Dietary approach to stop hypertension (DASH) diet and associated socioeconomic inequalities in the United Kingdom

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Abstract

The dietary approach to stop hypertension (DASH) diet is an effective measure in the prevention and treatment of CVD. We evaluated recent trends in socioeconomic differences in the DASH score in the UK population, using education, occupation and income as proxies of socioeconomic position (SEP). We analyzed data on 6416 subjects aged 18 and older collected in the National Diet and Nutrition Survey (NDNS 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 (standard deviation: 5). The estimated mean differences between people with no qualification and those having the highest level of education was -3.61 points (95% CI: -4.00; -3.22). The mean difference between subjects engaged in routine occupations and those engaged in high managerial and professional occupations was -3.41 points (95% CI: -3.89; -2.93) and for those in the first fifth and last fifth of the household income distribution was -2.71 points (95% CI: -3.15; -2.28). DASH score improved over time and no significant differences in the trend were observed across SEP. The widest socioeconomic differences emerged for consumption of fruit, vegetables, wholegrains, 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 socioeconomic inequality in CVD observed in the UK.

Keywords: Dietary Approaches to Stop Hypertension, Socio-economic inequalities, National Diet and Nutrition Survey

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Introduction

Cardiovascular disease (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 socioeconomic 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 socioeconomic inequalities in CVD morbidity and mortality[1,5-7]. A poorer diet has long been reported in low 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 approach 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 socioeconomic 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 or older) or one child selected for inclusion. Sociodemographic 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 and older at the time of interview. We excluded as implausible total daily energy intakes that

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were below 500 kcal or above 5000 kcal per day [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 (Ref. 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; nuts, seeds and legumes. Quintiles for red and processed meats, free sugar and sodium 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 sodium 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 (Table S1).**

Variables of socioeconomic position (SEP)

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) GCE, A level or equivalent; 4) General Certificate of Secondary Education (GCSE) grades A-C or

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equivalent; 5) GCSE 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 to 5 were merged in the same category (GCSE) as these categories correspond to academic school-leaving qualifications typically completed between 16 – 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 level of education; full-time students since they did not complete their education program; and individuals with missing values.

The occupation-based social class of the individual was reported according to the National Statistics of Socioeconomic 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; 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); 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 less than 14 years and 0.33 for each additional child aged 14 and over). Then household income was divided by the sum of the standard weights. Equivalisation allows a comparison across households of different size and composition [16,17]. The median values of each household income over each year was 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. Body mass index (BMI) was obtained as weight (kg) divided by height squared (m^2) and it was categorized as

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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, socioeconomic 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 socioeconomic 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 nonlinear relationship between age and the DASH score), socioeconomic variable, survey year and an interaction term between the socioeconomic 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 socioeconomic variable and the survey year [21]. For sugar-sweetened beverages we modeled the 80th centile instead of the median since less the 50% of subjects reported intakes greater than 0. These models included the same set of terms used in the main analysis. The 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 α=0.05. Results were also shown graphically by plotting the predicted values of the regression models in the

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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 socioeconomic 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 fourth 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 socioeconomic groups. Less educated individuals, those engaged in routine occupations and subjects with lower incomes had lower values of the score compared to 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 socioeconomic variables were not significant showing that the trend was not different across socioeconomic 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 points (95% CI: -4.00; -3.22). Similarly, the difference between people engaged in routine occupations and those engaged in high managerial and professional occupations was -3.41 points (95% CI: -3.89; -2.93), and the estimated mean difference between subjects in the first fifth and last fifth of the household income distribution was -2.71 points (95% CI: -3.15; -2.28).

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

The results of the quantile regression models are reported in the **Supplements (Table S2-S4). Figure 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 socioeconomic 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 sodium.

