# The relationship between lower socioeconomic position and higher BMI is explained by the social patterning of health-based food choice motives in UK and US adults

Eric Robinson, Andrew Jones, Lucile Marty

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**Author names and affiliations:**

Eric Robinson, PhD, Department of Psychological Sciences, University of Liverpool, Liverpool, UK

Andrew Jones, PhD, Department of Psychological Sciences, University of Liverpool, Liverpool, UK

Lucile Marty, PhD, Centre des Sciences Du Goût et de l'Alimentation, Agrosup Dijon, CNRS, INRAE, Université Bourgogne Franche-Comté, F-21000 Dijon, France

**Corresponding author information:**

Eric Robinson, Department of Psychological Sciences, University of Liverpool, Eleanor Rathbone Building, Bedford Street South, Liverpool L69 7ZA, UK, +44 151 794 1187, eric.robinson@liv.ac.uk

**Abbreviations:** SEP (socioeconomic position), BMI (body mass index)

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## Abstract

**Background/Objectives:** Lower socioeconomic position (SEP) is associated with increased risk of higher BMI and developing obesity. No research to date has examined whether the social patterning of health-based food choice motives or executive function explain why lower SEP is associated with higher BMI.

**Subjects/Methods:** We analysed observational data from large samples of UK (N=4130) and US (N=1898) adults which included measures of SEP (education level, household income and subjective social status) and self-reported BMI. Participants also completed validated self-report measures on the extent to which their day-to-day food choices were motivated by health and weight control, as well as completing computerized tasks measuring inhibitory control (Stroop task) and working memory (Digit span task).

**Results:** Across both UK and US adults, the relationship between indicators of lower SEP and higher BMI were consistently explained by participants from lower SEP backgrounds reporting being less motivated by health when making food choices, which accounted for 18-28% of the association between lower SEP and higher BMI. There was no evidence that measures of executive function explained associations between SEP and BMI or moderated relations between food choice motives and higher BMI.

**Conclusions:** The social patterning of health-based food choice motives may play an important role in explaining why lower SEP is associated with an increased risk of higher BMI.


**Key words:** SES, socioeconomic position; food choice motives; obesity; BMI; executive function

## Background

Socioeconomic position (SEP) refers to the social (e.g. level of education) and financial (e.g. household income) factors that determine a person's position or perceived position in society (1). Lower SEP tends to be associated with increased risk of higher BMI in developed countries (2, 3). A range of factors, including SEP differences relating to the built environment and economic circumstances likely to contribute to this association (4, 5), but psychological factors may also play an important role. Across studies of European adults, there is consistent evidence that lower SEP (i.e. education level) is associated with being less motivated by health when making choices (6-8). Other indicators of lower SEP (e.g. household income, occupation type) are associated with lower health motives (9, 10), but not in all studies (11). A related but distinct food choice motive is weight control motivation, although there is less convincing evidence linking measures of SEP to weight control motives and dietary patterns (11). The extent to which individuals are motivated by health when making dietary decisions is predictive of healthier diet (10, 12) and reduced likelihood of overweight (13). However, no research has examined whether the relationship between lower SEP and higher BMI is explained by SEP differences in food choice motives.

A further psychological factor that may explain SEP differences in BMI is executive function. Executive function is a set of mental processes that allow people to attend to information, plan and monitor behaviour (14). In the context of obesity, both inhibitory control (e.g. the (in)ability to control impulsive responses, such as desires for unhealthy food) and working memory (e.g. the (in)ability to hold competing information in mind, such as relative healthiness of food vs. sensory appeal) may be important. Lower SEP is associated with reduced executive function (15, 16), while reduced executive function is associated with less healthy diet and higher BMI (15, 17-20), which could in part explain why lower SEP is predictive of higher BMI (21). A further consideration is that executive function may interact with food choice motives to determine likelihood of maintaining a healthy body weight, as ability to translate motives into long-term behaviour may be dictated by individual differences in executive function (17, 22), but these hypotheses are yet to be tested.

Our primary aim was to examine for the first time whether the relationship between SEP and BMI is in part explained by social patterning of food choice motives relating to health and weight control in a large sample of UK adults. Consistent with previous research we examined education and income as measures of SEP (6, 8, 11, 23), as well as subjective social status because this may be an additional independent SEP predictor of higher BMI (24). Measures of executive function in a sub-sample of participants allowed us to explore whether individual differences in executive function explain i) the link between SEP and higher BMI or ii) moderate relationships between food choice motives and BMI. Finally, moving beyond existing work in European samples (6-9, 11), we examined cultural generalisability of findings in a sub-sample of US adults.

