

# BMJ Open Influence of individual life course and neighbourhood socioeconomic position on dietary intake in African Americans: the Jackson Heart Study

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## ABSTRACT

**Objective** African Americans, especially those in the Southeastern USA, have different dietary behaviours from the general US population, and have the highest prevalence, incidence and mortality of diet-related disease outcomes, such as cardiovascular disease. However, there are scant data regarding factors such as socioeconomic position (SEP) across the life course that influence dietary behaviours in this high-risk population. Our aim was to examine the impact of life course and neighbourhood SEPs on dietary intake among African Americans.

**Participants and setting** Data for this cross-sectional analysis came from the community-based Jackson Heart Study (JHS). We analysed a total of 3948 JHS participants (mean age: 55.4±12.5; 63.9% women), who had complete dietary intake and covariate information.

**Methods** We examined the associations of childhood SEP (CSEP), adulthood SEP (ASEP) and neighbourhood SEP (NSEP) with 10 selected dietary intake measures, using multilevel log-gamma generalised linear regression models.

**Outcome measures** Dietary intake measures include daily saturated fat, sodium, protein, fibre, fruits and vegetables, whole grains, sugar-sweetened beverage, nuts, fish and processed meat.

**Results** In age, sex and total energy intake adjusted models, most dietary intakes were associated with these three SEP measures. After additional adjustment for other SEP measures, most of the significant associations with CSEP and NSEP were attenuated, except for the associations of fibre with CSEP (relative rate [RR] [95% CI] 1.05 [1.00–1.10]) and whole grains with NSEP (RR [95% CI] 1.28 [1.02–1.61]). The associations (shown as RR [95% CI]) between ASEP and sugar-sweetened beverage: 0.70 (0.59–0.83), processed meat: 0.75 (0.63–0.90), sodium: 0.99 (0.94–1.00), fibre: 1.10 (1.03–1.16), protein: 1.05 (1.01–1.09), fruits and vegetables: 1.21 (1.11–1.32), nuts: 2.13 (1.59–2.87), and fish: 1.57 (1.27–1.95) generally persisted after additional adjustment for both CSEP and NSEP. However, the association between ASEP and whole grains was attenuated.

**Conclusions** High ASEP may have a more beneficial influence on dietary practices in African Americans than CSEP or NSEP.

## Strengths and limitations of this study

- The Jackson Heart Study cohort allowed us to use multiple measures of socioeconomic position (SEP) to capture social and economic conditions that may affect dietary practices, and a variety of dietary measures to capture unique diets among southern US population.
- We adjusted for multiple confounders, including other measures of SEP, to account for their effects on the relationship between each SEP measure and dietary intake.
- Retrospectively collected childhood SEP data and self-reported dietary measures may have introduced measurement error.
- The cross-sectional observational design limits our ability to draw inferences regarding the causal effects of SEPs on dietary intake.
- The results may not be generalisable to all African Americans across USA, as the sample was drawn entirely from a geographic area in the Southeastern US with a high burden of obesity and cardiovascular disease risk.

## INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death in the USA, and the CVD mortality rate in Mississippi (MS) is the highest in the country.<sup>1</sup> It is well established that several non-clinical risk factors contribute to the development of CVD.<sup>2</sup> Diet is one of the most modifiable non-communicable risk factors, yet most Americans have diets that do not meet federal dietary guidelines.<sup>3</sup> Unhealthy diets have been shown to play a significant role in the development of CVD and related risk factors.<sup>4</sup> African Americans, especially those in the Southeastern USA, have dietary behaviours that differ from the general US population<sup>5</sup> and have the highest prevalence, incidence and mortality of diet-related disease outcomes.<sup>6</sup>

There are scant data, however, regarding factors such as socioeconomic positions (SEP) across the life course that influence dietary behaviours in this high-risk population. SEP involves the social ranking based on resources (ie, wealth and assets) as well as inadequate resources (ie, poverty and deprivation), which affect health over the life course.<sup>7</sup> Life course SEP is characterised by resource-based measures that are linked to both childhood and adulthood social class position.<sup>7</sup> Recent data from the Bogalusa Heart Study illustrate that dietary behaviours in childhood remained consistent over a 15-year period<sup>8</sup> suggesting that dietary behaviours may traverse into adulthood. Consequently, low SEP that impact dietary behaviours in childhood may influence poor dietary behaviours in adulthood. A study among British women reported that both childhood and adulthood SEPs were associated with fruits and vegetables consumption in adulthood.<sup>9</sup> Neighbourhood SEP, the socioeconomic environment of neighbourhood (such as the education levels and occupations of residents, and quality of housing), also plays a role in shaping diet behaviours.<sup>10</sup> Using data from the Atherosclerosis Risk in Communities (ARIC), one study reported that fewer supermarkets were available in low-income and predominately African American neighbourhoods.<sup>11</sup> The availability of supermarkets was positively associated with fruits and vegetables intake, and other healthy food intake.<sup>11</sup> Healthy foods were generally less available in poor and minority neighbourhoods compared with wealthier and predominately white neighbourhoods.<sup>11 12</sup>

