Mortality disparities between Black and White Americans mediated by income and health behaviors

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ABSTRACT

Background: Race disparities in health outcomes including mortality risk are well known, but mediating mechanisms that link race to mortality risk have rarely been formally tested.

Methods: We analyzed public NHANES III data from 1988 to 1994 linked to mortality outcomes prospectively through 2015. Participants included 10,460 non-Hispanic Black (40.5%, n = 4233) and non-Hispanic White (59.5%, n = 6227) adults. Proportional hazards regression models examined mortality risk in association with race, demographics, income, and an index of risky health behaviors including smoking, poor diet and low physical activity. A mediation approach under the counterfactual framework was used to test effects of income and risky health behaviors as mediators between race and mortality risk.

Results: Considering only race, age and sex, Black participants had significantly higher mortality risk than Whites (HR = 1.46, 95% CI 1.35–1.58). When income and education were added, the race effect was lower but remained significant (HR = 1.15, 95% CI 1.02–1.30). In the subsequent model that also included risky behaviors the association between race and mortality was no longer significant (HR = 1.05, 95% CI 0.92–1.20); both higher income and healthier behaviors contributed to lower mortality risk. There was a significant indirect effect of race on mortality mediated through income, and the direct effect of race on mortality was not significant when the mediating effect of income was considered. Likewise, the risky behavior score significantly mediated the association between race with mortality, and the direct effect of race was not significant. In the separate models, income mediated 62% of the association between race and mortality and lifestyle mediated 61% of the relationship.

Conclusions: Efforts to reduce race-based mortality disparities may focus on policies to reduce income-based disparities and promote positive health behaviors that consider variations in socioeconomic resources and personal preferences.

1. Introduction

Racial disparities in life expectancy in the United States are well documented (Arias, 2016; Kochanek, Arias, & Anderson, 2013). In particular, Black Americans experience significantly shorter life expectancies than non-Hispanic White Americans, with higher mortality rates linked to relatively earlier mortality from diabetes, cancer, cardiovascular disease, homicide, and perinatal conditions (Firebaugh, Acciai, Noah, Prather, & Nau, 2014a, 2014b; Kochanek et al., 2013). These persistent race disparities contribute to the shorter life expectancies observed in the US relative to most other high-income countries (Collaborators, 2020; Li et al., 2018).

Mortality disparities experienced by Black Americans are potentially driven by multiple interrelated forces, including socioeconomic disadvantages, racial discrimination and segregation, poorer access to health care, greater environmental pollution exposures, worse access to health promoting amenities and practice of riskier health behaviors (Barnes et al., 2008; Chae et al., 2014, 2020; Elliott, Wang, Lowe, & Kleindorfer, 2004; Firebaugh & Acciai, 2016; Mode, Evans, & Zonderman, 2016; Nelson, 2002). Among these forces, lower income leads to poor health outcomes because it reduces access to healthier foods (Rao, Afshin, Singh, & Mozaffarian, 2013), cleaner and safer physical environments, and higher quality health care (Hood, 2005; Woolf et al., 2015).

Previous research has examined possible mediating variables that
connect race or ethnicity to mortality or other outcomes. For example, Beydoun et al. (2016) studied how race/ethnicity disparities in all-cause mortality were altered when modeling effects of dietary factors, education and other variables. Sudano and Baker (2006) examined how health insurance, socioeconomic status (SES) and health behaviors contributed to racial and ethnic disparities to mortality and health declines. These studies employed multiple regression or proportional hazards approaches to examine associations between race or ethnicity and outcome, then added variables to subsequent models such as socioeconomic status, health insurance, lifestyle behaviors and others, and examined whether the regression coefficient for race remained significant or was substantially altered as these putative mediators were added. As an extension of this previous work, we employ a formal mediation analysis that allows for the estimation not only of whether a race association remains significant, or a mediator is significant when added to a model, but also allows a quantitative estimation of how much of the direct association between race and outcome persists when the indirect association of race operating through the mediator is estimated.

