of the DASH score across socio-economic strata of the UK population, using education, occupation and income as proxies of the SEP.

Experimental methods

Data source

We analysed three waves (2008–2012, 2013–2014, 2015–2016) of the UK National Diet and Nutrition Survey (NDNS). The NDNS is an annual rolling cross-sectional survey carried out on behalf of Public Health England and the Food Standards Agency. It is designed to assess the diet, nutrient intake and nutritional status of a representative sample of UK adults and children. Households were randomly sampled from the UK Postcode Address File, with one adult and one child (18 months

Abbreviations: DASH, Dietary Approaches to Stop Hypertension; NDNS, National Diet and Nutrition Survey; SEP, socio-economic position.

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or older) or one child selected for inclusion. Socio-demographic data, lifestyle behaviours, dietary habits as well as height and weight were collected during a computer-assisted personal interview. We included all subjects aged 18 years and older at the time of interview. We excluded as implausible total daily energy intakes that were below 2092 kJ or above 20 920 kJ/d[15]. Written informed consent was obtained from participants or their parents/guardians. The survey was conducted according to the Declaration of Helsinki guidelines. Ethical approval for the NDNS was obtained from the Oxfordshire A Research Ethics Committee and the Cambridge South NRES Committee (reference no. 13/EE/0016)[16,17].

Dietary records

Respondents were asked to complete a dietary record for four consecutive days (including weekends and weekdays), giving a detailed description of each item consumed, the time of consumption and the amount (using household measures and photographs). Information on missing food items was collected on repeat visits by interviewers. Trained diet coders then entered the food intake data from completed recordings using an in-house dietary assessment system[16,17].

Outcomes

The DASH score was the primary outcome of the study, while the single components of the DASH score were the secondary outcomes. The DASH score was computed according to the method described in Fung *et al.*[18], where points (from 1 to 5) were assigned based on sex-specific quintiles of intake in order of most consumption for fruit; vegetables (excluding potatoes); whole grains; low-fat dairy products; and nuts, seeds and legumes. Quintiles for red and processed meats, free sugar and Na were assigned 1–5 points in order of least consumption. According to this algorithm, the overall DASH score ranged between 8 (lowest compliance) and 40 points (highest compliance)[18,19]. To compute the DASH score, we retrieved variables for fruit and vegetables, free sugar and Na intake from the NDNS archive. Using disaggregated foods from the database, we derived the intakes of whole grains, low-fat dairy products, nuts, seeds and legumes as well red and processed meats. Details of what was included in each of these components can be found in the Supplements (online Supplementary Table S1).

Variables of socio-economic position

We used three proxies to define the SEP of the individuals: education, occupation-based social class and income.

The original variables for the highest attained educational qualification included eight categories: (1) degree or equivalent; (2) higher education, below degree level; (3) General Certificate of Education, A level or equivalent; (4) General Certificate of Secondary Education grades A–C or equivalent; (5) General Certificate of Secondary Education grades D–G/Commercial qualifications/apprenticeship; (6) foreign or other qualifications; (7) no qualifications and (8) still in full-time education[16,17]. In the present analysis, categories 3–5 were merged in the same category (General Certificate of Secondary Education) as these categories correspond to academic school-leaving qualifications typically completed between 16 and 18 years or vocational courses of an equivalent level. From the analysis of education, we excluded 'foreign or other qualifications' since this category included individuals with different levels of education; full-time students since they did not complete their education programme; and individuals with missing values.

The occupation-based social class of the individual was reported according to the National Statistics of Socio-Economic Classification (NS-SEC8) which includes (1) routine; (2) semi-routine; (3) lower supervisory and technical; (4) small employers and own account holders; (5) intermediate; (6) lower managerial and professional; (7) higher managerial and professional and (8) never worked[16,17,20]. From the analysis of occupation-based social class, we excluded the category 'never worked' (it is likely that this category included sick and disabled individuals whose dietary choices could be affected by the underlying condition); long-term unemployed individuals (as there was no information in the survey questionnaire to assign them to a specific category) and individuals with missing values.

Total household income over the previous 12 months was equivalised to adjust for the presence of other adults and children in the household. Each household member was given a standard weight (0·67 for the first adult, 0·33 for other adults, 0·20 for each additional child aged <14 years, and 0·33 for each additional child aged 14 years and over). Then, household income was divided by the sum of the standard weights. Equivalisation allows a comparison across households of different sizes and compositions[16,17]. The median values of each household income over each year were then used to categorise the income into quartiles.