Taken together, an individual's dietary behaviour in adulthood is likely to be influenced by early exposures during childhood, socioeconomic status during adulthood and neighbourhood of residence during adulthood. In a study of British women,<sup>13</sup> life course and neighbourhood SEP measures were all significantly, independently and positively associated with intake of fruits and vegetables. To our knowledge, no studies in the USA have documented the extent to which life course and neighbourhood SEPs influences dietary intake among African Americans. In this study, we investigated associations of childhood, adulthood and neighbourhood SEPs with dietary intake in African Americans using the Jackson Heart Study (JHS). We hypothesised that individuals with lower SEP in childhood, adulthood and neighbourhood level will be more likely to have lower intake of healthy nutrients. The JHS provides a unique opportunity to examine these factors with its large, population-based African American sample, multiple measures of SEP that attempts to comprehensively and accurately measure social conditions at different stages in the life course and a detailed assessment of regional food consumption.

## METHODS

### Study design

We conducted a cross-sectional analysis using data from the JHS, a large single-site, community-based cohort study

of CVD in African Americans. Details of the study design,<sup>14</sup> recruitment protocol<sup>15</sup> and data collection methodology<sup>16</sup> have been published previously. Briefly, the study population consists of non-institutionalised African American adults, aged 21–94 years, recruited from a tri-county region of the Jackson, MS metropolitan statistical area: Hinds, Madison and Rankin counties. Participants were recruited from four sources: 31% from the Jackson, MS site of the ARIC study, 17% through random sampling of a commercially available database (Accudata) of households in the three counties, 30% as volunteers and 22% as additional family members. The final sample of the JHS cohort included 5306 African American men and women (mean [SD] age=55.6 [12.7] years, 63% women). Institutional review board approval was obtained from the JHS institutions (Jackson State University, Tougaloo College and the University of Mississippi Medical Centre) and informed consent was received from all participants.

### Dietary intake

The Lower Mississippi Delta Nutrition Intervention Research Initiative (Delta NIRI) collected dietary data via telephone surveys using 24-hour dietary recalls to describe dietary intake in this understudied southern portion of the USA. These recalls were used to develop a regionally specific food frequency questionnaire, the Delta NIRI food frequency questionnaire (FFQ).<sup>17</sup> For the use of the JHS, a shorter version of the Delta NIRI FFQ was created reducing the number of food items from 283 to 158 by collapsing similar food items into categories.<sup>18 19</sup> The Delta NIRI JHS FFQ was administered in-person at the baseline examination by trained interviewers.<sup>5 17</sup> Saturated fat, sodium, protein and fibre were calculated from the contributions of each of the 158 food items. Fruits and vegetables intake was calculated as the sum of fruits, 100% fruit juice, vegetables and vegetables used in mixed dishes. Servings of whole grains were calculated by summing whole grain foods, including breads, brown rice, oatmeal and other whole grain breakfast cereals, including partial contributions from mixed foods. Sugar-sweetened beverage consumption was calculated from responses to questions querying consumption of carbonated soft and fruit drinks (not 100% juice). Intake of nuts was calculated from questions on nuts and foods containing nuts such as nut butters. Servings of fish were calculated as the sum of baked fish and fish used in mixed dishes; fried fish and fish sandwiches were excluded. Processed meat was calculated as the total grams of all forms of processed meats (ie, regular, lean and extra lean) such as breakfast sausage, hot dogs and luncheon meats. These nutrients and food groups were selected because they have been used to define ideal cardiovascular health<sup>20</sup> or have been shown to be associated with chronic disease risk.<sup>2</sup>

### SEP measures

We investigated three measures of SEP to assess the associations of life course SEPs with dietary intake in adulthood:

childhood SEP (CSEP), adulthood SEP (ASEP) and neighbourhood SEP (NSEP).

The measures of CSEP were derived from an interviewer-administered questionnaire during the first JHS annual follow-up call. Participants were asked to think back to childhood and to select the number of years of schooling or highest academic degree attained by their parents or primary caretaker. Due to the excessive missing data for father's education, mother's education was used, and coded as 0 (<high school [HS]), 1 (HS or Graduate Equivalency Degree [GED]) or 2 (>HS or GED). Participants' parental (or primary caretaker) housing tenure status before they reached age 10 was coded as one for owners and 0 for renters or other living arrangements. A childhood amenities score was derived based on access to eight items (indoor plumbing, electricity, refrigerator, telephone, television, air conditioning, parental car ownership and number of rooms) while growing up until age 10. Participants who had access to each item were coded as 1 and those with no access were coded as 0. The number of rooms was dichotomised at the median and coded into 0 (<5) or 1 ( $\geq 5$ ). A summary score of childhood amenities was created by summing the points for these eight items and subsequently categorised into tertiles of low, medium and high (0 to 2). All childhood SEP measures (parental education [0 to 2], parental home ownership [0 to 1] and amenities [0 to 2]) were added together to generate a summary CSEP score (range 0–5, higher values indicate better CSEP) based on prior work.<sup>21</sup>