In addition, the mediation analysis we conduct under a counterfactual framework allows for the interactions between race and potential mediators, which other studies have not included.

In addition to income, other possible mediating influences between race and mortality are health behaviors such as smoking, diet and physical activity. Black American adults smoke less than White adults but are more likely to die from smoking-related diseases (CDC, 2020). Previous evidence indicates that members of racial and ethnic minority groups including Black Americans engage in less physical activity than Whites (August & Sorkin, 2011; Zoeller, 2009). Satia (2009) observed that Black Americans and other minority groups experience diet-related disparities (poorer nutrient profiles and dietary behaviors) but suggested that these disparities are driven by socioeconomic status. As with income, however, formal quantitative tests of the role of health behaviors as an interaction-sensitive mediator of race-based mortality disparities have not been reported. The current study uses nationally representative data from the National Health and Nutrition Examination Survey (NHANES) linked prospectively with mortality outcomes to test income and health behaviors as formal mediators between race and mortality.

2. Methods

2.1. Design and data

We conducted a prospective analysis of direct and mediating associations between race (non-Hispanic Black or non-Hispanic White), other demographic and risk variables, and mortality. Baseline characteristics were obtained from the NHANES III data, collected between 1988 and 1994. The NHANES III was designed to obtain a nationally representative sample. NHANES data were linked to National Center for Health Statistics (NCHS) mortality data through 2015. Analyses used public, anonymous data sources and human subjects review was not required.

2.2. Study population

Among 13,696 non-Hispanic Black and non-Hispanic White adults aged 18 years or more, after excluding 1455 participants lost to follow-up and 1781 participants with missing values for major covariates including smoking, education, income, diet quality and BMI, 10,460 participants remained for final analysis. We compared baseline age and gender demographic characteristics among the participants who were lost to follow-up, excluded for missing data, or retained. We found that those lost to follow-up and those excluded were older on average than the retained participants (mean age: 58, 59, and 49, respectively) and that the three groups had similar gender distributions (female: 55%, 57% and 54%, respectively.)

2.3. Independent variables

The primary independent variable of interest was race, which included self-reported race as non-Hispanic Black or non-Hispanic White. Other key independent variables which also served as mediators included income and an index of risky lifestyle behaviors. Income was measured as household income in dollars (<$10,000, $10,000-$30,000, $30,000-$50,000, or $50,000 or more).

Risky lifestyle was measured from 0 to 6 as the sum of three behaviors each measured 0 to 2; the behaviors included smoking (never smoke: 0; former smoker: 1; and current smoker: 2); physical activity (active: 0; insufficiently active: 1; inactive: 2); and diet quality. The physically active group was defined as those who had leisure time moderate activity (METs ranging from 3 to 6) of five or more times per week or leisure time vigorous activity (MET >6) three or more times per week. The insufficiently active group was defined as those who were not inactive but did not meet the criteria for recommended levels of physical activity (Beddhu, Baird, Zitterkoph, Neilsen, & Greene, 2009). Diet quality was assessed by the Healthy Eating Index (DHHS, 1999), originally scored 0–100, and grouped into thirds for the current study.

Additional covariates included age in years, sex, and years of education grouped into three categories (0–11, 12, or 13 or more). Body mass index (BMI) (kg/m²) categories were included (normal: <25; overweight: 25 to <30; obese: ≥30), as was an index of social integration, using the measurement developed by Berkman and Syme (1979) and used in other prior research (Ford, Loucks, & Berkman, 2006). The social integration index included marital status; number of contacts with family, friends and neighbors; attendance at religious services; and participation in voluntary organizations.

2.4. Outcome

The outcome measure was mortality by the end of the follow up on December 31, 2015. Participants were followed until loss to follow-up, date of death or end of follow-up. Death records were obtained from the NCHS using ICD-10 codes and linked to the NHANES survey data (NCHS, 2021).