Other variables

In this analysis, we also used ethnic group and BMI. For ethnic group, the original variable included the following groups: White, mixed ethnic group, Black or Black British, Asian or Asian British and any other group. Since the majority of the survey population was White (93 %), we grouped all the non-White individuals in the same category. BMI was obtained as weight (kg) divided by height-squared (m^2), and it was categorised as underweight (<18·5 kg/m^2), normal weight (18·5–24·9 kg/m^2), overweight (25–29·9 kg/m^2) and obesity (≥30 kg/m^2)[16,17].

Statistical analysis

Demographic, socio-economic variables and BMI across survey years were presented as counts and percentages. Trends over the survey period (in the proportion of males, Whites, overweight individuals, mean age, individuals with no qualification, routine occupation and income) were evaluated through logistic regression models (for categorical variables) or using linear regression models (for continuous variables) including the calendar year (in continuous) as independent variable.

We fitted multiple linear regression models to evaluate the association between socio-economic variables and the DASH score. The models included terms for sex, ethnic group (Whites and non-Whites), age (as linear and quadratic term to account for non-linear relationship between age and the

DASH score), socio-economic variable, survey year and an interaction term between the socio-economic variable and the survey year. The *F* test was used to test the significance of each term included in the regression models.

Since the distribution of each component of the DASH score was highly skewed, we carried out a quantile regression analysis to model the median intake of each component of the DASH score as a function of the socio-economic variable and the survey year[21]. For sugar-sweetened beverages, we modelled the 80th centile instead of the median as more than 50 % of subjects reported an intake of 0 ml/d. These models included the same set of terms used in the main analysis. Wald's test was used to verify the significance of each term included in the quantile regression models[22]. All statistical tests were two-sided with $\alpha = 0{\cdot}05$. Results were also shown graphically by plotting the predicted values of the regression models in the two extreme categories of the SEP variables. All analyses were performed using R (version 3.5.0), and quantile regression models were fitted using the package 'quantreg'.

Results

The study included 6416 adults (3741 women and 2675 men) included in the database. Nineteen subjects were excluded due to unreliable daily energy intake. Table 1 gives their demographic and socio-economic characteristics by survey year. More women were enrolled in each wave of the survey, but the proportion of men and women did not change over the period. More than 90 % of subjects were Whites, although the proportion of non-Whites increased over the period. Mean age was 48 years (range 18–96 years), with no significant differences across survey years. One-quarter of subjects were obese and almost one-third overweight and these figures remained constant over the period. The proportion of individuals with no qualification significantly decreased, while there was no difference in the proportion of individuals engaged in routine occupations. Household income also tended to increase over the period.

Table 2 shows the mean values of the DASH score across socio-economic groups. Less educated individuals, those engaged in routine occupations and subjects with lower incomes had lower values of the score compared with the individuals with higher SEP. There was a positive and significant association of the survey year, indicating that the DASH score increased over the period, while the interaction term between the survey year and the socio-economic variables was not significant showing that the trend was not different across socio-economic groups. Thus, the interaction term was not retained in the final models.

Table 3 gives the results of the regression models. The estimated mean difference in DASH score between people with no qualification and those having the highest level of education was −3·61 (95 % CI −4·00, −3·22) points. Similarly, the difference between people engaged in routine occupations and those engaged in high managerial and professional occupations was −3·41 (95 % CI −3·89, −2·93) points, and the estimated mean difference between subjects in the first fifth and last fifth of the household income distribution was −2·71 (95 % CI −3·15, −2·28) points.

Fig. 1 shows the estimated mean values of the DASH score according to survey year and SEP. A gradient relationship between DASH score and all socio-economic variables emerged, with increasing values of the score at higher SEP.

The results of the quantile regression models are reported in the Supplements (online Supplementary Tables S2–S4). Figs. 2, 3 and 4 show the median intake of each component of the DASH score estimated for the extreme categories of education, occupation and household income, respectively. The widest socio-economic differences emerged for consumption of fruit, vegetables, whole grains, nuts, seeds and legumes. Over the period, consumption of whole grains, nuts, legumes and seeds generally increased and was mirrored by a reduction in the intake of red and processed meat, sugar-sweetened beverages and Na.

Discussion

We found that the DASH score increased over time in all socio-economic groups in the UK; however, less educated individuals, those engaged in routine occupations and subjects with lower incomes had lower scores, indicating a persisting socio-economic gap. This gap was mainly driven by a lower intake of fruit, vegetables, whole grains, nuts, legumes and seeds.

Of note, we observed a gradient relationship between the DASH score and all SEP variables analysed. Similar patterns of association were found in previous studies investigating the relationship between SEP and tobacco smoking, obesity, low physical activity, prevalence and treatment of hypertension[23] as well as CVD mortality[24].

Our results are consistent with other published UK studies, which reported that overall population compliance to four key UK recommendations (fruit and vegetable intake, oily fish intake, salt intake and red and processed meat intake) was low to moderate, but improved over time[25–27].