Discussion

We found that the DASH score increased over time in all socioeconomic groups in the UK, however less educated individuals, those engaged in routine occupations and subjects with lower incomes had lower scores, indicating a persisting socioeconomic 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 analyzed. 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 11 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 128g/day 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 1000 kcal, a greater

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percentage of their energy derived from total sugars and proteins, and their intake of sodium 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 sodium in all groups. The gradual decrease in sodium 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 socioeconomic groups [13,31-33]. Accessibility, availability, cost, food preferences, as well as nutritional knowledge and sociocultural 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]. 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 (NCDs) 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 wholegrains, nuts and legumes in the higher SEP groups. Wholegrains and legumes are high in fibre, rich in vitamins, minerals and phytochemicals and epidemiological evidence suggests an inverse association between wholegrain, fibre consumption and the risk of non-communicable diseases such as CVD [42]. Furthermore, wholegrains and legumes are essential to meet the recommendation by the UK Scientific Advisory Committee on Nutrition to increase dietary intake of fiber up to 30 g/d [43].

This study has important strengths. Firstly, this is the first study to explore recent trends of socioeconomic dietary inequality in relation with the DASH diet among the UK adult population using a number of different sociodemographic indicators. We used three proxies of SEP that, although correlated, act through different mechanisms in generating socio-

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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 generalizable on a population level and can be compared to other recent studies. Finally, food and nutrient data were gathered from a self-reported four-day diary, which provides better representation of usual consumption than food frequency questionnaires 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 socioeconomic 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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Conflicts of interest: None

Authors' Contributions: Linia Patel conceptualised the study, Linia Patel and Gianfranco Alicandro designed the study, Gianfranco Alicandro performed the data analysis, Linia Patel and Gianfranco Alicandro wrote the original draft and all authors reviewed and edited drafts. Carlo La Vecchia was responsible for overall supervision. All authors read and approved the final manuscript."