Details on the summary ASEP score have been published previously.<sup>21</sup> Education was coded as 0 ( $\leq$ HS/GED), 1 (vocational certification/some college), 2 (associate/bachelor's degree) or 3 (postgraduate degree). Family income was categorised into four groups (<\$25 000, \$25 000 to \$39 999, \$40 000 to \$74 999 or  $\geq$ \$75 000), and assigned scores of 0 to 3, respectively. A summary score of wealth (range 0 to 3) was created by summing home ownership (yes/no), car ownership (yes/no) and liquid assets (0 for  $\leq$ median, or 1 for  $\geq$ median), then was categorised as low (0 or one asset), medium (two assets) or high (three assets), and reassigned scores of 0 to 2, respectively. Public assistance was constructed from three questions 'In the past year, did you or anyone living in your household receive any income from the following sources (1) Food Stamps (yes/no)? (2) Other welfare program (yes/no)? (3) Supplemental Security Income (SSI) (yes/no)?' Participants on  $\geq 2$  types of assistance were assigned a score of 0, those on 1 type of assistance was assigned a score of 1 and participants with no assistance were assigned a score of 2. A summary ASEP score (ranged from 0 to 10) was generated by summing the participant's scores for education (0 to 3), income (0 to 3), wealth (0 to 2) and public assistance (0 to 2).

As described in previous work,<sup>22</sup> census tract neighbourhood measures were obtained from the 2000 US Census data and American Community Survey (ACS) 2005–2009 and geocoded to the JHS data. Sixteen neighbourhood SEP variables related to education, occupation,

household income and wealth, poverty, employment and housing were used to conduct factor analysis with orthogonal rotation. All variables were standardised before conducting factor analysis. Weighted scales were calculated by multiplying the standardised variables by the factor weights. The first factor which makes the best use of the factor loadings by incorporating weights based on these loadings into the score was reverse coded such that higher values indicate increasing socioeconomic advantage, then used as the summary of NSEP (range: –1.65 to 2.23) for this study.

We standardised the different SEP measures to compare effects on comparable scales by dividing ASEP and CSEP by their ranges and NSEP by a modified range (99th to 1st percentile, for robustness against outlier effects).

### Covariates

Information on demographic (age [years] and sex [male/female]), body mass index (BMI), hypertension (HTN) and type 2 diabetes were from the baseline examination. BMI was calculated in  $\text{kg}/\text{m}^2$  using measurements of weight and height. HTN was defined as systolic pressure  $\geq 140$  mm Hg or diastolic pressure  $\geq 90$  mm Hg, taking antihypertensive medications within 2 weeks prior to the visit, or self-reported history of hypertension. Type 2 diabetes was defined as fasting glucose  $\geq 126$  mg/dL, taking antidiabetic medications or self-reported diabetes diagnosis. Total energy was estimated directly from the foods and portion sizes on the FFQ, using the Nutrient Data System for Research from the University of Minnesota.

### Data availability statement

JHS data are deidentified participant data. Requests for JHS data require approval of a JHS Manuscript Proposal or Ancillary Study Proposal. As part of the manuscript proposal or ancillary study process, you will be asked to submit a Data and Materials Distribution Agreement prior to obtaining data. To submit a request for data, complete a data request form (<https://redcap.umc.edu/surveys/?s=R48NR37HA8>).

### Statistical analysis

Descriptive statistics were calculated for SEP factors, dietary nutrient intakes and other participant characteristics. To account for skewness in dietary nutrient outcome distributions, multilevel log-gamma generalised linear regression models were employed to assess adjusted associations of CSEP, ASEP and NSEP with dietary nutrient intake. Generalised estimating equation techniques were used to account for clustering at the census tract level, with Huber-White robust variance estimates. SEP measures were first included in separate models, and then included simultaneously in one (full) model. All models were adjusted for age, sex and total energy intake.

Sensitivity analyses included re-estimating models using factor analysis-derived CSEP and ASEP measures; diagnosing potential non-linear relationships between CSEP,

ASEP and NSEP and each dietary nutrient intake using LOWESS (locally weighted scatterplot smoothing) techniques; examining potential synergistic effects of CSEP/NSEP and ASEP on each dietary intake using adjusted interactions of ASEP and CSEP, and ASEP and NSEP on dietary intake and testing model improvement with omnibus likelihood ratio tests; and examining effect modification of SEP-diet associations by sex and age using interaction models. STATA V.14 (College Station, Texas, USA) was used for analyses.

### Participant involvement

Participants who met eligibility requirements were asked to bring their family members for the family study, but they were not directly involved in recruitment,<sup>15</sup> or any other steps in this research process. Participants are sent lay summaries of the results of published manuscripts that derive from the JHS. Lay summaries of study findings are also disseminated to the general community and participants at JHS events.