2.5. Analysis

We prepared a descriptive summary of study variables. Differences between Black and White participants on baseline characteristics were examined using chi-square tests for categorical variables and t-tests for continuous variables.

Next, we conducted a series of Cox proportional hazards multivariate regression models with survival time by the end of the follow-up as the dependent variable. The first model included only age, sex and race as independent variables. The second model added BMI, social integration, income and education. The third model further added the risky lifestyle index. One supplementary analysis estimated the models by both race and gender, and another considered additional covariates including urban/rural status, marital status (married or not), and health insurance (uninsured or not). The models accounted for the complex sampling design including sampling cluster, strata and weights as provided in the NHANES III data. Analyses were conducted using SAS software version 9.4 Proc SURVEYPHREG.

Finally, we conducted two mediation analyses under a counterfactual framework using the %mediation macro in SAS software version 9.4 (Valeri & VanderWeele, 2013). The analyses tested whether lower income or risky lifestyle index served as a mediator between race and mortality risk. These models contained the same covariates as the final regression models. Interactions between exposure and mediator were allowed. Results disaggregate the total association between race and outcome into direct effects and indirect effects operating through the mediator. The direct effect is defined as how much mortality would change when race changes from White to Black while the mediator is
kept at the level when race is White. The indirect effect is defined as how much mortality would change on average when race is Black, but the mediator was changed from the level it would take when race is White to the level when race is Black. The total effect is defined as how much mortality would change overall when race changes from White to Black.

The mediation analysis was first conducted overall, once for each mediator. Then, mediation analyses for each mediator were reanalyzed when stratified by the second mediator. Therefore, the analysis of income as a mediator was stratified by high (score ≥4) and low (score<4) risky lifestyle index; the analysis of risky lifestyle was stratified by low (<$50,000) and high (≥$50,000) income. This was done to gain a better sense of proportion mediated by each mediator independently.

3. Results

A summary of baseline participant characteristics is provided in Table 1. Differences between White and Black participants were significant for all variables. Black participants compared to White participants were younger, had fewer years of education and less income, higher current smoking rates but lower former smoking rates, less physical activity, scored lower on the Healthy Eating Index, higher on the risky lifestyle index, were more likely to be obese, and had lower social integration scores.

Over an average of 19 years (range 0–27 years) of follow-up, 4177 participants (39.9%) died. This included 2842 (45.6%) White participants and 1335 (31.6%) Black participants.

Table 2 presents the results of a set of multivariate-adjusted Cox proportional hazard models on the association between race and mortality. The table shows hazard ratios (HR) and 95% confidence intervals. Model 1 adjusted only for race, age and sex, and showed that Black participants had significantly higher mortality risk compared to White participants (HR = 1.46, 95% CI 1.35–1.58). Model 2 added BMI, social integration, income and education; the point estimate for the race effect was lower but remained significant (HR = 1.15, 95% CI 1.02–1.30). Higher income was related to lower mortality risk in a dose response pattern, and education was significant only at the highest level. Model 3 added the risky lifestyle index score; results from this model indicated that the association between race and mortality was no longer significant (HR = 1.05, 95% CI 0.92–1.20), that education was not significant, but that both higher income and healthier behaviors contributed to lower mortality risk. Based on these findings, analyses were undertaken to examine mediating effects of both income and risky lifestyle scores. Results (not shown) of the supplementary analysis by race and gender were very similar to those observed by race alone, as was the analysis that considered marital status, urban/rural status and lack of health insurance as additional covariates.

Results of the overall mediation analyses are provided in the left side of Table 3. Hazard ratios for income show that there was a significant indirect effect whereby the higher mortality risk associated with Black race was mediated through income, and that the direct effect of race on mortality was not significant when the mediating effect of income was considered. Likewise, the risky lifestyle index significantly mediated the association of race with mortality, and the direct effect of race was not significant. In the separate models, income mediated 62% of the association between race and mortality and lifestyle mediated 61% of the relationship.