In line with our analysis, a systematic review of eleven European studies found that individuals in high SEP have higher consumption of fruit and vegetables[28]. Similarly, a study looking at the NDNS data reported that those in the highest socio-economic groups consumed up to 128 g/d more fruit and vegetables[26]. Another study from the UK reported that high-income groups not only consumed more vegetables and fruit but also consumed lower amounts of processed meat, sweet snacks and processed potato products (chips and crisps)[29]. Moreover, high-income groups consumed more grams of fibre per 4184 kJ, a greater percentage of their energy derived from total sugars and proteins and their intake of Na was 3 % less than that of lower income groups.

Interestingly over the time, our results showed a lower consumption of sugar-sweetened beverages and a decrease in Na in all groups. The gradual decrease in Na consumption across all socio-economic groups is likely an encouraging reflection of the UK Salt Reduction Programme[30].

A range of mechanisms are at work in determining food intake across all socio-economic groups[13,31–33]. Accessibility, availability, cost, food preferences, as well as nutritional knowledge and socio-cultural norms all influence a dietary choices[34].

The influence of education and occupation on dietary choices could be indirect and partially mediated by income[33,35].

Table 1. Demographic and socio-economic characteristics of the study population by survey
(Numbers and percentages; mean values and standard deviations; medians and quintile 1–quintile 4 (Q1–Q4))

	2008–2009		2009–2010		2010–2011		2011–2012		2012–2013		2013–2014		2014–2015		2015–2016		$P_{for\ trend}$*
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
Sex																	
Males	355	42·5	369	43·5	365	44·0	430	39·7	264	40·2	265	38·8	335	45·3	292	39·5	0·243
Females	481	57·5	479	56·5	464	56·0	654	60·3	393	59·8	418	61·2	404	54·7	448	60·5	
Age (years)																	0·202
Mean	48·1		48·3		47·3		48·9		48·7		48·8		48·9		48·7		
SD	18·4		18·5		18·5		17·6		18·3		18·6		19·2		18·2		
Race																	
White	786	94·0	801	94·4	770	92·9	1020	94·1	599	91·2	634	92·8	680	92·0	664	89·7	<0·001
Mixed ethnic group	9	1·1	4	0·5	7	0·8	13	1·2	4	0·6	8	1·2	4	0·5	11	1·5	
Black or Black British	18	2·2	15	1·8	19	2·3	15	1·4	18	2·7	11	1·6	14	1·9	23	3·1	
Asian or Asian British	17	2·0	17	2·0	21	2·5	25	2·3	21	3·2	21	3·1	31	4·2	27	3·6	
Any other group	6	0·7	11	1·3	12	1·5	11	1·0	15	2·3	9	1·3	10	1·4	8	1·1	
Not available	0		0		0		0		0		0		0		7	1·0	
BMI (kg/m^2)																	
<18·5	11	1·3	15	1·8	12	1·4	15	1·4	15	2·3	9	1·3	14	1·9	10	1·3	0·996
18·5–24·9	279	33·4	271	31·9	270	32·6	322	29·7	231	35·1	227	33·2	228	30·9	235	31·8	
25·0–30·0	291	34·8	290	34·2	273	32·9	353	32·6	222	33·8	236	34·6	251	34·0	245	33·1	
≥30	210	25·1	228	26·9	212	25·6	317	29·2	151	23·0	186	27·2	189	25·5	188	25·4	
Not available	45	5·4	44	5·2	62	7·5	77	7·1	38	5·8	25	3·7	57	7·7	62	8·4	
Education																	0·006
Degree or equivalent	168	20·1	169	20·0	187	22·5	227	20·9	172	26·2	150	22·0	179	24·2	205	27·8	
Higher education, below degree level	218	26·1	190	22·4	210	25·3	298	27·5	148	22·5	142	20·8	153	20·7	151	20·5	
General Certificate of Secondary Education	168	20·1	180	21·2	167	20·1	225	20·8	112	17·1	162	23·7	152	20·6	153	20·7	
No qualification	211	25·2	224	26·4	173	20·9	255	23·5	148	22·5	133	19·5	155	21·0	155	21·0	
Foreign	21	2·5	41	4·8	42	5·1	33	3·0	30	4·6	30	4·4	23	3·1	26	3·5	
Still in full-time education	40	4·8	40	4·7	50	6·0	41	3·8	43	6·5	33	4·8	37	5·0	44	6·0	
Not available	10	1·2	4	0·5	0		2	0·5	4	0·6	31	4·8	39	5·4	4	0·5	
Occupation																	0·804
Higher managerial and professional occupations	109	13·0	110	13·0	119	14·4	141	13·0	128	19·5	106	15·5	115	15·6	108	14·6	
Lower managerial and professional occupations	207	24·8	228	26·9	209	25·2	255	23·5	151	23·0	157	23·0	173	23·4	175	23·7	
Intermediate occupations	79	9·4	65	7·7	89	10·7	113	10·4	64	9·7	83	12·2	65	8·8	64	8·6	
Small employers and own account workers	88	10·6	85	10·0	95	11·5	118	10·9	71	10·8	67	9·8	88	11·9	89	12·0	
Lower supervisory and technical occupations	97	11·6	98	11·5	84	10·1	86	7·9	58	8·8	51	7·5	67	9·1	63	8·5	
Semi-routine occupations	111	13·3	123	14·5	106	12·8	170	15·7	80	12·2	104	15·2	97	13·1	120	16·2	
Routine occupations	104	12·4	100	11·8	92	11·1	156	14·4	65	9·9	76	11·1	101	13·7	91	12·3	
Never worked	19	2·3	21	2·5	29	3·5	20	1·8	21	3·2	25	3·7	28	3·8	19	2·6	
Long-term unemployed	22	2·6	18	2·1	6	0·7	18	1·7	19	2·9	11	1·6	3	0·4	6	0·8	
Not available	0	0·0	0	0·0	0	0·0	7	0·7	0	0·0	3	0·4	2	0·3	5	0·7	
Income (£, thousands)																	
Median	25·6		26·8		27·5		24·1		24·7		26·4		27·5		27·9		0·052
Q1–Q4	12·3–44·1		12·8–44·1		13·2–42·5		12·3–45·1		12·9–47·5		12·5–45·1		13·1–45·0		12·5–49·2		
Not available	112	13·4	104	12·3	124	15·0	188	17·3	82	12·5	96	14·1	108	14·6	110	14·9	0·243