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Figure legends

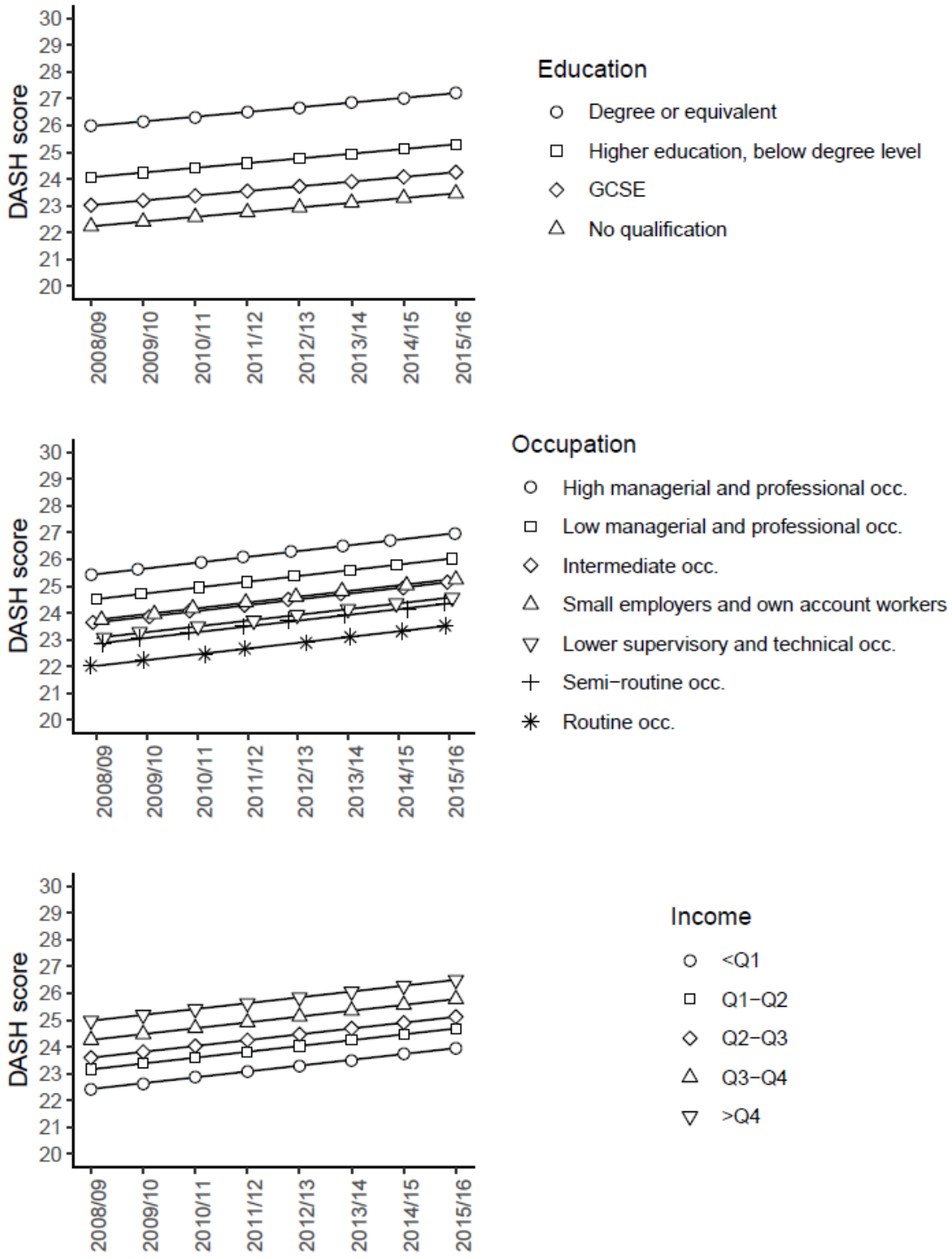

Figure 1. Estimated mean values of the DASH score according to survey year and socioeconomic position. Estimates were obtained at a mean age of 48 years (mean age of the survey population) from linear regression models including survey year, age and one of the socioeconomic variables (education, occupation based social class and income).

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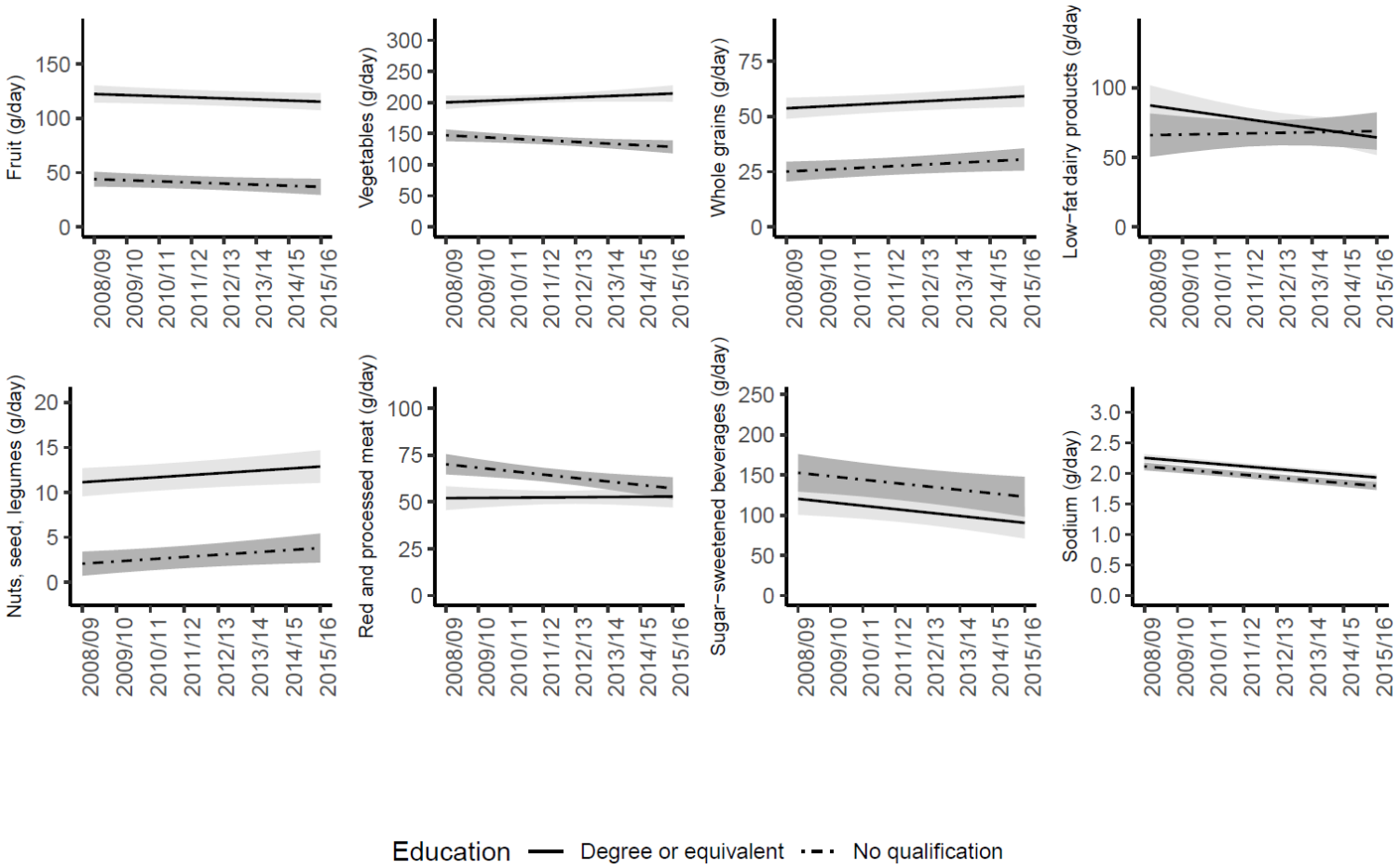