## Methods

*Overview.* We made use of data collected from UK and US adults participating in six online studies that used similar methodology to examine the effect of structural and information-based interventions on simulated dietary choice. In all studies, participants reported on health and weight control food choice motives, SEP indices (education, income, subjective socioeconomic status) and BMI (calculated from self-reported weight and height). Studies received ethical approval from the University of Liverpool Health and Life Sciences Research Ethics Committee and informed consent was obtained from all participants. Participants were recruited online from Prolific Academic (UK participants) or Amazon Mechanical Turk (US participants). Participants were eligible to participate if they were UK/ US residents, aged 18 or above, fluent in English, had access to a computer with an internet connection, and had no dietary restrictions. All studies aimed to recruit a sample stratified by gender and by highest educational qualification to be broadly representative of the UK/US adult population and contain similar numbers of 'higher' and 'lower' educated adults. Studies 1 and 2 (25) examined dietary choice in a virtual fast food restaurant. UK participants (n=1743 in original studies) selected a meal after being randomized to one of four conditions in a 2x2 between-subjects design: menu energy labelling present vs. absent and increased vs. normal availability of lower energy options. Study 3 (26) examined simulated supermarket purchasing. UK participants (n=899) were randomized in a 2x2 between-subjects design to: labelling of lower ED products (vs. absence) and increased (vs. normal) availability of lower ED products. Study 4 (27) examined hypothetical portion size selection. UK participants (n=1667) selected their desired portion size for main meals in the absence or presence of different types of energy labelling. In studies 5 and 6 (28), US participants (n=2091) made simulated dietary choices from six sit-down restaurant menus after being randomized to: the absence vs. presence of menu energy labelling and from menus with normal vs. increased availability of lower energy main dishes. In all studies, demographic data were collected at the beginning of the study. Food choice motives (and executive function) measures were collected at the end of the study.

*SEP measures*

*Education level.* Participants reported on their highest education level. UK participants completed the following items: "What is your highest educational qualification? If you are a student please select the diploma being studied for." *No formal qualifications, 1-3 GCSEs or equivalent, 4+ GCSEs or equivalent, A level or equivalent, Certificate of higher education (CertHE) or equivalent, Diploma of higher education (DipHE) or equivalent, Bachelor's degree or equivalent, Master's degree or equivalent, Doctoral degree or equivalent*.

Participants also reported on years in higher education using a free-text response format: "After leaving school (i.e. at 16 years old), how many further years of higher education (i.e. a formal course) did you study for?". US participants completed the following items: "What is your highest educational qualification? If you are a student please select the diploma being studied for." *Less than high-school, High-school completion, Some college or associate degree, Bachelor's degree, Master's degree, Doctoral or professional degree*. "After leaving middle school (i.e. after 8th grade), how many further years of higher education did you study for?" (free-text).

*Household income.* UK participants were asked to report the annual after-tax income of their household including all earners to the nearest £1000. Participants also reported on the number of adults and children (<14 y) living in their household. Equivalised household income was calculated by dividing the after-tax household income by the sum of the equivalence value of all the household members (first adult = 1, additional adult or child aged 14 and over = 0.5, child aged 0–13 = 0.3). US participants reported their annual household income (before tax) to the nearest $1000.

*Subjective social status.* Both UK and US participants rated where they believed they are in society from 1 (people who have the least money, least education and the worst jobs or no job) to 10 (people who have the most money, most education and the best jobs) using the MacArthur scale of subjective social status (29).

*Food choice motives.* In studies 1, 2 and 5 participants completed a single item food choice questionnaire (30) in which the following two statements "It is important to me that the food I eat on a typical day: is healthy (health motivation), helps me control my weight (weight control motivation)" were rated on a scale from 1 (Not at all important) and 7 (Very important).The health and weight control motivation items were answered alongside other 1-

item dimensions (30). In studies 3, 4 and 6, participants completed the health and weight control subscales of the Food Choice Questionnaire (31). The health subscale has 6 items (e.g. "It is important to me that the food I eat on a typical day keeps me healthy") and weight control subscale has 3 items (e.g. "It is important to me that the food I eat on a typical day helps me control my weight"), with responses ranging from 1 = Not at all important to 4 = Very important. Across all studies combined indices of food choice motives had acceptable internal consistency.

*Executive function measures.* In studies 1, 2 and 4 participants completed two measures of executive function. A Stroop task was used to measure inhibitory control. See online supplementary materials for full task information. The Stroop interference effect was calculated as the difference between the median RTs of the incongruent trials and the congruent trials [incongruent RT – congruent RT] for correct trials only. A larger interference score is indicative of poorer inhibition. We also calculated the proportion of correct responses in incongruent trials, as a secondary outcome because there is some evidence of an association with poorer diet (32). We used a backwards digit-span task to measure working memory. See online supplementary materials for full task information. The primary outcome was the two-error maximum length as the last digit-span a participant got correct before making two consecutive errors and as a secondary outcome we included maximum length i.e., the maximal backward digit span that a participant recalled correctly during all 14 trials.

*Standardising of variables.* To ensure comparability across UK and US studies, we dichotomised highest education level into 'lower' (anything below UK degree/US college level) and 'higher' (degree/college level and above). To account for both the level of qualification achieved and time spent in education, we calculated a secondary continuous composite measure of amount of education, as the mean of the z-scores for highest educational level and years in higher education) for each study. To account for the non-linear distribution of income participants were recoded into quintiles (quintiles calculated for UK and US data separately). To account for the difference in the number of items included in the two scales used to measure food choice motives, in primary analyses we treated health and weight control motives as single item measures (i.e. we used the 1 question from the multi-item scale that was directly comparable to the question from the single item, with data z-scored within studies to account for differences in response scales). To gauge whether results were consistent when multi-item scale scores were available, in sensitivity analyses we z-scored total scale scores in each study.

*Data exclusions.* As in the original studies, any participants that failed one or more attention checks or did not complete the study in full were not included. Because our main interest was in the relationship between food choice motives, SEP and higher BMI, we excluded participants with a BMI < 18.5. In line with (33, 34), we excluded participants with implausible weight (<30 kg or >250kg) and height (<145 cm or > 3m) values or likely implausible BMI (>70) values. For income data, if a participant reported a household income that was extreme (i.e. approximately > 10 times the UK median equivalised income [>£300,000] or US median [>$650,000] their data was treated as missing. See online supplementary materials for individual study sample sizes and data exclusions.