### RESULTS

A total of 3948 JHS participants (mean age: 55.4±12.5; 63.9% women) had complete dietary intake and covariate information. In general, women were older, tended to have lower CSEP, ASEP and NSEP, consumed more whole grain and fruits and vegetables, and less dietary fibre, protein, nuts, fish, sugar-sweetened beverages, processed meat, saturated fatty acid and sodium, compared with men. Roughly one in two participants reported that their mothers completed 0–11 years of schooling (54%) and that their parents owned or were buying homes (56%), approximately one in three had a high school diploma or less (36%), or income less than \$25 000 (34%), and nearly 1 in 10 reported 0–1 wealth item (15%). In neighbourhoods of participant residence, nearly three in four had high school diploma or higher education; the median home value was \$65 842; and median household income was \$33 630 on average (table 1).

Participants with high CSEP, ASEP and NSEP were younger, more likely to be male, and had lower prevalence of HTN and type 2 diabetes. Participants with high CSEP had greater energy intake, while those with high ASEP reported lower energy intake. Participants with high ASEP had lower BMI (table 2).

In age-, sex-, and total energy-adjusted models, CSEP was positively associated with intakes of fibre, fruits and vegetables, and nuts; NSEP was positively associated with intakes of fish, fibre, whole grain, fruits and vegetables and nuts, and negatively associated with sugar-sweetened beverages; ASEP was associated with higher intakes of fish, fibre, whole grain, fruits and vegetables, protein and nuts and lower intakes of processed meat and sugar-sweetened beverages (figure 1).

After additionally adjusting for ASEP and NSEP, CSEP was only associated with higher intake of fibre (5% more intake for highest vs lowest CSEP); all other CSEP

associations from the individual SEP models were no longer supported. After adjusting for ASEP and CSEP, NSEP was still significantly associated with whole grains (28% more intake for highest vs lowest NSEP); all other NSEP associations from the individual SEP models were no longer supported. After adjusting for CSEP and NSEP, most significant associations with ASEP remained with minimal attenuation in the associations; exceptions to this included whole grains, where the association with ASEP decreased substantially and sodium, where the association with ASEP increased slightly (figure 2).

In analyses using de novo ASEP and CSEP measures with factor analytic methods, similar associations were found. Additionally, we only found marginal support for synergistic effects between CSEP and ASEP for fish intake. CSEP or NSEP did not appear to modify relationships between ASEP and dietary intake. CSEP and ASEP appeared weakly correlated (Spearman  $p$  value=0.24), and NSEP and ASEP were correlated more closely (Spearman  $p$  value=0.36).

### DISCUSSION

To our knowledge, this is the first study to examine the associations of multiple measures of life course and neighbourhood SEP with dietary intake in adulthood in a large African American sample of adults in Southeastern USA. Findings from this research suggest that high ASEP may have more beneficial influence on diet in African Americans than CSEP or NSEP. The only exception was that NSEP had a potentially stronger association with whole grain intake.

The findings that ASEP was positively associated with fibre, protein, fruits and vegetables, nuts and non-fried fish and negatively associated with sugar-sweetened beverages, processed meat and sodium intake are consistent with prior studies. However, many of these studies used limited SEP measures, limited dietary intake measures or relatively smaller or non-African American samples.<sup>9 23–27</sup> It is noteworthy that we found a positive association of ASEP with whole grain intake in age, sex and total energy intake-adjusted models, but this was attenuated after additionally adjusting for CSEP and NSEP. Several studies have reported that intake of whole grain products was associated with higher SES.<sup>28 29</sup> Unlike our study, they did not adjust for CSEP and NSEP.

Higher CSEP was associated with higher fibre, fruits and vegetables and nut consumption in age, sex and total energy intake-adjusted models. After additional adjustment for ASEP and NSEP, most of the significant associations were attenuated, with only the association with fibre intake remaining significant, suggesting that ASEP and NSEP play a mediating role. Previous work has investigated the association of CSEP and diet in non-African American samples, where findings have been mixed. The British Women's Heart and Health Study found that CSEP was significantly associated with fruits and vegetables, fish (positively) and processed meat (negatively),