* Trends over the survey period in the proportion of males, White individuals, mean age, overweight, individuals with no qualification, routine occupation and income were tested including the calendar year (in continuous) in logistic regression models (for categorical variables) or linear regression models (for continuous variables).

Table 2. Dietary Approaches to Stop Hypertension score according to socio-economic groups and survey years (Mean values and standard deviations)

	2008		2009		2010		2011		2012		2013		2014		2015		SEP effect (P)*	Survey year effect (P)*	SEP × survey year effect (P)*
Socio-economic position variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
Education																			
Degree or equivalent	25·5	5·4	25·8	4·9	25·4	5·3	24·9	5·3	26·4	5·1	26·5	5·3	26·4	5·0	26·1	5·2	<0·001	<0·001	0·192
Higher education, below degree level	22·9	5·5	23·8	5·2	23·4	5·4	23·8	5·3	24·3	4·9	24·1	5·5	23·4	5·4	24·4	5·1			
General Certificate of Secondary Education	22·0	5·5	22·1	5·9	21·8	5·6	22·3	5·5	23·6	6·2	23·5	5·4	23·9	5·8	24·0	6·2			
No qualification	22·5	5·2	22·5	5·2	23·3	5·3	24·2	5·1	23·6	4·9	23·2	5·2	23·5	4·6	24·4	5·0			
Occupation																			
Higher managerial and professional occupations	24·9	4·9	25·2	4·9	25·9	5·0	25·5	5·4	26·3	5·2	25·4	5·4	25·3	5·1	26·3	5·2	<0·001	<0·001	0·120
Lower managerial and professional occupations	23·7	5·6	24·3	5·5	24·0	5·3	24·7	5·2	24·1	5·5	25·4	5·4	25·4	5·2	25·6	5·5			
Intermediate occupations	22·5	5·3	23·2	5·1	23·3	5·4	23·9	5·6	24·2	5·6	23·9	5·4	24·3	5·6	24·4	5·1			
Small employers and own account workers	24·0	5·6	23·9	5·8	23·0	5·0	24·0	5·2	24·9	4·6	24·0	5·0	24·9	5·3	23·7	5·4			
Lower supervisory and technical occupation	22·6	5·1	23·0	5·5	23·0	5·9	23·3	5·4	24·2	5·6	22·3	5·9	23·0	5·6	25·0	5·0			
Semi-routine occupations	22·3	5·4	22·4	5·5	21·9	5·3	22·4	5·3	24·1	5·4	23·2	5·0	23·4	5·1	24·2	5·7			
Routine occupations	21·0	6·0	20·9	5·3	21·3	5·5	22·8	5·4	22·5	5·3	23·2	5·5	22·6	5·2	23·1	5·1			
Household income																			
≤Q1	21·5	5·2	21·3	5·4	22·6	5·6	22·5	5·4	23·0	5·2	22·5	5·1	22·7	5·9	23·6	5·9	<0·001	<0·001	0·942
Q1–Q2	22·7	5·9	23·0	5·8	22·1	5·3	23·5	6·0	24·2	5·4	23·3	5·3	23·8	5·8	24·6	5·7			
Q2–Q3	23·6	5·5	23·7	5·5	23·4	5·5	23·8	5·1	24·0	5·9	24·8	5·5	24·2	5·0	24·7	5·3			
Q3–Q4	23·4	5·7	24·4	5·6	23·8	5·5	24·5	5·2	24·5	5·6	24·3	5·5	25·5	4·9	25·0	5·5			
≥Q4	23·9	5·2	24·7	5·0	25·2	4·9	24·5	5·1	26·3	5·0	25·8	5·3	25·1	5·2	25·9	5·3			

Q, quintile.