The stratified mediation analysis results are shown in the middle and right-side columns of Table 3. The indirect effects for both income and risk lifestyle remain significant when stratified by the other mediator. Direct effects of race remain non-significant in all stratification conditions. The proportion of the association mediated by risky lifestyle is not influenced by low or high income. However, the proportion of the association mediated by income is reduced when stratified into both low and high risky lifestyle groups.

### Table 1
Baseline characteristic of participants between non-Hispanic White and non-Hispanic Black American adults.

| Variable label | Overall N = 10460 | Non-Hispanic White N = 6227 | Black N = 4233 |
|---------------|------------------|---------------------------|---------------|
| Age at interview (years) | 48.5 ± 19.9 | 52.9 ± 20.3 | 42.1 ± 17.5 |
| Sex Male | 4836 | 2909 (46.7%) | 1927 (45.5%) |
| Female | 5624 | 3318 (53.3%) | 2306 (54.5%) |
| Education | | | |
| 0–11 years | 3231 | 1715 (27.5%) | 1516 |
| 12 years | 3712 | 2140 (34.4%) | 1572 |
| 13 years or more | 3517 | 2372 (38.1%) | 1145 |
| Income ≤$10,000 | 1907 | 755 (12.1%) | 1152 |
| $10,000–$30,000 | 4444 | 2518 (40.4%) | 1926 |
| $30,000–$50,000 | 2363 | 1564 (25.1%) | 799 (18.9%) |
| ≥$50,000 or above | 1746 | 1390 (22.3%) | 356 (8.4%) |
| Smoke Never | 4945 | 2773 (44.5%) | 2172 |
| Former | 2640 | 1949 (31.3%) | 691 (16.3%) |
| Current | 2875 | 1505 (24.2%) | 1370 |
| Physical activity Inactive | 2702 | 1329 (21.3%) | 1373 |
| Intermediate | 3609 | 2285 (36.7%) | 1324 |
| Active | 4149 | 2613 (42.0%) | 1536 |
| Healthy Eating Index score (0–100) | | | |
| ≥62.5 | 64.9 ± 13.2 | 56.8 ± 13.0 |
| Body Mass Index | | | |
| Normal weight (<25 kg/m²) | 4427 | 2790 (44.8%) | 1637 |
| Overweight (25–<30 kg/m²) | 3429 | 2118 (34.0%) | 1311 |
| Obese (≥30 kg/m²) | 2604 | 1319 (21.2%) | 1285 |
| Social Integration | | | |
| 1 | 2192 | 1132 (18.2%) | 1060 |
| 2 | 3497 | 1954 (31.4%) | 1543 |
| 3 | 3249 | 2063 (33.1%) | 1186 |
| 4 | 1522 | 1078 (17.3%) | 444 (10.5%) |

4. Discussion

Although socioeconomic disadvantage is an established poor health outcome risk, and Black Americans on average experience poorer socioeconomic conditions than White Americans, results from the current study extend the knowledge base by quantifying the mediating effect of income between Black race and mortality risk, and by showing that a direct race disparity is reduced to non-statistical significance when accounting for income as a mediator. This is meaningful because it suggests that income-based interventions that target racial disparity in income levels may prove effective in reducing population mortality disparities.
Mediation analysis of racial disparities for overall mortality by income and risky lifestyle index.