*Analyses.* The analysis protocol was pre-registered is available with the study data at https://osf.io/tjgcy/

*Primary analyses for SEP, food choice motives and BMI (UK sample)*. To examine whether measures of SEP were associated with food choice motives we conducted two linear regression models (z-scored single item health motives and weight control motives as dependent variables), with age, gender, ethnicity (white vs, not), BMI (continuous) household income, highest education level (lower vs. higher) and subjective social status as predictor variables. To test whether food choices motives independently predict BMI we planned a further regression (BMI dependent variable) controlling for the same demographic and each SEP measure. Next, we planned to identify any measures of SEP that were associated with BMI (in unadjusted raw associations). If we found evidence that a measure(s) of SEP was associated with BMI, and that the same measure(s) of SEP was associated with a food choice motivation measure (health and/or weight control motives) that was in turn associated with BMI in regression analyses, we planned to conduct a formal indirect effects analysis to test whether food choices motives mediated SEP-BMI associations. If more than one SEP measure was identified for indirect effects analyses we planned to conduct indirect effect analysis for each and if both health and weight control motives were associated with the same measure of SEP and BMI, we conducted parallel indirect effects analyses to examine their independent indirect effects. In primary analyses alpha was set at .05.

*Secondary analyses for SEP, food choice motives and BMI (US sample)*. We replicated the above primary analyses in the US sample.

*Secondary analyses examining executive function (UK sample).* To explore whether measures of executive function explained associations between measures of SEP and BMI we repeated the above primary analysis strategy, but replaced food choice motive measured with the measures of executive function when predicting BMI. To examine whether the relationship between food choice motives and BMI was moderated by measures of executive function, we conducted linear regression in which we included measures of executive function, food choice motives and mean centred interaction terms between each measure of executive function and food choice motives in a second step of the model. To account for multiple comparisons, for all secondary analyses alpha was set a .01. 99% confidence intervals are reported.

*Sensitivity analyses.* We repeated primary and secondary analyses using the secondary composite (continuous) measure of education level, as well as replacing the z-scored single item food motive measures with the z-scored extended measure, where available. We also examined if results were consistent when the alternate measures of inhibitory control (Stroop proportion correct as opposed to interference) and working memory (maximum total as opposed to two error total) were used.

*Sample size*. To be powered to detect statistically small unadjusted associations ($r = .10$) between variables of interest (GPOWER 3.1.3, 90% power, $p < .01$) and statistically small effects in the regression and indirect effects analysis models described above (35), we estimated a minimum sample size of N~1500. Available data for both UK and US participants exceeded this. Analyses were conducted in SPSS25 with the exception of indirect effect analyses that we conducted in SAS using the PROCESS MACRO (MODEL 4).

## Results

*UK sample characteristics.* Complete data were available for N=4130 UK (2092 / 51% female) participants. Of the sample, 47% had an education level that was university degree or higher. The sample's mean BMI = 27.1 (SD=5.9) and 57% were classed as having a BMI in the overweight or obesity range. See Table 1 for sample characteristics. Lower household income (r = -.06), lower subjective social status (r = -.14) and lower education level (r = -.11) were significantly associated with higher BMI. Higher BMI was significantly associated with being less motivated by health when making food choices (r = -.12) and more motivated by weight (r = .08). See online supplementary material for unadjusted associations between BMI, food choice motives and measures of SEP. Lower household income, lower subjective status and lower education level were all significantly associated with being less motivated by health (r = .12, r = .21, r = .18 respectively) and weight (r = .07, r = .12, r = .04). For proportions of participants endorsing health and weight as important food choice motives (vs. not) split by SEP, BMI and demographic categories, see online supplementary material.

*Primary analyses*

*SEP predictors of food choice motives (UK sample)*. Adjusting for other demographic factors and BMI, subjective social status and education level were independently associated with lower health motivation, but household income was not (p = .052). Results were consistent when the composite measure of education level was used. Results were the same when the multi-item food choice measure was used, with the exception that income became a significant predictor of health motives (p = .034). In the linear regression model examining weight motives, lower household income and subjective social status (but not education level) were independently associated with lower weight motivation. Results were robust across sensitivity analyses. See Table 2 for results in full.

*Food choice motives predictors of BMI (UK sample).* Adjusting for demographic variables, being less motivated by health and more motivated by weight control were predictive of higher BMI. See Table 3. Results remained the same in all sensitivity analyses.

*Indirect effects analyses (UK sample).* For the model examining subjective social status and BMI we included both health and weight control motives as parallel mediators (as subjective social status was independently associated with both). We found a negative indirect effect of health motives (-.138, 95%CI [-.172; -.105], explaining 21% of the SEP-BMI association) and a positive indirect effect of weight control motives (.076, 95%CI [.052; .103], explaining 11% of the SEP-BMI association). We adopted the same approach for household income as income tended to be associated with both food choice motives across the majority of primary and sensitivity analyses. We found a negative indirect effect of health motives (-.096, 95%CI [-.127; -.068], 28% of SEP-BMI association) and a positive indirect effect of weight control motives (.054, 95%CI [.030; .079], 16% of association). For the model examining education level (categorical) and BMI we included only health motives (single item measure) as education level was not independently associated with weight control motives either in primary or sensitivity analyses. We found a negative indirect effect of health motives (-.213, 95%CI [-.290; -.147], explaining 25% of SEP-BMI association). Figure 1 displays unstandardised regression coefficients for the three mediation models. Results were consistent in all sensitivity analyses.