* P values were obtained from the F test comparing nested multiple linear regression models with and without the term. The models included also sex, age (centred at mean), age^2 and ethnic group (Whites and non-Whites) as covariates.

Table 3. Results of the multiple linear regression models used to evaluate the relationship between socio-economic variables and the Dietary Approaches to Stop Hypertension score*
(β Values and 95 % confidence intervals)

	Model 1		Model 2		Model 3	
Parameter†	β	95 % CI	β	95 % CI	β	95 % CI
Intercept	23·14	22·3, 23·97	22·06	21·28, 22·84	21·19	20·38, 22·00
Female sex	0·42	0·16, 0·69	0·55	0·29, 0·81	0·52	0·25, 0·80
Non-White	1·80	1·26, 2·32	2·23	1·72, 2·74	2·65	2·12, 3·19
Age (years)	0·12	0·11, 0·13	0·10	0·09, 0·11	0·10	0·09, 0·11
Age^2	−0·0019	−0·0023, −0·0015	−0·0018	−0·0022, −0·0015	−0·0014	−0·0018, −0·0010
Survey year	0·17	0·11, 0·22	0·20	0·14, 0·25	0·20	0·14, 0·26
Education						
Higher education below degree level	−1·78	−2·13, −1·42				
General Certificate of Secondary Education	−2·81	−3·18, −2·44				
No qualification	−3·61	−4·00, −3·22				
Occupation						
Low managerial and professional			−0·96	−1·37, −0·55		
Intermediate			−1·87	−2·38, −1·35		
Small employers and own account workers			−1·76	−2·26, −1·27	–	
Lower supervisory and technical	–		-2·36	−2·88, −1·85	–	
Semi-routine	–		−2·64	−3·10, −2·18		
Routine	–		−3·41	−3·89, −2·93	–	
Household income						
Q3–Q4	–		–		−0·67	−1·11, −0·24
Q2–Q3	–		–		−1·39	−1·82, −0·96
Q1–Q2	–		–		−1·86	−2·29, −1·44
≤Q1	–		–		−2·71	−3·15, −2·28

Q, quintile.
* All models included sex (reference category: male), ethnic group (reference category: Whites), age (centred at mean), age^2, survey year and one of the socio-economic variables among highest education attainment (model 1) (reference category: degree or equivalent), occupation-based social class (model 2) (reference category: high managerial and professional) and equalised household incomes (model 3) (above the 4th quintile of the distribution).
† Reference categories: male (sex), White (race), degree or equivalent (education), higher managerial and professional (occupation) and ≥Q4 (household income).