Figure 2. Estimated median intake of each component of the DASH score in individuals with degree or equivalent qualification and those with no qualification according to survey year. Estimates were obtained at a mean age of 48 years (mean age of the survey population) from quantile regression models including survey year, age and education.

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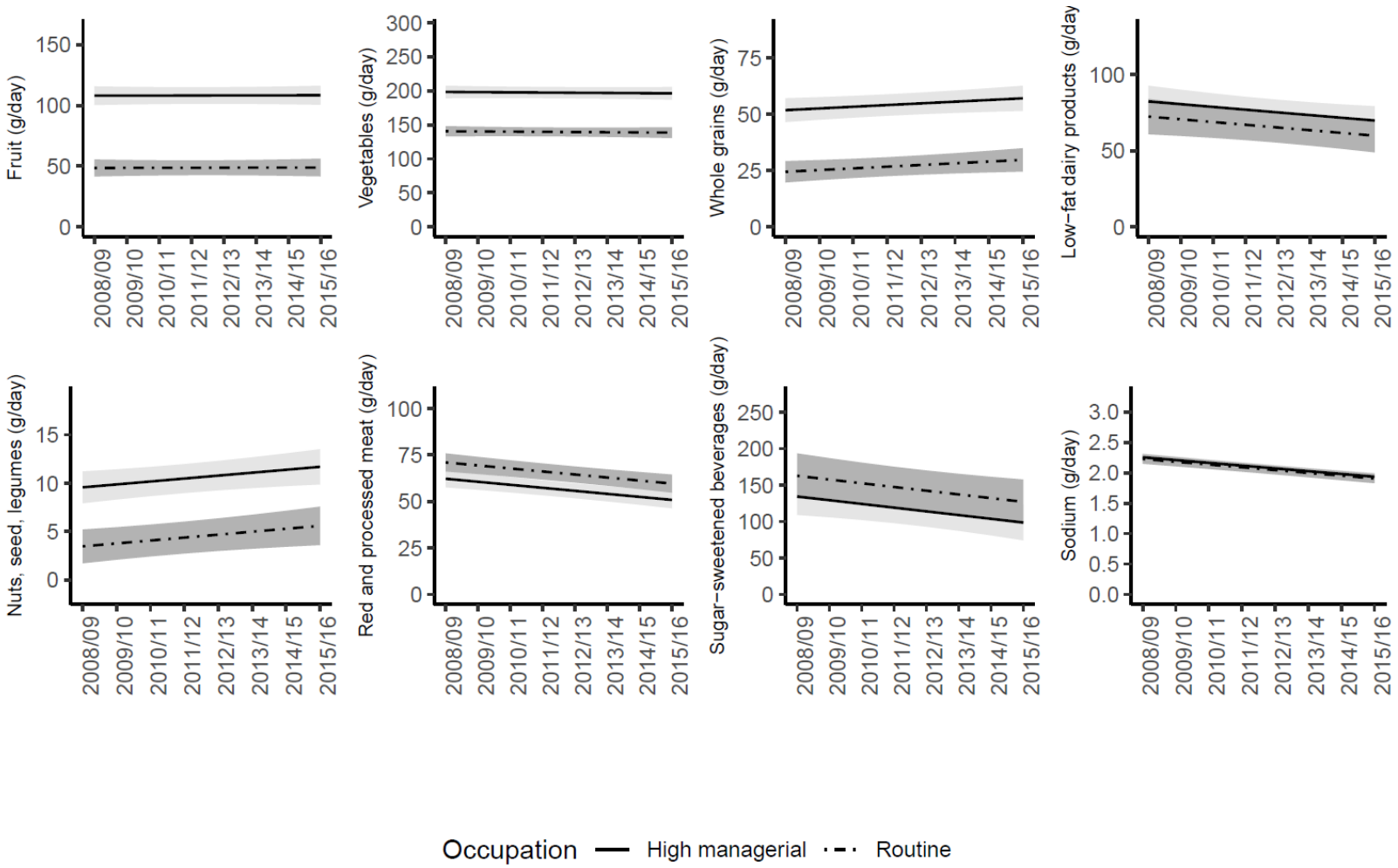

