Examining disparities in diet quality between SNAP participants and non-participants using Oaxaca-Blinder decomposition analysis

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ABSTRACT

Recent studies have reported that SNAP participants have poorer diet quality than non-participants. This study aimed to examine how differences in socio-demographic, household, and health-related measures explain disparities in diet quality between SNAP participants and non-participants using Oaxaca-Blinder decomposition analysis.

We analyzed cross-sectional data on 14,331 adult respondents of the National Health and Nutrition Examination Survey (NHANES) 2009 – 2014. To measure diet quality, we applied the Healthy Eating Index (HEI)-2015 to respondents’ 24-hour dietary recall data (scale: 0 – 100 points). We used Oaxaca-Blinder decomposition analysis to determine how much of the disparity in HEI-2015 total score between SNAP participants and non-participants was explained by socio-demographic (e.g., age, race/ethnicity, educational), household (e.g., household size, food security status), and health-related measures (e.g., BMI, smoking status).

Analyses performed revealed significant differences in HEI-2015 total score by SNAP participation status (p < 0.001). We found that the total gap in HEI-2015 total score between SNAP participants and income-ineligible non-participants was 6.30 points. Socio-demographic measures alone explained 72.40% of the disparity. All measures together explained 86.31% of the disparity.

The total gap between SNAP participants and income-eligible non-participants was 3.24 points. Socio-demographic measures alone explained 35.51% of this disparity while all measures together explained 56.86%.

We observed disparities in diet quality between SNAP participants and non-participants. Socio-demographic, household, and health-related measures explained a significant amount of the disparity that existed between SNAP participants and income-eligible non-participants; they explained less of the disparity between SNAP participants and income-eligible non-participants.

1. Introduction

The Supplemental Nutrition Assistance Program (SNAP), formerly titled the Food Stamp Program, is the largest federally-funded food assistance program in the United States (Committee on Examination of the Adequacy of Food Resources and SNAP Allotments, 2013). In 2017, the program provided monetary benefits to over 40 million individuals in an effort to alleviate the public health burden of food insecurity and hunger (Center on Budget and Policy Priorities, 2018). The dollar amount of benefits an individual receives depends on their net monthly income based on gross income, pre-determined household expenses, and total number of household members (U.S. Department of Agriculture, 2018). SNAP participation has been linked to positive outcomes among low-income adults including increased food security,
lower healthcare costs, and improved long-term health (Center on Budget and Policy Priorities, 2018; Bartfield et al., 2015; Gregory and Deb, 2015; Berkowitz et al., 2017; Mabli and Ohls, 2015).

In recent years, studies have reported that adults participating in SNAP have poorer diet quality (as measured by the Healthy Eating Index) than income-eligible non-participants, and in some cases, income-eligible non-participants (Andreyeva et al., 2015; Leung et al., 2012; Hilmers et al., 2014; Nguyen et al., 2014; Nguyen et al., 2015). Furthermore, a recent study by Zhang and colleagues revealed that disparities in diet quality between SNAP participants and non-participants persisted between 1999 and 2014 despite a slight overall improvement in diet quality among adults in the US (Zhang et al., 2018). Given that SNAP aims to mitigate food insecurity so program participants can attain a healthier diet (Committee on Examination of the Adequacy of Food Resources and SNAP Allotments, 2013; Center on Budget and Policy Priorities, 2018), there is a need to better understand the disparities in diet quality that exist between SNAP participants and non-participants in order to improve the health and nutritional status of low-income populations in the U.S.

There is a large body of scientific literature that documents the differences between SNAP participants and non-participants in regards to socio-demographic, household, and health-related factors (Smith et al., 2017; U.S. Department of Agriculture, 2017; Vega et al., 2017; Gummorn and Tallie, 2017; Andreyeva et al., 2012; Tallie et al., 2018). For example, working individuals who participate in SNAP are more likely to be younger, women, minorities, and have children compared to those not participating (Smith et al., 2017; U.S. Department of Agriculture, 2017). These factors may explain, in part, the disparities in diet quality that exist between SNAP participants and non-participants. To our knowledge, no study conducted to date has attempted to quantify 1) how much of the disparity in diet quality that exists between SNAP participants and non-participants is explained by key socio-demographic, household, and health-related factors and 2) how much this disparity would be attenuated if SNAP participants had similar characteristics as non-participants.