**Table 1** Selected baseline characteristics (Jackson Heart Study, 2000–2004)

Characteristics	Total (n=3948)	Female (n=2524 [64%])	Male (n=1424 [36%])	P value
Age	55.4 (12.5)	55.9 (12.5)	54.7 (12.4)	<0.01
Childhood socioeconomic position*				
Mother's education				<0.01
0–11 years	1603 (54%)	1094 (57%)	509 (48%)	
12 years or GED	697 (23%)	418 (22%)	279 (27%)	
>12/GED years	671 (23%)	407 (21%)	264 (25%)	
Parents own or buying home	2032 (56%)	1278 (54%)	754 (58%)	0.01
Summary score of amenities				0.02
0–3 points (low tertile)	1306 (36%)	856 (37%)	450 (35%)	
4–6 points (medium tertile)	1037 (29%)	697 (30%)	340 (27%)	
7–8 points (high tertile)	1276 (35%)	788 (34%)	488 (38%)	
Adulthood socioeconomic position*				
Education				0.10
<High school/High school/GED	1416 (36%)	903 (36%)	513 (36%)	
Some college, vocation or trade school with/without certification	844 (21%)	525 (21%)	319 (22%)	
Bachelor, associate	955 (24%)	599 (24%)	356 (25%)	
Postcollege	725 (18%)	491 (19%)	234 (16%)	
Household income				<0.01
<\$25 000	1149 (34%)	840 (40%)	309 (25%)	
25 000–39 999	419 (13%)	286 (14%)	133 (11%)	
40 000–74 999	1190 (36%)	723 (34%)	467 (38%)	
75 000+	580 (17%)	269 (13%)	311 (25%)	
Wealth				<0.01
0–1 wealth item	510 (15%)	349 (17%)	161 (13%)	
2 wealth items	1603 (48%)	1091 (52%)	512 (42%)	
3 wealth items	1218 (37%)	671 (32%)	547 (45%)	
Public assistance				<0.01
>=2 assistances	112 (3%)	94 (4%)	18 (1%)	
One assistance	326 (8%)	232 (9%)	94 (7%)	
0 assistance	3413 (89%)	2140 (87%)	1273 (92%)	
Neighbourhood socioeconomic position*				
Percent of persons 25+ with at least a bachelor's degree	22 (13)	22 (13)	23 (14)	<0.01
Percent persons 25+ with at least a high school diploma	74 (13)	73 (13)	75 (13)	<0.01
Percent of persons with managerial/professional occupation	28 (11)	27 (11)	29 (11)	<0.01
Median owner value of households	65 842.5 (31827.0)	63 981.7 (29955.3)	69 144.2 (34667.6)	<0.01
Percent of households with interest, dividend or rental income	18 (11)	18 (11)	19 (12)	<0.01
Median household income	33 630.3 (15839.0)	32 690.9 (15178.0)	35 297.0 (16825.2)	<0.01
Percent of household income >\$50 000	30 (17)	29 (17)	31 (18)	<0.01
Dietary Intake				
Sugar-sweetened beverages (g/day)	311.2 (336.4)	293.9 (332.1)	341.7 (341.9)	<0.01
Processed meat (g/day)	20.0 (23.5)	18.0 (22.2)	23.5 (25.2)	<0.01
Saturated fatty acid (g/day)	28.8 (14.3)	27.3 (13.9)	31.6 (14.6)	<0.01

Continued

**Table 1** Continued

Characteristics	Total (n=3948)	Female (n=2524 [64%])	Male (n=1424 [36%])	P value
Sodium (g/day)	3.5 (1.5)	3.3 (1.4)	3.9 (1.6)	<0.01
Dietary fibre (g/day)	22.6 (10.3)	22.2 (10.4)	23.3 (10.2)	<0.01
Protein (g/day)	82.4 (37.3)	76.8 (34.6)	92.5 (39.6)	<0.01
Fruits and vegetables (g/day)	639.6 (332.2)	648.1 (333.3)	624.7 (329.9)	0.03
Whole grain (g/day)	63.3 (76.9)	66.8 (77.5)	57.2 (75.3)	<0.01
Nuts (g/day)	7.7 (11.7)	7.4 (11.0)	8.1 (11.2)	0.06
Fish (g/day)	21.3 (27.9)	19.9 (26.6)	23.8 (29.9)	<0.01
Total calories per day	2277.9 (905.2)	2157.7 (872.6)	2490.9 (922.9)	<0.01

Data are numbers (proportions) for categorical variables and means (SD) for continuous variables.

\*Sample sizes: CSEP=2890; ASEP=3127; NSEP=3945.

GED, Graduate Equivalency Degree.

but only the significant association with fruits and vegetables consumption was independent of ASEP.<sup>9</sup> A study in the Netherlands reported that CSEP, measured by father's occupation and mother's education, had no association with fruits consumption even without adjustment for ASEP.<sup>30</sup> The discrepant findings could be due to differences in the cohorts. Our cohort is African American in the Southeastern USA, whose childhood exposures may differ from those in Britain or the Netherlands. It may also be due to differences in the definitions of CSEP. We incorporated mother's education, parental home ownership and childhood exposures into our study,

while studies in Britain and the Netherlands considered father's occupation, which was not available in our study.