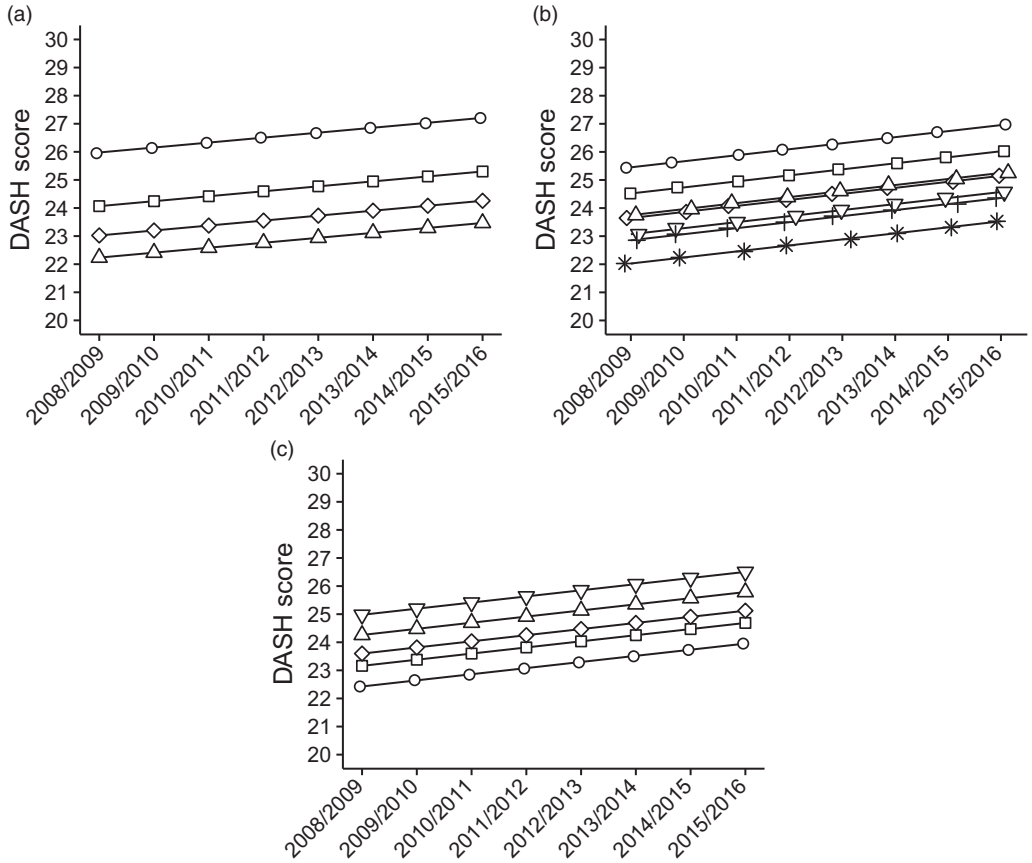

Fig. 1. Estimated mean values of the Dietary Approaches to Stop Hypertension (DASH) score according to survey year and education (a), occupation (b) or income (c). Estimates were obtained at a mean age of 48 years (mean age of the survey population) from linear regression models including survey year, age and one of the socio-economic variables (education, occupation-based social class and income). Education: ○, degree or equivalent; □, higher education, below degree level; ◇, GCSE; △, no qualification. Occupation: ○, high managerial and professional occupation; □, low managerial and professional occupation; ◇, intermediate occupation; △, small employers and own account workers; ▽, lower supervisory and technical occupation; +, semi-routine occupation; ✳, routine occupation. Income: ○, ≤ quintile 1 (Q1); □, Q1–Q2; ◇, Q2–Q3; △, Q3–Q4; ▽, Q4.

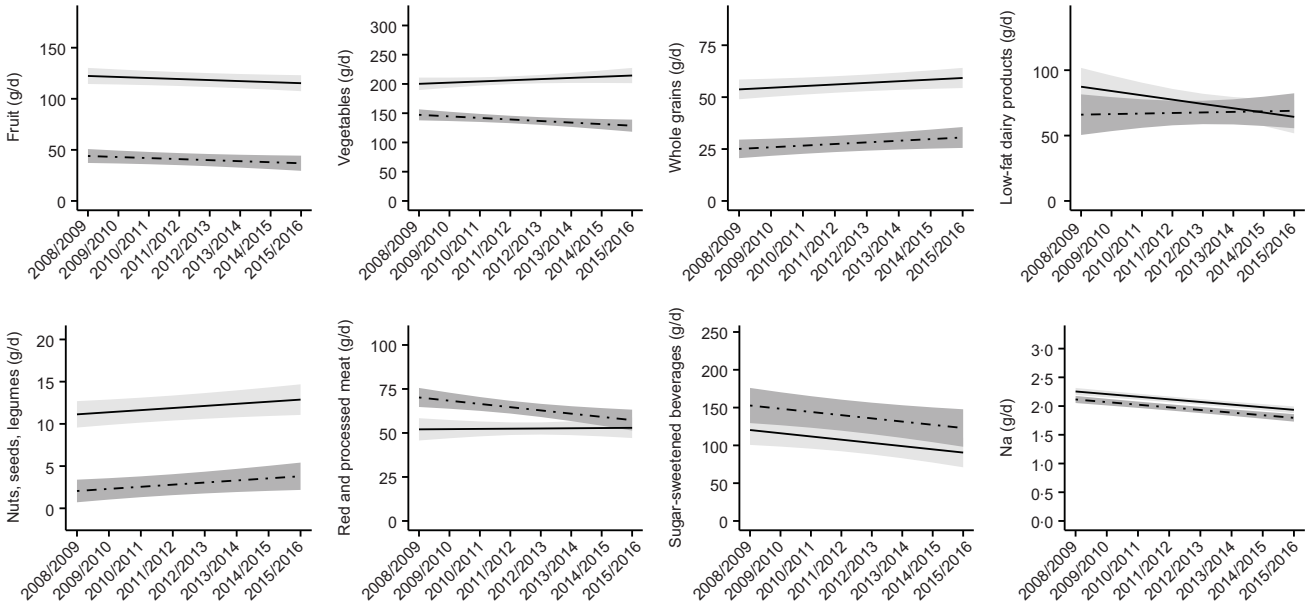

Fig. 2. Estimated median or 80th percentile intake (for sugar-sweetened beverages) of each component of the Dietary Approaches to Stop Hypertension score in individuals with degree or equivalent qualification and those with no qualification according to survey year. Estimates were obtained at a mean age of 48 years (mean age of the survey population) from quantile regression models including survey year, age and education. Education: ——, degree or equivalent; · – ·, no qualification.