The objective of this research is to examine disparities in diet quality between SNAP participants and non-participants (both income-eligible and income-ineligible) using Oaxaca-Blinder decomposition analysis (Jann, 2008) — a regression-based analytical approach that has been previously utilized to evaluate disparities in obesity and nutrition (Sen, 2014; Singleton et al., 2016; Powell et al., 2012; Caian et al., 2017). By utilizing Oaxaca-Blinder decomposition analysis, we can calculate how much differences in socio-demographic, household, and health-related measures explain observed disparities in diet quality between SNAP participants and non-participants. Furthermore, we can estimate how the diet quality of SNAP participants may improve if they had similar mean characteristics as non-participants. We hypothesize that socio-demographic measures will explain a significant amount of disparity in diet quality between SNAP participants and non-participants.

2. Methods

2.1. Data source

We obtained cross-sectional data from the National Health and Nutrition Examination Survey (NHANES) cycles 2009–2010, 2011–2012, and 2013–2014. Detailed information about NHANES is available online (Centers for Disease Control and Prevention, 2017). To summarize, NHANES is a program of the National Center for Health Statistics that aims to assess the health and nutritional status of a nationally-representative sample of U.S. citizens (Centers for Disease Control and Prevention, 2017). NHANES employs a series of interview-administered questionnaires and physical examinations to collect a wide-range of socio-demographic, dietary, and health information from respondents (Centers for Disease Control and Prevention, 2017). A complex sampling scheme is used to identify eligible adults and children each year (Johnson et al., 2014). NHANES oversampled non-Hispanic blacks and Hispanics from 2009 to 2014 and non-Hispanic Asians from 2011 to 2014 to support precise estimates for these demographic groups (Johnson et al., 2014). There were 30,468 respondents in the selected cycles. After excluding respondents who were < 18 years old (n = 11,964), had inadequate 24-hour recall data (n = 2,020), and were missing information on receipt of SNAP benefits in the prior year and/or poverty-to-income ratio (PIR) (n = 2,153), we derived a final analytical sample of 14,331 adult respondents. Institutional Review Board at the University of Illinois at Chicago approved this research.

3. Measures

3.1. SNAP eligibility & participation status

We categorized respondents into the following three groups: current SNAP participant, income-eligible non-participant, and income-ineligible non-participant. We used the measures receipt of SNAP benefits in the prior year and PIR to estimate SNAP eligibility and participation status for each NHANES participant. The measure receipt of SNAP benefits is self-reported (yes vs. no) and assessed at the household level. It is important to note that the SNAP program employs several criteria to determine eligibility (e.g., income, household size, age of household members, disability status, etc.) (Center on Budget and Policy Priorities, 2018). Thus, SNAP eligibility and participation status can only be estimated with these data. It is likely that some NHANES participants are misclassified by SNAP eligibility and participation status.

To be considered a current SNAP participant, a respondent had to self-report that they, or a household member, received any amount of SNAP benefits in the prior 12 months regardless of income. A respondent had to have a PIR < 1.3 (i.e., 130% of the federal poverty line) but not self-report they received SNAP benefits in the prior year to be labeled an income-eligible non-participant. We selected this cut point for PIR because the SNAP administration uses it to identify individuals who qualify for participation according to income (Center on Budget and Policy Priorities, 2018). We considered all other respondents income-ineligible non-participants. Of the 14,331 respondents in the sample, 3,641 (18.30%) were labeled SNAP participants, 2,356 (11.52%) were income-eligible non-participants, and 8,334 (70.18%) were income-ineligible non-participants.