We found that living in higher NSEP was significantly associated with lower sugar-sweetened beverage intake, and higher intakes of fibre, fruits and vegetables, nuts, fish and whole grains. Patterns generally persisted after adjustment for ASEP and CSEP, but significance remained only for whole grains. These findings are generally congruent with prior studies<sup>12 31</sup> showing that healthy food availability is patterned by NSES. Contrary to our findings, a study among female Japanese dietetic students reported that NSEP was not significantly associated with most

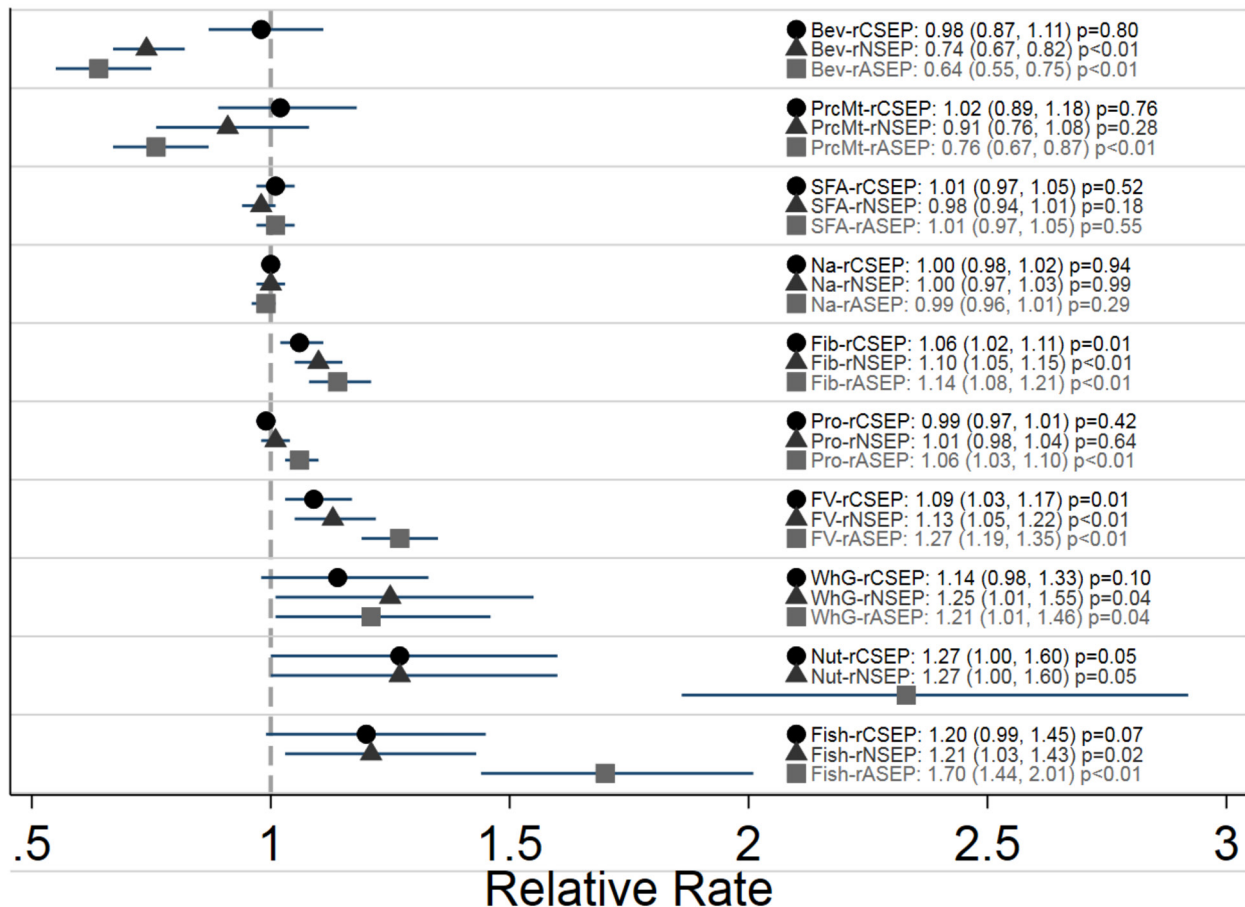
**Table 2** Selected characteristics of the study sample by tertiles of childhood, adult and neighbourhood SEPs

	Age, year	Female	Energy, kcal	BMI	HTN	Type 2 diabetes
Total	55.4 (12.5)	2524 (64%)	2278 (905)	31.7 (7.2)	2372 (60%)	856 (22%)
CSEP						
Low (0-1)	62.3 (9.6)	691 (67%)	2178 (864)	31.5 (6.4)	735 (71%)	267 (26%)
Medium (2-3)	52.9 (10.3)	709 (68%)	2286 (893)	31.8 (7.4)	603 (58%)	195 (19%)
High (4-5)	44.9 (10.4)	476 (58%)	2453 (934)	31.8 (7.7)	328 (40%)	108 (13%)
P value	<0.01	<0.01	<0.01	0.54	<0.01	<0.01
ASEP						
Low (0-4)	58.3 (13.5)	765 (70%)	2303 (948)	32.5 (8.2)	740 (68%)	292 (27%)
Medium (5-7)	52.9 (11.9)	713 (62%)	2301 (886)	31.6 (6.8)	628 (55%)	231 (20%)
High (8-10)	54.2 (10.5)	498 (57%)	2212 (876)	30.9 (6.2)	486 (55%)	136 (16%)
P value	<0.01	<0.01	<0.01	<0.01	<0.01	0.04
NSEP						
Low (-1.7 to -1.0)	57.9 (12.0)	911 (66%)	2281 (930)	31.9 (7.1)	903 (66%)	358 (26%)
Med (-1.0 to -0.5)	55.7 (13.1)	816 (64%)	2294 (900)	32.0 (7.4)	780 (62%)	281 (22%)
High (-0.5 to 2.2)	52.6 (11.8)	796 (61%)	2260(886)	31.2 (6.9)	686 (53%)	217 (17%)
P value	<0.01	0.02	0.64	0.01	<0.01	<0.01