*Secondary analyses*

*Executive function measures (UK sample)*. In the UK sub-sample with measures of executive function (N=3256), poorer inhibitory control (stroop interference) and working memory (two error maximum length) tended to be weakly associated with higher BMI and lower SEP (rs ranging from .001 to .095) in unadjusted analyses. In linear regression models, no SEP variables predicted executive function, and no measures of executive function predicted BMI. No executive function measures significantly interacting with food choice motives measures to explain variation in BMI. See online supplementary materials for executive function analyses.

*Relations between SEP, food choice motives and BMI (US sample)*. The US sample (N=1898) was broadly similar to the UK sample in terms of demographic profile, but had a higher proportion of participants with a university degree level of education and above (65% vs. 47%). See Table 1. In unadjusted analyses, results were consistent with the UK sample, whereby there were statistically significant but small positive associations (rs ranging from .07 to .15) between each measure of SEP and each measure of food choice motives, as well as small negative associations between measures of SEP and BMI (rs ranging from -.08 to -.10). See online supplementary materials for results in full. As in the UK sample, higher BMI was associated with lower health motivation ($r = -.09$) and higher weight control motivation ($r = .08$). Similar to the UK sample, in linear regression analyses, lower education level and subjective social status (but not household income) were associated with lower health motives and results remained the same in sensitivity analyses. As in the UK sample, lower subjective social status was significantly associated with lower weight motives. Household income was not and this pattern of results remain the same across sensitivity analyses. Similar to the UK sample, lower education level was not significantly associated with weight control motives in the main analysis, although in sensitivity analyses in which the multi-item food choice measure was used, this association became significant ($p = .006$). See Table 2 for results in full. Similar to the UK sample both lower health motives and higher weight control motives predicted higher BMI when controlling for measures of SEP and demographics (Table 3).

*Indirect effects analyses (US sample).* We examined whether the association between both education level (composite measure) and subjective social status with BMI were mediated by health motives and weight control motives (single item measures) as both tended to be associated with education level and subjective social status across analyses. We found that both health motives (-.197, 99%CI [-.305; -.105], 24% of association) and weight control motives (.115, 99%CI [.035; .213], 14% of association) mediated the association between education level and BMI, negatively and positively respectively. We also found that both health motives (-.103, 99%CI [-.166; -.051], 18% of association) and weight control motives (.085, 99%CI [.038; .140], 15% of association) mediated the association between subjective social status and BMI, negatively and positively respectively. Results were consistent in sensitivity analyses.

## Discussion

Consistent with previous research in other countries (6-8), across samples of both UK and US adults we found that lower SEP was associated with participants having a higher BMI and reporting being less motivated by health and weight control when making food choices. Critically, we also found convincing and consistent statistical evidence that cross-sectional associations between lower SEP and higher BMI were in part explained by social patterning of food choice motives. In particular, among UK adults lower health motives among lower SEP participants explained between 21% and 28% of the association. Similarly, among US adults lower health motives explained between 18% and 24% of this association.

Being more motivated by weight control when making dietary choices were associated with higher BMI. After accounting for health motives, weight control motives also mediated some of the SEP and BMI relationship, whereby higher SEP was associated with greater weight control motives and in turn higher BMI. However, this pattern of results was not consistent across all SEP indicators and variance explained tended to be smaller than for health motives (11-16%). We assume that the positive association between weight control motives and BMI is likely to reflect a greater desire to lose or manage weight among individuals with overweight and obesity and the direction of this relationship may be reversed if examined prospectively). However unsuccessful weight control efforts could contribute to increased weight gain (36-38), so it will be important to understand the potential casual role that any social patterning of weight control motives has on SEP-BMI associations.

It will now be important to understand SEP patterning of health-based food choice motives. For example, lack of financial resources may result in healthiness being deprioritised, as food expenditure has been shown to in part explain SES differences in healthiness of food purchases (23, 39). Education level and subjective social status were independently associated with health food choice motives, which suggests that there may be distinct pathways relating to education (e.g. lack of nutrition literacy) and perceived social standing (e.g. higher psychological distress) that explain link lower SEP to lower health motives (40, 41).

We found no convincing evidence that either inhibitory control or working memory explained the cross-sectional association between any indicator of SEP and higher BMI or that relations between food choice motives and BMI were moderated by executive function. These findings may indicate that relations between SEP, executive function and BMI may be better explained by executive function having a causal effect on adult SEP and/or higher BMI having a causal effect on executive function (42), as opposed to the social patterning of executive function explained SEP-BMI associations. However, we measured only two indices of executive function and it may be the case that other measures (e.g. cognitive flexibility) in part explain links between SEP and BMI (43).

Limitations includes reliance on self-reported data that can be prone to bias. Findings are cross-sectional and therefore we cannot rule out reverse causality, e.g. lower SEP increases risk of higher BMI, but the reverse may also be true (44). Only data on health and weight control motives were available and we were unable to examine other types of food choice motives, such as price, taste and familiarity. Previous research has shown that participants with low levels of education and income place greater importance on price and familiarity of food than higher educated samples (9) and both importance of price and familiarity explained SES-differences in healthy diet adoption in a UK study (11). Similarly, it would be informative to examine relative ranking of food choice motives (i.e. the extent to which individuals prioritise health over price) in future research, as in the present studied we relied on absolute ratings of health and weight control food choice motives. The sample was predominantly white and future work would benefit from recruiting more ethnically diverse samples to examine generalisability of findings (45).