Table 3

| Mediator                        | Overall | Low risky lifestyle (Index score < 4) | High risky lifestyle (Index score ≥4) |
|--------------------------------|---------|--------------------------------------|--------------------------------------|
|                                | Hazard Ratio (95% CI) | Proportion mediated | Hazard Ratio (95% CI) | Proportion mediated | Hazard Ratio (95% CI) | Proportion mediated |
| Income (<$50,000 vs ≥$50,000)   | 0.62     | 0.41                                 | 0.30                                 |
| Natural direct effect           | 1.02 (0.95–1.10)       | 1.07 (0.97–1.17)       | 1.06 (0.95–1.19)       |
| Natural indirect effect         | 1.03 (1.01–1.05)        | 1.04 (1.01–1.07)        | 1.03 (1.002–1.05)      |
| Total effect                    | 1.06 (0.99–1.13)        | 1.11 (1.02–1.22)        | 1.09 (0.97–1.21)       |
| Overall                         |                       |                       |                        |
| Hazard Ratio (95% CI)           | Proportion mediated    |                       |                        |
| Income (<$50,000)               | 0.61                 |                       |                        |
| Natural direct effect           | 1.03 (0.96–1.10)       | 1.02 (0.95–1.10)       | 1.07 (0.80–1.43)       |
| Natural indirect effect         | 1.04 (1.03–1.05)       | 1.04 (1.02–1.05)       | 1.10 (1.02–1.18)       |
| Total effect                    | 1.07 (1.00–1.15)       | 1.06 (0.99–1.14)       | 1.18 (0.87–1.59)       |

* Models adjusted for age, sex, education, income, lifestyle index, BMI and social integration except for the variable being assessed as a mediator.
not so much a question of different causes of death for Black versus White Americans, but of similar causes on an accelerated timeline (Firebaugh, Acciai, Noah, Prather, & Nau, 2014b). The focus on engaging in healthier behaviors, for example, becomes fundamentally more challenging when it must be accomplished under conditions of structural racism. This implies, importantly, that lifestyle interventions, no matter how well-tailored to cultural or racial identity, will not eliminate disparities and that policies that target and eradicate basic racial disparities are needed.

Strengths of the study include the long follow-up period, use of validated death records, a large and representative sample, and formal tests of mediating effects. However, several study limitations should be recognized. Outcomes were limited to overall mortality only and not to specific causes of mortality. Only one mediator at a time was modeled and mediators may have correlated influences. We had a measure of income but not of wealth, which may be important for older adults. Income was not adjusted for inflation over the six-year baseline period. Important covariates were included but it is possible that unmeasured confounds may influence the associations. Mediators were measured at the same time as baseline indicators. Possible changes in baseline measures after baseline and before mortality were not assessed. Data for most measures were dependent on self-report.

In conclusion, this study provides quantitative estimates of the contributions of low income, and health behaviors, in illuminating the relationship between race and mortality risk in the US. The direct effects of race on mortality are not significant when accounting for the mediating influences of income and of health behaviors. Efforts to reduce race-based mortality disparities may benefit from health behavior programs that are attuned to race differences in preferred methods of healthy behavioral practices. Reductions in income-based race disparities through policy initiatives offers a means to reduce mortality disparities and improve life expectancy. Finally, both of these objectives require efforts to eliminate underlying structural and institutional racism.

Author statement

Michael Hendryx: Conceptualization, investigation, methodology, project administration, supervision, visualization, writing – original draft. Juhua Luo: conceptualization, formal analysis, investigation, data curation, methodology, writing – review and editing. Fengge Wang: writing – review and editing, visualization.

Ethical statement

The research analyzed public anonymous data and human subjects review was not required.

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Arias, E. (2016). Changes in life expectancy by race and Hispanic Origin in the United States, 2013-2014. NCHS Data Brief, (244), 1-8.

August, K. J., & Sorkin, D. H. (2011). Racial/ethnic disparities in exercise and dietary behaviors of middle-aged and older adults. *Journal of General Internal Medicine, 26* (3), 245-250. https://doi.org/10.1007/s11606-010-1514-7

Barnes, L. L., de Leon, C. F., Lewis, T. T., Bienias, J. L., Wilson, R. S., & Evans, D. A. (2008). Perceived discrimination and mortality in a population-based study of older adults. *American Journal of Public Health, 98*(7), 1241-1247. https://doi.org/10.2105/AJPH.2007.114397

Beddhu, S., Baird, B. C., Zitterkoph, J., Neilson, J., & Greene, T. (2009). Physical activity and mortality in chronic kidney disease (NIHANES III). *Clinical Journal of the American Society of Nephrology, 4*(12), 1901-1906. https://doi.org/10.2215/CJN.01970309