Data are numbers (proportions) for categorical variables and means (SD) for continuous variables.

P value is for tests for trend among each SEP measure.

ASEP, adulthood SEP; BMI, body mass index; CSEP, childhood SEP; HTN, hypertension; NSEP, neighbourhood SEP; SEP, socioeconomic position.

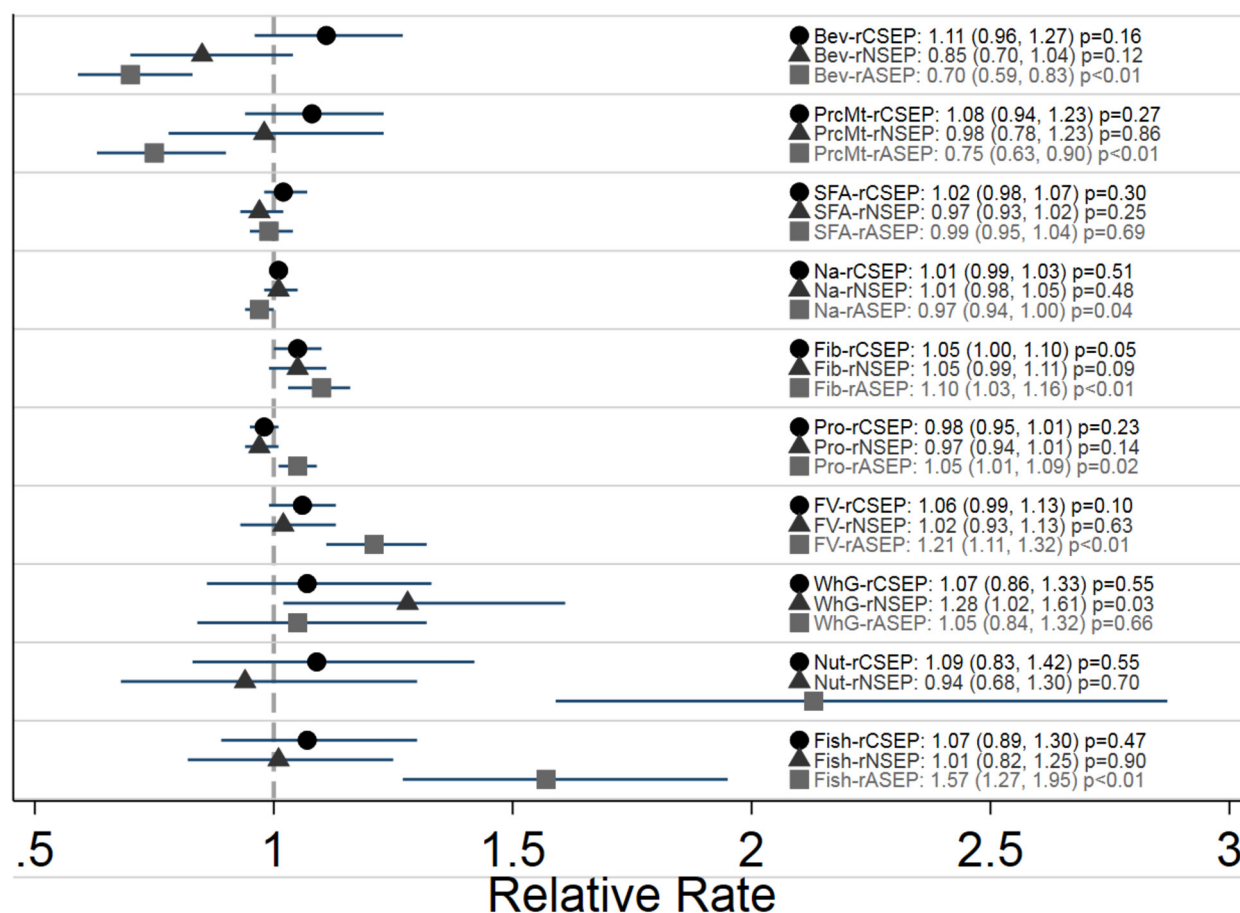


**Figure 1** SEP associations with dietary intake (standardised relative rates adjusted for age, gender, total energy intake). For example Fish-rASEP: 1.71 (1.48, 1.98)  $p < 0.001$  is the adjusted relative rate between fish intake and standardised ASEP, indicating fish intake was 71% higher in the highest versus lowest ASEP categories; Bev-rASEP: 0.64 (0.55, 0.75)  $p < 0.01$  is the adjusted relative rate between sugar-sweetened beverage intake and standardised ASEP, indicating sugar-sweetened beverage intake was 36% lower in the highest versus lowest ASEP categories. Bev, sugar-sweetened beverages (g); Fib, Fibre (g); Fish, fish (g); FV, fruits and vegetables (g); Na, sodium (mg); Nut, nuts (g); PrcMt, processed meat (g); Pro, protein(g); SFA, saturated fatty acid (g); WhG, whole grains (g).