## Abbreviations

SEP (Socioeconomic position)

BMI (Body mass index)

## Declarations

**Availability of data and materials.** The study dataset and registered protocol is available on the Open Science Framework repository at https://osf.io/tjgcy/

**Competing interests.** ER has previously received research funding from the American Beverage Association and Unilever for projects unrelated to the present work.

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**Consent for publication**: N/A

## Figure Headings

**Figure 1.** Mediation models between individual measures of SEP and BMI, values are regression coefficients, ***p < 0.001, SSS: subjective social status, BMI: body mass index

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Figure 1.

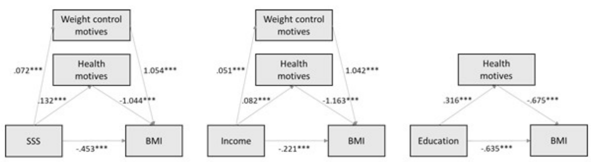

*Table 1*. UK and US Sample Characteristics

| | *UK (N = 4130)* | US *(N = 1898)* |
|---|---|---|
| Gender (Female) | 2092 (51%) | 1041 (55%) |
| Ethnicity (White) | 3785 (92%) | 1546 (82%) |
| Age (M years, SD) | 37 (13) | 41 (17) |
| BMI (M, SD) | 27.1 (5.9) | 28.5 (7.4) |
| Normal weight BMI | 1769 (43%) | 729 (38%) |
| Overweight BMI | 1367 (33%) | 575 (30%) |
| Obesity BMI | 994 (24%) | 594 (31%) |
| Education level (Higher) | 1924 (47%) | 1238 (65%) |
| Household income (M, SD) | £21,163 (£15, 169) | $54, 912 ($45,874) |
| Subjective social status 9M, SD) | 5.1 (1.6) | 4.9 (1.8) |
| | | |
| | *UK (N=3256)* | |
| Inhibitory control: Stroop interference, (M, SD) | 237.5 (238.5) | - |
| Inhibitory control: Stroop proportion correct (M, SD) | 0.90 (0.12) | - |
| Working memory: Two error maximum length (M, SD) | 5.9 (1.8) | - |
| Working memory: Maximum length (M, SD) | 6.7 (1.7) | - |

*Education level (Higher)denotes degree/college level and above*
*Household income is equivalised for UK participants, total for US participants*
*Subjective social status is rated on a scale of 1 (low) to 10 (high)*
*Inhibitory control and working memory measures only available in a sub-sample of UK participants*
*Stroop interference is calculated as the difference between the median response times (milliseconds) of incongruent trials and congruent trials for correct trials only in the Stroop task (a larger interference score is indicative of poorer inhibition)*
*Stroop proportion correct is proportion of trials answered without error*
*Two error maximum length is the last digit-span a participant got correct before making two consecutive errors in the backwards digit span test*
*Maximum length is the largest number of digits a participant recalled correctly during all trial in the backwards digit span test*

*Table 2.* Linear regression examining demographic and SEP predictors of food choice motives in UK and US samples.

| | *UK sample (N=4123)* | | | | *US sample (N=1897)* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Motives: Health $R^2 = .08$* | | *Motives: Weight $R^2 = .04$* | | *Motives: Health $R^2 = .05$* | | *Motives: Weight $R^2 = .03$* | |
| | *B (SE)* | *p* | *B (SE)* | *p* | *B (SE)* | *p* | *B (SE)* | *p* |
| *Gender* | *-.16 (.03)* | *<.001 ** | *-.24 (.03)* | *<.001 ** | *-.14 (.05)* | *.003** | *-.14 (.05)* | *.002** |
| *Ethnicity* | *.11 (.06)* | *.051* | *.20 (.06)* | *.721* | *.06 (.06)* | *.296* | *.08 (.06)* | *.181* |
| *Age* | *.007 (.001)* | *<.001 ** | *-.01 (.001)* | *.984* | *.01 (.001)* | *<.001 ** | *.002 (.001)* | *.182* |
| *BMI* | *-.02 (.003)* | *<.001 ** | *.02 (.003)* | *<.001 ** | *-.01 (.003)* | *<.001 ** | *.01 (.003)* | *<.001** |
| *Income* | *.02 (.01)* | *.052* | *.03 (.01)* | *.03** | *-.01 (.02)* | *.654* | *.02 (.02)* | *.411* |
| *SSS* | *.09 (.01)* | *<.001 ** | *.07 (.01)* | *<.001 ** | *.06 (.01)* | *<.001 ** | *.05 (.02)* | *<.001** |
| *Education* | *.22 (.03)* | *<.001 ** | *.03 (.03)* | *.314* | *.17 (.05)* | *.001** | *.11 (.07)* | *.032* |

*Gender reference category is females. Ethnicity reference category is white. Education reference category is lower education. Income ranges from 1-5, lowest to highest quartiles. Motives health and weight reference category is not rating as important. SSS is subjective social status.*

**indicates statistically significant (p < .05 for primary analyses using UK sample and <.01 for secondary analyses using US sample)*