3.2. Diet quality

The outcome measure was diet quality as measured by the Healthy Eating Index 2015 (HEI-2015). We calculated HEI-2015 total score using the first day of each respondent’s 24-hour recall data. The United States Department of Agriculture and the National Cancer Institute collaborated to develop the HEI-2015 to align with the 2015–2020 Dietary Guidelines for Americans (DGAs) (United States, 2015). Studies on the details of HEI-2015 are available in the literature (Krebs-Smith et al., 2018; Reedy et al., 2018). To summarize, HEI-2015 total score is the sum of thirteen component scores (Krebs-Smith et al., 2018). The total score ranges from 0 to 100 points; a higher score indicates better diet quality (Krebs-Smith et al., 2018). Nine components are adequacy components (i.e., greater consumption of these foods will increase an individual’s HEI-2015 total score): total fruits (maximum of 5 pts), whole fruits (5 pts), total vegetables (5 pts), greens and beans (5 pts), whole grains (10 pts), dairy (10 pts), total protein foods (5 pts), seafood and plant proteins (5 pts), and fatty acids (10 pts). Four components are moderation components (i.e., lower consumption of these foods will increase an individual’s HEI-2015 total score): refined grains (10 pts), sodium (10 pts), added sugars (10 pts), and saturated fats (10 pts). HEI-2015 is considered a valid and reliable measure of diet quality (Reedy et al., 2018). A HEI-2015 total score < 59 is considered poor diet quality (Krebs-Smith et al., 2018).
We selected a variety of socio-demographic, household, and health-related measures for inclusion in the Oaxaca-Blinder decomposition analysis. The selection of these measures was guided by 1) prior nutrition research on significant predictors of poor diet quality among US adults (Hiza et al., 2013; Darmon and Drewnowski, 2008; Monsivais et al., 2012; Leung et al., 2014; Bittoni et al., 2015; Fulkerson, 2018; MacLean et al., 2018; Leung and Villamor, 2010) and 2) the Household Production Theory as described in the Institute of Medicine’s 2013 report titled “Supplemental Nutrition Assistance Program: Examining the Evidence to Define Benefit Adequacy” (IOM, 2013). The Household Production Theory states that consumers choose foods for consumption within the context of their family’s characteristics, food preferences, available resources, and time constraints (IOM, 2013). Thus, this theory provides a framework for studying the factors that drive consumer choice for food consumption (IOM, 2013). We attempted to determine how NHANES participants’ characteristics (e.g., educational attainment, household size), available resources (e.g., food security status, PIR) and time constraints (e.g., frequency of prepared meal acquisition) are associated with disparities in diet quality by SNAP participation status.

Among the socio-demographic measures included in the Oaxaca-Blinder decomposition analysis were age (years), sex (male or female), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or other), educational attainment (< high school, high school or equivalent, some college, or ≥ college degree), and marital status. For marital status, we compared respondents who self-reported they were married or living with a partner to respondents who were single, divorced, or widowed. The household and health-related measures selected include number of household members, household food security status, number of meals acquired that were prepared away from home, body mass index (BMI), health insurance status (insured or uninsured), and cigarette smoking status (current smoker or non-smoker). Each respondent’s household food security status was evaluated by NHANES using the U.S. Food Security Survey Module (United States, 2012); the response was categorized as food secure, marginal food security, low food security, and very low food security. Number of meals prepared away from home corresponds to the total number of meals the respondent prepared that were acquired away from home.