Figure 3. Estimated median intake of each component of the DASH score among high managerial and routine manual workers according to survey year. Estimates were obtained at a mean age of 48 years (mean age of the survey population) from quantile regression models including survey year, age and occupation-based social class.

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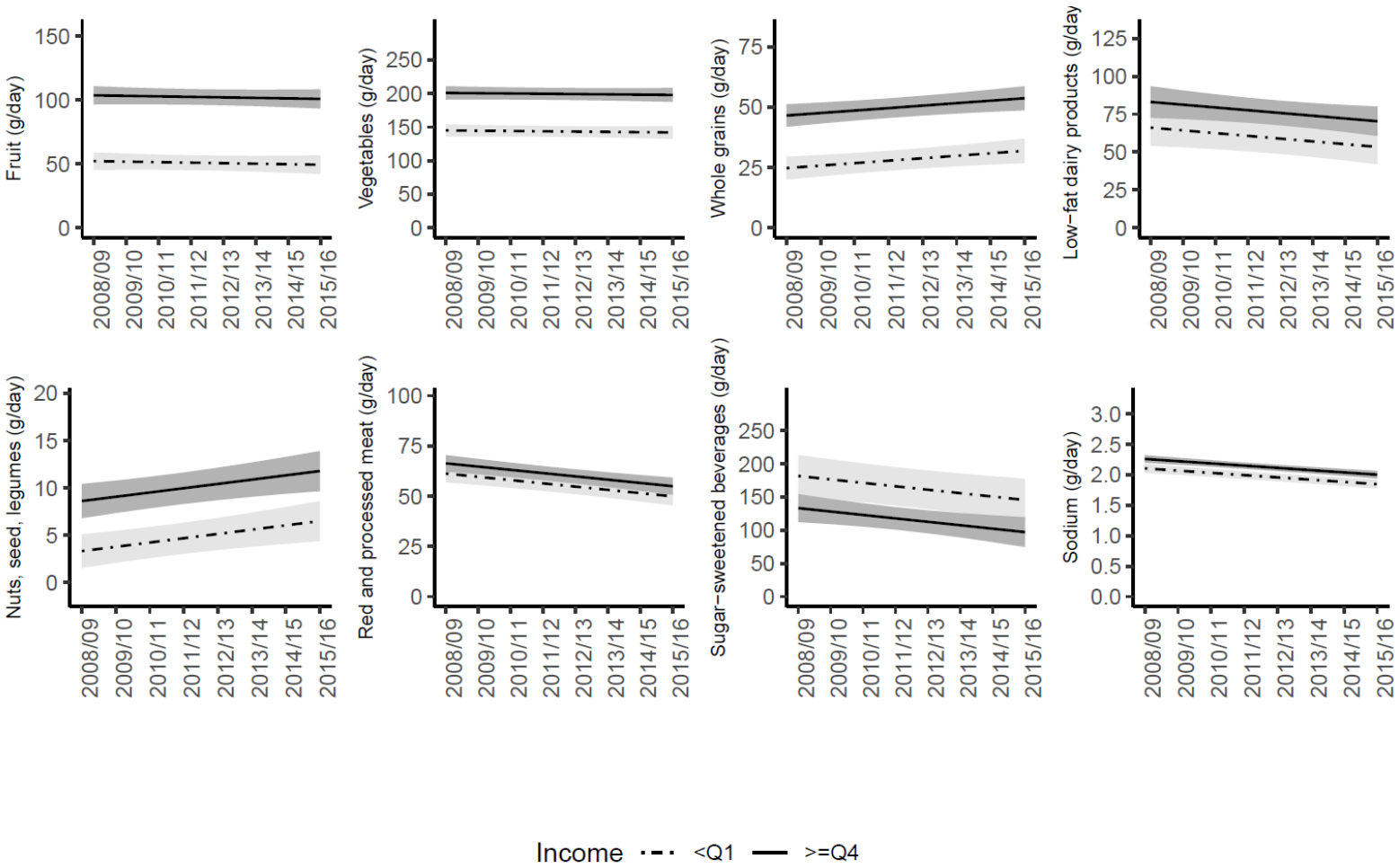