*Table 3*. Linear regression examining demographic, SEP and food choice motives predictors of BMI in UK and US samples.

| | *UK sample (N=4123)* $R^2$ *=.09* | | *US sample (N=1889)* $R^2$ *=.05* | |
|---|---|---|---|---|
| | *B (SE)* | *p* | *B (SE)* | *p* |
| *Gender* | *-.53 (.18)* | *.003** | *-.69 (.34)* | *.040* |
| *Ethnicity* | *-.93 (.32)* | *.004** | *-.63 (.44)* | *.159* |
| *Age* | *.08 (.007)* | *<.001** | *.02 (.01)* | *.030* |
| *Income* | *.01 (.07)* | *.882* | *-.40 (.14)* | *.004** |
| *SSS* | *-.49 (.06)* | *<.001** | *-.29 (.11)* | *.007** |
| *Education level* | *-.03 (.18)* | *.876* | *.67 (.37)* | *.072* |
| *Motives: health* | *-1.11 (.10)* | *<.001** | *-1.37 (.20)* | *< .001** |
| *Motives: weight* | *1.04 (.10)* | *<.001** | *1.35 (.20)* | *< .001** |

*Gender reference category is females. Ethnicity reference category is white. Education reference category is lower education. Income ranges from 1-5, lowest to highest quartiles. Motives health and weight reference category is not rating as important. SSS is subjective social status.*

**indicates statistically significant (p < .05 for primary analyses using UK sample and <.01 for secondary analyses using US sample)*

Online Supplementary Materials for 'The relationship between lower socioeconomic position and higher BMI is explained by the social patterning of health-based food choice motives in UK and US adults' by Robinson et al.

*Stroop task information*

Participants saw names of colours presented in varying colours and were asked to indicate the colour of the word by key press as fast as they could whilst trying to restrict errors. The task included congruent trials where the word and the colour it was presented in were the same (e.g. the word 'blue' presented in blue text), incongruent trials where colour word and the colour it was presented in were not the same (e.g. the word 'blue' presented in red text), and control trials with coloured rectangles in a mixed design. The task included four colours (red, green, blue, black), three colour-stimuli congruency conditions (congruent, incongruent and control), and 7 repetitions for a total of 84 trials (28 congruent, incongruent and control trials). We calculated the median reaction times (RTs) for correct responses in incongruent and congruent trials.

*Backward digit task information*

The task required participants to repeat series of digits (presented visually on screen) of increasing length in reversed order, via key presses. The task was adaptive to performance. If participants made a correct response the subsequent trial became more difficult (addition of a digit), if the participants made an incorrect response the subsequent became easier (removal of a digit). The first trial was a sequence of two digits and the task consisted of 14 trials.

*Supplementary Table 1. Individual study sample sizes*

| Study | Country | Setting | n |
|---|---|---|---|
| 1 | UK | Fast-food | 868 |
| 2 | UK | Fast-food | 875 |
| 3 | UK | Supermarket | 899 |
| 4 | UK | Portion selection | 1667 |
| 5 | US | Restaurant | 1001 |
| 6 | US | Restaurant | 1090 |

*Supplementary Table 2. Planned data exclusions*[1]

- BMI < 18.5 or > = 70 participants
- Weight < 30 or > = 250 participants
- Height < 145 or > = 300 participants
- Equivalised income (UK) > £300,000 or Gross income (US) > $650,000 = 6 participants

| **Study** | **n before exclusion** | **n after exclusion** | **n excluded** |
|---|---|---|---|
| 1 | 868 | 822 | 46 (5.3%) |
| 2 | 875 | 833 | 42 (4.8%) |
| 3 | 899 | 876 | 23 (2.6%) |
| 4 | 1667 | 1601 | 66 (4.0%) |
| 5 | 1001 | 885 | 116 (11.6%) |
| 6 | 1090 | 1025 | 65 (6.0%) |

*Unplanned data exclusions*

After excluding the above participants (pre-registered), we also identified n=14 participants that did not specify their gender and excluded these participants, resulting in a total sample size of N = 6028 (5.8% of data excluded in total).

*Food choice motives by demographic group*

We originally planned to report metrics for similarity derived from effect sizes observed (e.g. degree of similarity vs. difference between people of lower vs. higher SEP on food choice motives); Cohen's U3 and probability of superiority; Cohen's U3 is the expected % of participants with higher SEP expected to be above the average (mean) food choice motives score of participants with lower SEP; Probability of difference is the likelihood that a randomly selected participant with higher SEP have a higher score on food choice motives if compared to a randomly selected participant of lower SEP. However, we now instead report percentages participants from different demographics endorsing each food choice motive as on reflection this is a more direct way of presenting this data (as opposed to making inferences from group means). See supplementary tables 3 and 4.