dietary variables.<sup>32</sup> These discrepant findings could be due to the different cohorts. It is worth pointing out that NSEP had a strong association with whole grain intake, which appears to play a mediating role in the pathway from ASEP to whole grain intake. As far as we are aware, this finding has not been previously reported. However, it has been reported that easy access to supermarkets was associated with higher intake of fruits and vegetables,<sup>11</sup> even within a US population with low ASEP.<sup>33 34</sup> While affluent neighbourhoods have more supermarkets and grocery stores, some lower-income neighbourhoods have been characterised as ‘food deserts’.<sup>33 35 36</sup> This suggests that neighbourhood environmental factors such as NSEP are importantly related to dietary choice. The reason why NSEP mediates the pathway from ASEP to whole grain, instead of other diets in our cohort, is unknown, warranting further study to clarify the association of NSEP on whole grain intake in African American.

A distinctive feature of our study is the use of the JHS cohort, which allowed us to use multiple measures of SEP, compared with prior studies that relied on only few measures. The use of those multiple measures improves the likelihood of capturing social and economic conditions that may affect dietary practices. In addition, the JHS used the Delta NIRI JHS FFQ, the most suitable diet assessment tool for southern US population, which provided a variety of dietary measures not commonly available in many studies. Another novel aspect of our study is that we adjusted for the other two SEPs to account for their effects on the relationship between one SEP measure and diets, which has rarely been done in previous studies.

Limitations of this study must be kept in mind when interpreting the results. As mentioned in prior work,<sup>21</sup> childhood economic measures were collected retrospectively, which might underestimate CSEP effects on adult



**Figure 2** SEP associations with dietary intake (standardised relative rates adjusted for age, gender, total energy intake and other SEP measures). For example, Fish-rASEP: 1.57 (1.27, 1.95)  $p<0.001$  is the adjusted relative rate between fish intake and standardised ASEP, indicating fish intake was 57% higher in the highest versus lowest ASEP categories; Bev-rASEP: 0.70 (0.59, 0.83)  $p<0.01$  is the adjusted relative rate between sugar-sweetened beverage intake and standardised ASEP, indicating sugar-sweetened beverage intake was 30% lower in the highest versus lowest ASEP categories. Bev, sugar-sweetened beverages (g); Fib, Fibre (g); Fish, fish(g); FV, fruits and vegetables (g); Na, sodium (mg); Nut, nuts (g); PrcMt, processed meat (g); Pro, protein(g); SFA, saturated fatty acid (g); WhG, whole grains (g).

health outcomes. Another limitation is that there was lack of evidence to prove that the large number of missing data on CSEP were missing at random. Moreover, the CSEP did not consider father's education and occupation, which might limit the ability of full assessment of CSEP. Additionally, limitations of the dietary assessment tool need to be taken into account. Although the Delta NIRI JHS FFQ is probably the most suitable diet assessment tool for JHS, there are problems inherent to assessing dietary intake with self-reported measures, which may have introduced measurement error, although the FFQ we used has been validated.<sup>37 38</sup> Our study was cross-sectional, which limited our ability to draw inferences regarding the causal effects of SEPs on dietary intake. The results may not be generalisable to all African Americans across USA, as the sample was drawn entirely from a geographic area in the Southeastern USA with a high burden of obesity and CVD risk.

In conclusion, our findings suggest that higher ASEP may provide more beneficial influence on dietary intake in African Americans than higher CSEP or NSEP. The only exception is that whole grain intake was strongly patterned by NSEP. Thus, effects on diet may be one of the mechanisms through which SEP effects chronic diseases, such as CVD. Participants with lower SEP, especially ASEP, might be at increased risk of CVD as a result of their unhealthy dietary intake. Our findings suggest that policies should work to decrease the costs of healthy foods which would increase the access to healthy foods especially for individuals with low SEP who live in disadvantaged neighbourhoods, and provide healthy eating educational programmes across the life course that will ultimately improve people's health status. Successfully educating adults to improve their diets will reduce not only their CVD risk but that of their children. Dietitians and other healthcare providers should consider family



SEP when assessing family dietary patterns and the quality of family diets. In addition to considering the quality of family diets, health professionals and policy makers should consider the impact family diets have on the health of the overall community in which families of varying SEPs live.

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