Berkman, L. F., & Syme, S. L. (1979). Social networks, host resistance, and mortality: A nine-year follow-up study of Alameda county residents. *American Journal of Epidemiology, 109*(2), 186-204. https://doi.org/10.1093/oxfordjournals.aje.a112674

Beydoun, M. A., Beydoun, H. A., Mode, N., Dore, G. A., Canas, J. A., Eid, S. M., et al. (2012). Racial disparities in health outcomes: Race cause and cause-specific mortality among us adults: Mediating and moderating factors. *BMC Public Health, 16*(1), 1113. https://doi.org/10.1186/s12889-016-3744-z

CDC. (2020). African Americans and tobacco use. Retrieved from https://www.cdc.gov/tobacco/disparities/african-americans/index.htm.

Chae, D. H., Nuru-Jeter, A. M., Adler, N. E., Brody, G. H., Lin, J., Blackburn, E. H., et al. (2014). Discrimination, racial bias, and telomere length in African-American men. *American Journal of Preventive Medicine, 46*(2), 103-111. https://doi.org/10.1016/j.amepre.2013.10.026

Chae, D. H., Wang, Y., Martz, C. D., Slopen, N., Vip, T., Adler, N. E., … Epe1, E. S. (2020). Racial discrimination and telomere shortening among African Americans: The coronary Artery risk development in young adults (CARDIA) study. *Health Psychology, 39*(3), 209-219. https://doi.org/10.1037/hea0008822

Cohen, S. S., Matthews, C. E., Signorello, L. B., Schlundt, D. G., Blot, W. J., & Buchowski, M. S. (2013). Sedentary and physically active behavior patterns low-income African-American and white adults living in the southeastern United States. *PloS One, 8*(4), Article e59975. https://doi.org/10.1371/journal. pone.0059975

Collaborators, G. B. D. D. (2020). Global age-sexspecific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950-2019: A comprehensive demographic analysis for the global burden of disease study 2019. *Lancet, 396*(10258), 1160-1203. https://doi.org/10.1016/S0140-6736(20)30977-6

DHHS. (1999). Third national health and nutrition examination survey, 1988-1994. *NIHANES III healthy eating index data file (series 11, No. 64).* Hyattsville MD: Centers for Disease Control and Prevention.

Elliot, M. R., Wang, Y., Lowe, R. A., & Kleinendorf, P. R. (2004). Environmental justice: Frequency and severity of US chemical industry accidents and the socioeconomic status of surrounding communities. *Journal of Epidemiology & Community Health, 58*(1), 24–30. https://doi.org/10.1136/jech.58.1.24

Firebaugh, G., & Acciai, F. (2016). For blacks in America, the gap in neighborhood poverty has declined faster than segregation. *Proceedings of the National Academy of Sciences of the United States of America, 113*(47), 13572-13577. https://doi.org/10.1073/pnas.1607220113

Firebaugh, G., Acciai, F., Noah, A. J., Prather, C., & Nau, C. (2014a). Why lifespans are more variable among blacks than among whites in the United States. *Demography, 51*(6), 2025-2045. https://doi.org/10.1007/s13214-014-0345-2

Firebaugh, G., Acciai, F., Noah, A. J., Prather, C., & Nau, C. (2014b). Why the racial gap in life expectancy is declining in the United States. *Demographic Research, 31*, 997-1022. https://doi.org/10.4054/demres.2014.31.32

Ford, E. S., Loucks, E. B., & Berkman, L. F. (2006). Social integration and concentrations of C-reactive protein among US adults. *Annals of Epidemiology, 16*(2), 78-84. https://doi.org/10.1016/j.annepidem.2005.08.005

Hood, E. (2005). Dwelling disparities: How poor housing leads to poor health. *Environmental Health Perspectives, 113*(5), A310-A317. https://doi.org/10.1289/ ehp.113-a310