[1] Participants who failed an attention or did not complete the study were already excluded from original study datasets

*Supplementary Table 3. Proportion of participants rating health and weight as 'important' when making food choices from 4-item food choice motives questionnaire*

| | *UK (N = 2475)* | | *US (N = 1898)* | |
|---|---|---|---|---|
| | *Health important* | *Weight important* | *Health important* | *Weight important* |
| *Lower education* | 920 (70%) | 576 (44%) | 224 (64%) | 159 (46%) |
| *Higher education* | 958 (83%) | 530 (46%) | 506 (76%) | 344 (52%) |
| | | | | |
| *Lowest income quintile* | 336 (68%) | 209 (42%) | 138 (72%) | 95 (50%) |
| *2nd income quintile* | 355 (71%) | 201 (40%) | 141 (68%) | 94 (45%) |
| *3rd income quintile* | 366 (75%) | 210 (43%) | 149 (70%) | 100 (47%) |
| *4th income quintile* | 407 (82%) | 236 (48%) | 150 (74%) | 107 (53%) |
| *Highest income quintile* | 410 (83%) | 248 (50%) | 152 (76%) | 107 (54%) |
| | | | | |
| *Normal weight BMI (18.5-24.9)* | 842 (80%) | 405 (38%) | 285 (74%) | 167 (44%) |
| *Overweight BMI (25-29.9)* | 643 (77%) | 421 (50%) | 237 (75%) | 176 (56%) |
| *Obesity BMI (≥30)* | 393 (67%) | 280 (48%) | 208 (66%) | 160 (51%) |
| | | | | |
| *Male* | 895 (74%) | 498 (41%) | 304 (71%) | 203 (471%) |
| *Female* | 983 (78%) | 608 (48%) | 426 (73%) | 300 (52%) |
| | | | | |
| *White* | 1708 (75%) | 1004 (44%) | 618 (72%) | 421 (49%) |
| *Not white* | 170 (82%) | 102 (49%) | 112 (73%) | 82 (53%) |

*Lower education denotes below degree/college level. Higher education denotes degree/college level and above*
*Health and weight importance when making food choices scored on a 4-point scale:*
*1 = not at all important, 2 = a little important, 3 = moderately important, 4 = very important*
*'Important' = response options 3 and 4*

*Supplementary Table 4. Proportion of participants rating health and weight as important when making food choices from 7-item food choice motives questionnaire*

| | *UK (N = 1655)* | | *US (N =885)* | |
|---|---|---|---|---|
| | *Health important* | *Weight important* | *Health important* | *Weight important* |
| *Lower education* | 179 (20%) | 131 (15%) | 81 (26%) | 37 (12%) |
| *Higher education* | 253 (33%) | 137 (18%) | 196 (34%) | 94 (16%) |
| | | | | |
| *Lowest income quintile* | 82 (26%) | 50 (16%) | 45 (26%) | 24 (14%) |
| *2nd income quintile* | 76 (23%) | 52 (16%) | 56 (32%) | 19 (11%) |
| *3rd income quintile* | 71 (22%) | 50 (16%) | 43 (24%) | 24 (14%) |
| *4th income quintile* | 93 (27%) | 51 (15%) | 64 (36%) | 33 (19%) |
| *Highest income quintile* | 109 (33%) | 64 (19%) | 69 (38%) | 31 (17%) |
| | | | | |
| *Normal weight BMI (18.5-24.9)* | 223 (31%) | 112 (16%) | 124 (36%) | 39 (11%) |
| *Overweight BMI (25-29.9)* | 126 (24%) | 87 (16%) | 89 (35%) | 48 (19%) |
| *Obesity BMI (≥30)* | 83 (20%) | 69 (17%) | 64 (23%) | 44 (16%) |
| | | | | |
| *Male* | 191 (23%) | 108 (13%) | 126 (30%) | 59 (14%) |
| *Female* | 241 (29%) | 160 (19%) | 151 (33%) | 72 (16%) |
| | | | | |
| *White* | 391 (26%) | 248 (16%) | 211 (31%) | 104 (51%) |
| *Not white* | 41 (30%) | 20 (15%) | 666 (33%) | 27 (15%) |

*Lower education denotes below degree/college level. Higher education denotes degree/college level and above*

*Health and weight importance when making food choices scored on a 7-point scale: 1: not at all important; 2: not important; 3: not very important; 4: neutral; 5: slightly important; 6: important; 7: very important*

*Important' = response options 6 and 7*

*Supplementary Table 5. Zero-order associations between measures of SEP, food choice motives and BMI in UK participants (N=4130)*

| | *Food choice motives health* | *Food choice motives weight* | *Education level (composite)* | *Subjective social status* | *Household income* | *BMI* | | *Education level low (n=2206)* | *Education level high (n=1924)* | *Low vs. high education* |
|---|---|---|---|---|---|---|---|---|---|---|
| *Food choice motives health* | - | .452 p < .001 | .177 p < .001 | .212 p < .001 | .117 p < .001 | -.124 p < .001 | | M= -0.14 SD= 1.01 | M= -0.17 SD= 0.95 | d = 0.31 p < .001 |
| *Food choice motives weight* | - | - | .040 p = .04 | .117 p < .001 | .073 p < .001 | .084 p < .001 | | M= -0.02, SD= 0.99 | M= 0.07 SD= 0.99 | d = 0.09 p = .004 |
| *Education level (composite)* | - | - | - | .293 p < .001 | .252 p < .001 | -.107 p < .001 | | - | - | - |
| *Subjective social status* | - | - | - | - | .398 p < .001 | -.141 p < .001 | | - | - | - |
| *Household income* | - | - | - | - | - | -.064 p < .001 | | - | - | - |
| *BMI* | - | - | - | - | - | - | | M=27.49, SD = 5.94 | M=26.64, SD=5.70 | d = .15 p < .001 |

*Food choices motives measures are z-scored single item only measure. All associations statistically significant (p < .05)*