### Table 1
Demographic, Household, and Health Characteristics of NHANES 2009–2014 Respondents, N (Weighted %)

| Characteristic | All Participants | SNAP Participants | Income-Eligible Non-Participants | Income-Ineligible Non-Participants | P Value |
|---------------|-----------------|-------------------|----------------------------------|------------------------------------|---------|
| Demographics  |                 |                   |                                  |                                    |         |
| Age, years    | 46.29 (± 0.39)a | 41.06 (± 0.43)    | 42.76 (1.72)                     | 48.23 (± 0.38)                     | < 0.0001|
| Sex:          |                 |                   |                                  |                                    |         |
| Male          | 7,023 (48.84)   | 1,625 (44.36)     | 1,151 (48.08)                    | 4,247 (50.13)                      | < 0.0001|
| Female        | 7,308 (51.16)   | 2,016 (55.64)     | 1,205 (51.92)                    | 4,087 (49.87)                      |         |
| Race/Ethnicity: |                 |                   |                                  |                                    |         |
| Non-Hispanic White | 6,393 (68.74) | 1,255 (48.37)   | 948 (53.77)                      | 4,190 (76.51)                      | < 0.0001|
| Non-Hispanic Black | 2,981 (10.68) | 1,167 (23.35)   | 360 (11.02)                      | 1,454 (7.33)                       | < 0.0001|
| Hispanic      | 3,341 (13.59)   | 970 (22.12)       | 776 (26.62)                      | 1,595 (9.22)                       |         |
| Other         | 1,616 (6.99)    | 249 (6.16)        | 272 (8.60)                       | 1,095 (5.94)                       |         |
| Marital Status: |               |                   |                                  |                                    |         |
| Married or Living with Partner | 7,953 (62.96) | 1,539 (46.48) | 1,043 (47.89)                     | 5,371 (69.53)                     | < 0.0001|
| Other         | 5,630 (37.04)   | 1,861 (53.52)     | 1,113 (52.11)                    | 2,656 (30.47)                      |         |
| Educational Attainment: |           |                   |                                  |                                    |         |
| < High School | 3,436 (16.46)   | 1,436 (34.11)     | 849 (31.06)                      | 1,151 (9.46)                       | < 0.0001|
| High School or Equivalent | 3,228 (16.77) | 1,024 (29.45) | 551 (23.62)                      | 1,653 (19.33)                     | < 0.0001|
| Some College  | 4,277 (31.63)   | 977 (30.18)       | 684 (32.24)                      | 2,616 (31.91)                      | < 0.0001|
| ≥ College Degree | 3,374 (20.34) | 197 (6.27)       | 269 (13.08)                      | 2,908 (39.30)                      |         |
| Household     |                 |                   |                                  |                                    |         |
| Number of Household Members | 3.05 (± 0.03) | 3.83 (± 0.08)    | 3.17 (± 0.08)                    | 2.83 (± 0.03)                      | < 0.0001|
| Poverty-to-Income Ratio | 2.99 (± 0.06) | 1.22 (± 0.05)    | 0.85 (± 0.02)                    | 3.75 (± 0.04)                      | < 0.0001|
| Food Security Status: |           |                   |                                  |                                    |         |
| Food Secure   | 3,621 (9.10)    | 666 (18.23)       | 357 (14.44)                      | 598 (5.83)                         | < 0.0001|
| Marginal Food Security | 1,759 (8.72) | 942 (23.67)      | 392 (15.53)                      | 425 (3.71)                         |         |
| Low Food Security | 1,111 (5.69) | 667 (18.74)      | 266 (10.24)                      | 178 (1.54)                         |         |
| Very Low Food Security |            |                   |                                  |                                    |         |
| Number of Meals Prepared Away from Home, past 7 days: |         |                   |                                  |                                    |         |
| Health        | 3.74 (± 0.07)   | 2.88 (± 0.10)     | 3.79 (± 0.47)                    | 3.95 (± 0.06)                      | < 0.0001|
| BMI, kg/m²    | 28.78 (± 0.10)  | 30.22 (± 0.26)    | 28.33 (± 0.23)                  | 28.48 (± 0.12)                     | < 0.0001|
| Health Insurance Status: |             |                   |                                  |                                    |         |
| Insured       | 11,072 (81.47)  | 2,344 (62.37)     | 1,514 (65.88)                    | 7,214 (89.01)                      |         |
| Uninsured     | 3,246 (18.53)   | 1,290 (37.63)     | 839 (34.12)                      | 1,177 (10.99)                      | < 0.0001|
| Cigarette Smoking Status: |         |                   |                                  |                                    |         |
| Current Smoker | 2,787 (19.20)  | 1,292 (39.63)    | 437 (21.57)                      | 1,058 (13.58)                      | < 0.0001|
| Non-Smoker    | 11,048 (80.79)  | 2,188 (60.37)     | 1,786 (78.43)                    | 7,074 (86.42)                      |         |
| Dietary       |                 |                   |                                  |                                    |         |
| HEI 2015 Total Score, 100 | 51.68 (± 0.25) | 47.10 (± 0.38) | 49.88 (± 0.42)                    | 53.23 (± 0.28)                     | < 0.0001|

BMI: Body Mass Index; NHANES: National Health and Nutrition Examination Survey; SNAP: Supplemental Nutrition Assistance Program.