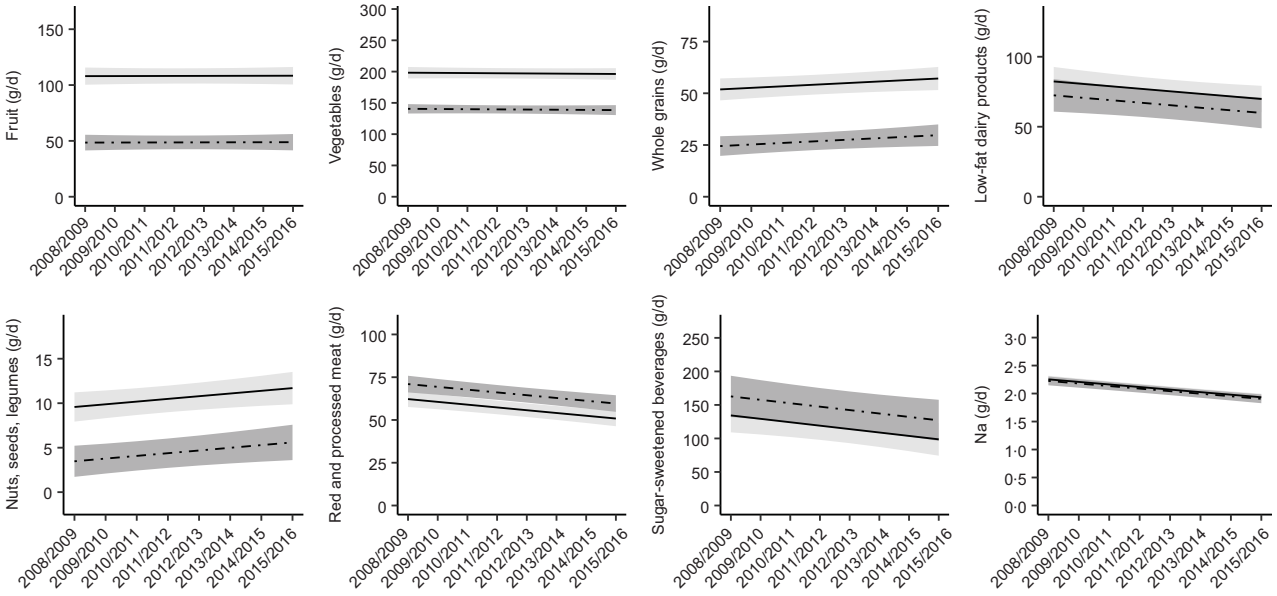

Fig. 3. Estimated median or 80th percentile intake (for sugar-sweetened beverages) of each component of the Dietary Approaches to Stop Hypertension score among high managerial and routine manual workers according to survey year. Estimates were obtained at a mean age of 48 years (mean age of the survey population) from quantile regression models including survey year, age and occupation-based social class. Occupation: ——, high managerial; · – ·, routine.

High food cost could be a barrier against adopting a healthy diet among people of low SEP[14,36,37]. Differences in the price of 'healthy' and 'less healthy' foods and diets could contribute to obesity, non-communicable diseases such as CVD and their inequalities[34]. Some studies suggest that the income–diet and cost–diet pathway is stronger in lower educated individuals than in higher educated individuals[32,38–41]. In support of this, a recent study in Australia found that households with the lowest incomes are more vulnerable to increasing food prices, as they spend less per person on food[34]. Studies that estimated dietary costs in the UK showed that people who score more favourably on healthy diet indicators, as well as those who consume more fruit and vegetables tended to spend more on food or consume higher value diets[35]. An increase in the price of whole fruit may also drive consumers to buy more fruit juices instead of fruit[32].

Another interesting finding is the higher consumption of whole grains, nuts and legumes in the higher SEP groups. Whole grains and legumes are high in fibre, rich in vitamins,