*Supplementary Table 6. Zero-order associations between measures of SEP, food choice motives and BMI in US participants (N=1898)*

| | *Food choice motives health* | *Food choice motives weight* | *Education level (composite)* | *Subjective social status* | *Household income* | *BMI* | | *Education level low (n=660)* | *Education level high (n=1238)* | *Low vs. high education* |
|---|---|---|---|---|---|---|---|---|---|---|
| *Food choice motives health* | - | .526<br>p < .001 | .151<br>p < .001 | .150<br>p < .001 | .074<br>p < .001 | -.089<br>p < .005 | | M= -0.17<br>SD= 1.04 | M= 0.09<br>SD= 0.95 | d = 0.26<br>p < .001 |
| *Food choice motives weight* | - | - | .086<br>p < .001 | .115<br>p < .001 | .072<br>p = .002 | .081<br>p < .001 | | M= -0.11<br>SD= 1.01 | M= 0.07<br>SD= 0.99 | d = 0.18<br>p = .001 |
| *Education level (composite)* | - | - | - | .370<br>p < .001 | .341<br>p < .001 | -.076<br>p = .001 | | - | - | - |
| *Subjective social status* | - | - | - | - | .494<br>p < .001 | -.097<br>p < .001 | | - | - | - |
| *Household income* | - | - | - | - | - | -.100<br>p < .001 | | - | - | - |
| *BMI* | - | - | - | - | - | - | | M=28.53,<br>SD=7.19 | M=28.56,<br>SD=7.50 | d = .004<br>p = .926 |

*Food choices motives measures are z-scored single item only measure. All associations significant (p <.05) with the exception of low vs. high education BMI difference*

*Supplementary Table 7. Zero-order associations between measures of executive function, SEP and BMI in UK participants (N=3256)*

| | *BMI* | *Education level (z-scored )* | *Income (1-5 quintiles)* | *Subjective social status (1-10)* |
|---|---|---|---|---|
| *Stroop interference* | *r = .065 (p < .001)** | *r = -.032 (p = .064)* | *r < .001 (p = .99)* | *r < .001 (p = .989)* |
| *Stroop proportion correct* | *r = -.030 (p = .087)* | *r = .044 (p = .013)* | *r = .033 (p = .058)* | *r =.001 (p = .975)* |
| *Working memory two error max* | *r = -.057 (p = .001)** | *r = .095 (p < .001)** | *r = .045 (p = .010)* | *r = .053 (p = .002)** |
| *Working memory maximum length* | *r = -.046 (p = .009)** | *r =.097 (p < .001)** | *r = .054 (p = .002)** | *r = .046 (p = .009)** |

**indicates statistically significant (alpha value < .01)*

*Supplementary Table 8. Linear regression examining demographic and SEP predictors of executive function measures*

| | Inhibitory control Stroop interference | | Working memory Two error max length | |
|---|---|---|---|---|
| | *B (SE)* | *p* | *B (SE)* | *p* |
| *Gender* | *-20.9 (8.2)* | *.010* | *.05 (.06)* | *.484* |
| *Ethnicity* | *49.7 (14.8)* | *.001** | *.14 (.12)* | *.222* |
| *Age* | *3.6 (.34)* | *< .001 ** | *.003 (.003)* | *.323* |
| *BMI* | *1.4 (0.7)* | *.060* | *-.02 (.006)* | *.008** |
| *Income* | *1.1 (3.2)* | *.730* | *.03 (.03)* | *.216* |
| *SSS* | *-2.1 (2.9)* | *.457* | *.03 (.02)* | *.206* |
| *Education level* | *-5.2 (8.6)* | *.549* | *.16 (.07)* | *.017* |

**indicates statistically significant (alpha value < .01).*

*Gender reference category is female. Ethnicity reference category is white. Education reference category is lower education. Income ranges from 1-5, lowest to highest quartiles. Motives health and weight control reference category is not rating as important. SSS is subjective social status. Results remain same when z-scored measure of education level used.*

*When Stroop proportion correct is used in place of Stroop interference statistical significance of all predictors remains the same. When maximum length error is used in place of two error maximum length statistical significance of predictors remains the same with the exception of age (B=.006, p = .009) and education level (B=.18, p = .004).*

*Supplementary Table 9. Linear regression examining executive function predictors of BMI*

| | *BMI* | |
|---|---|---|
| | *B (SE)* | *p* |
| *Model 1* | | |
| *Stroop interference* | *.001 (.001)* | *.127* |
| *Two error max length* | *-.134 (.056)* | *.016* |
| | | |
| *Model 2* | | |
| *Stroop proportion correct* | *-.026 (.841)* | *.975* |
| *Two error max length* | *-.141 (.061)* | *.021* |
| | | |
| *Model 3* | | |
| *Stroop interference* | *.001 (.001)* | *.111* |
| *Maximum length* | *-.129 (.061)* | *.035* |
| | | |
| *Model 4* | | |
| *Stroop proportion correct* | *-.026 (.841)* | *.975* |
| *Maximum length* | *-1.41 (.06)* | *.021* |

*All models control for age, gender, ethnicity, income, subjective social status and education level. Alpha value < .01*

Analyses examining whether relationship between food choice motives and BMI is moderated by measures of executive function.

No interaction terms between any measure of food choice motives (weight control or health motives, single item or z-scored measures) or any measure of executive function (Stroop interference, proportion correct, working memory two error maximum length or maximum length) significantly predicted BMI in primary or sensitivity analyses (all ps > .01), indicating no significant evidence that associations between food choice motives and BMI were moderated by measures of executive function.