Figure 4. Estimated median intake of each component of the DASH score among those in the lowest (Q1) and highest fifth (>=Q4) of the distribution of equivalised household income. Estimates were obtained at a mean age of 48 years (mean age of the survey population) from quantile regression models including survey year, age and household income.

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Table 1. Demographic and socioeconomic characteristics of the study population by survey year.

	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	*P*-value for trend [a]
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)	.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									
Mean (SD)	48.1 (18.4)	48.3 (18.5)	47.3 (18.5)	48.9 (17.6)	48.7 (18.3)	48.8 (18.6)	48.9 (19.2)	48.7 (18.2)	.202
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)	<.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) 0	12 (1.5) 0	11 (1.0) 0	15 (2.3) 0	9 (1.3) 0	10 (1.4) 0	8 (1.1)	
Not available	0							7 (1.0)	
BMI (kg/m2)									
<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)	.996

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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									.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)	
GCSE	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									.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)	

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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 (Q1-Q4)	25.6 (12.3-44.1)	26.8 (12.8-44.1)	27.5 (13.2-42.5)	24.1 (12.3-45.1)	24.7 (12.9-47.5)	26.4 (12.5-45.1)	27.5 (13.1-45.0)	27.9 (12.5-49.2)	.052
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)	.243

GCSE: General Certificate of Secondary Education, Q: Quintile, SD: Standard Deviation,

[a] 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).

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Table 2. DASH score according to socioeconomic groups and survey years.

SEP variable	2008	2009	2010	2011	2012	2013	2014	2015	SEP effect (*P*-value) [a]	Survey year effect (*P*-value) [a]	SEP x Survey year effect (*P*-value) [a]
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)	<.001	<.001	.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)			
GCSE	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)	<.001	<.001	.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 occ.	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)	<.001	<.001	.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)			

Data are mean (Standard deviations)
GCSE: General Certificate of Secondary Education, Q: Quintile, SEP: Socioeconomic position
[a] *P*-values were obtained from F test comparing nested multiple linear regression models with and without the term. The models included also sex, age (centered at mean), age^2 and ethnic group (whites and non-whites) as covariates.

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Table 3. Results of the multiple linear regression models used to evaluate the relationship between socioeconomic variables and the DASH score

	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	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)	.	.
GCSE	-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)

CI: Confidence intervals, GCSE: General Certificate of Secondary Education, Q: Quintile

All models included sex (reference category: male), ethnic group (reference category: whites), age (centered at mean), age^2, survey year and one of the socioeconomic 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 4^{th} quintile of the distribution).

Reference categories: male (sex), white (race), degree or equivalent (education), higher managerial and professional (occupation) and >= Q4 (household income).

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