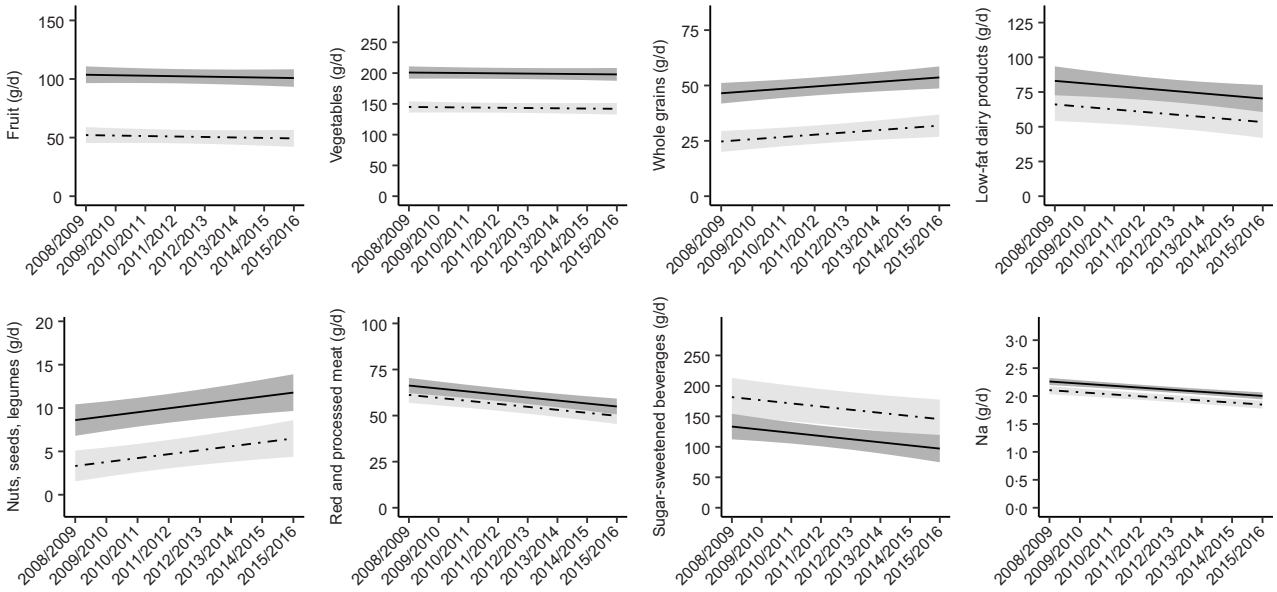

Fig. 4. Estimated median or 80th percentile intake (for sugar-sweetened beverages) of each component of the Dietary Approaches to Stop Hypertension score among those in the lowest (Q1) and highest fifth (≥Q4) of the distribution of equivalised household income. Estimates were obtained at a mean age of 48 years (mean age of the survey population) from quantile regression models including survey year, age and household income. Income: · – ·, ≤ quintile 1 (Q1); ——, ≥Q4.

minerals and phytochemicals, and epidemiological evidence suggests an inverse association between whole grain, fibre consumption and the risk of non-communicable diseases such as CVD[42]. Furthermore, whole grains and legumes are essential to meet the recommendation by the UK Scientific Advisory Committee on Nutrition to increase dietary intake of fibre up to 30 g/d[43].

This study has important strengths. Firstly, this is the first study to explore recent trends of socio-economic dietary inequality in relation with the DASH diet among the UK adult population using a number of different socio-demographic indicators. We used three proxies of SEP that, although correlated, act through different mechanisms in generating socio-economic disparities in lifestyle risk factors and health[44]. While education reflects the ability of the individual to understand and act in response to health promoting messages, occupation and income better indicate material resources, prestige, job control and effort–reward imbalance[45,46]. Secondly, the analysis was based on the NDNS data, a high-quality, representative, up-to-date UK data source. Results are thus generalisable on a population level and can be compared with other recent studies. Finally, food and nutrient data were gathered from a self-reported 4-d diary, which provides better representation of usual consumption than FFQ or 24-h dietary recalls, commonly used in epidemiological studies.

The study has also some limitations. Firstly, the cross-sectional nature of the study limits our findings since trends in compliance with the DASH plan were not estimated on the same individuals but on different individuals over time. Secondly, as in most nationwide population surveys, the most deprived groups may be under-represented (i.e. homeless, unemployed or migrants not speaking English) as they are less likely to participate in the survey[26,47]. Although measures were taken by the NDNS team to reduce the effect of potential non-response bias[16,17]. Finally, food diaries are self-reported and are then subject to recall bias and misreporting.

In conclusion, in the UK, people with low SEP have a lower DASH score and this gap persisted over the last decade despite an overall increase in the score. This is an important limiting factor in reducing the high socio-economic inequality in CVD observed in the UK and calls for more effective promotion of healthy diet in the most disadvantaged individuals.

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L. P. conceptualised the study; L. P. and G. A. designed the study; G. A. performed the data analysis; L. P. and G. A. wrote the original draft and all authors reviewed and edited drafts. C. L. V. was responsible for overall supervision. All authors read and approved the final manuscript.

The authors declare that there are no conflicts of interest.

Supplementary material

For supplementary material referred to in this article, please visit https://doi.org/10.1017/S0007114520001087.

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