Joseph, R. P., Ainsworth, B. E., Keller, C., & Doddson, J. E. (2015). Barriers to physical activity among African American women: An integrative review of the literature. *Women & Health, 55*(6), 679-699. https://doi.org/10.1080/0300770X.2015.1039184

Keeley, B. (2015). How can governments respond to income inequality? In *Income inequality: The gap between rich and poor. Paris: Organisation for Economic Cooperation and Development,*

Kochanek, K. D., Arias, E., & Anderson, R. N. (2013). How did cause of death contribute to racial differences in life expectancy in the United States in 2010? NCHS Data Brief, (125).1-8

Li, Y., Pan, A., Wang, D. D., Liu, X., Dhana, K., Franco, O. H., … Hu, F. B. (2018). Impact of healthy lifestyle factors on life expectancies in the US population. *Circulation, 138*(4), 345-355. https://doi.org/10.1161/CIRCULATIONAHA.117.023049

Mode, N. A., Evans, M. K., & Zonderman, A. B. (2016). Race, neighborhood economic status, income inequality and mortality. *PloS One, 11*(5), Article e0154535. https://doi.org/10.1371/journal.pone.0154535

NCHS. (2021). About the national health and nutrition examination survey. Retrieved from https://www.cdc.gov/nchs/nhanes/about_nhanes.htm.

Nelson, A. (2002). Unequal treatment: Confronting racial and ethnic disparities in health care. *Journal of the National Medical Association, 94*(8), 666-668.

Powell, J. A. (2021). Six policies to reduce economic inequality. Retrieved from https://bel imaging.berkeley.edu/six-policies-reduce-economic-inequality.

Rao, M., Afshin, A., Singh, G., & Mozaffarian, D. (2013). Do healthier foods and diets patterns cost more than less healthy options? A systematic review and meta-analysis. *BMJ Open, 3*(12), Article e004277. https://doi.org/10.1136/bmjopen-2013-004277
Saint Onge, J. M., & Krueger, P. M. (2011). Education and racial-ethnic differences in types of exercise in the United States. *Journal of Health and Social Behavior, 52*(2), 197–211. https://doi.org/10.1177/0022146510394862

Satia, J. A. (2009). Diet-related disparities: Understanding the problem and accelerating solutions. *Journal of the American Dietetic Association, 109*(4), 610–615. https://doi.org/10.1016/j.jada.2008.12.019

Simons, R. L., Lei, M. K., Klopack, E., Beach, S. R. H., Gibbons, F. X., & Philibert, R. A. (2021). The effects of social adversity, discrimination, and health risk behaviors on the accelerated aging of African Americans: Further support for the weathering hypothesis. *Social Science & Medicine, 282*, 113169. https://doi.org/10.1016/j.socsci.med.2020.113169

Slocum, R. (2010). Race in the study of food. *Progress in Human Geography, 35*(3), 303–327.

Sudano, J. J., & Baker, D. W. (2006). Explaining US racial/ethnic disparities in health declines and mortality in late middle age: The roles of socioeconomic status, health behaviors, and health insurance. *Social Science & Medicine, 62*(4), 909–922. https://doi.org/10.1016/j.socscimed.2005.06.041

Valeri, L., & Vanderweele, T. J. (2013). Mediation analysis allowing for exposure-mediator interactions and causal interpretation: Theoretical assumptions and implementation with SAS and SPSS macros. *Psychological Methods, 18*(2), 137–150. https://doi.org/10.1037/a0031034

Woolf, S. H., Aron, L., Dubay, L., Simon, S. M., Zimmerman, E., & Luk, K. X. (2015). How are income and wealth linked to health and longevity? Retrieved from https://www.urban.org/sites/default/files/publication/49116/2000178-How-are-Income-and-Wealth-Linked-to-Health-and-Longevity.pdf.

Zoeller, R. F. (2009). Physical activity and fitness in African Americans: Implications for cardiovascular health. *American Journal of Lifestyle Medicine, 3*(3), 188–194.