Cell counts may not equal the sample size due to missing information.

Statistical test adjusted for the NHANES sampling scheme.

Chi-square test and ANOVA used to calculate P values.

a. Mean (± standard error) for continuous variables.
they were signifi-portion analyses. The fi-
measures together. Thus, we conducted four Oaxaca-Blinder decom-
portions of the gap in HEI-2015 total score.

...square and analysis of variance (ANOVA) tests were used to identify
ic statistics (i.e., means and frequencies) were examined for selected measures
weights to account for inclusion of three waves of NHANES data
account for the complex sampling scheme. We adjusted the sampling
*
p-value < 0.05, **p-value < 0.01, ***p-value < 0.001.
BMI: Body Mass Index; HEI: Healthy Eating Index; SNAP: Supplemental Nutrition Assistance Program.

3.4. Statistical analysis

We utilized NHANES sampling weights in all analyses performed to
account for the complex sampling scheme. We adjusted the sampling
weights to account for inclusion of three waves of NHANES data
(Centers for Disease Control and Prevention, 2019). Descriptive stati-
tics (frequencies and frequencies) were examined for selected measures
among all participants and stratified by SNAP participation status. Chi-
...s squared and analysis of variance (ANOVA) tests were used to identify
significant differences in selected measures among SNAP participants,
income-eligible non-participants, and income-ineligible non-partici-
...nts. We considered P-values < 0.05 to be statistically significant.

The main objective of our analyses was to use Oaxaca-Blinder de-
composition analysis to examine disparities in diet quality between
SNAP participants and non-participants. Other studies have also em-
ployed Oaxaca-Blinder decomposition analysis to examine disparities in
outcomes such as diet, BMI, and food access (Sen, 2014; Singleton et al.,
2016; Powell et al., 2012; Ciaian et al., 2017). For example, Powell and
colleagues used Oaxaca-Blinder decomposition analysis to evaluate
racial/ethnic disparities in BMI among adolescents (Powell et al.,
2012), and Ciaian and colleagues used it to examine disparities in diet
...ersity in Romania (Ciaian et al., 2017).

We used two-fold Oaxaca-Blinder decomposition analysis as de-
scribed in the paper by Ben Jann for this research (Jann, 2008). Spe-
cifically, we used the “OAXACA” command with the pooled regression
option in Stata version 14 (Jann, 2008). This approach partitions the
mean gap in HEI-2015 total score between SNAP participants and
income-eligible non-participants. Other studies have also em-
ployed Oaxaca-Blinder decomposition analysis to evaluate
racial/ethnic disparities in BMI among adolescents (Powell et al.,
2012; Ciaian et al., 2017). For example, Powell and

Table 2 displays descriptive characteristics of NHANES 2009–2014
adult respondents. Analyses performed revealed statistically significant
differences by SNAP participation status for all measures of interest. On
average, HEI-2015 total score was lower among SNAP participants
(47.10 ± 0.38) compared to income-eligible non-participants
(49.88 ± 0.42) and ineligible non-participants (53.23 ± 0.28)
(p < 0.0001). SNAP participants were, on average, younger, had more
household members, had a greater BMI, and purchased fewer prepared
meals compared to income-eligible non-participants and income-in-
eligible non-participants. Furthermore, a larger percentage of SNAP
participants were non-Hispanic black, Hispanic, food insecure, un-
insured, and a current smoker compared to income-eligible non-partici-
pants and income-ineligible non-participants.

We aimed to compare how much differences in socio-demographic
measures alone explained the mean differential in HEI-2015 score to all
measures together. Thus, we conducted four Oaxaca-Blinder decom-
position analyses. The first calculated the portion of the gap in HEI-
2015 total score explained solely by socio-demographic measures be-
tween SNAP participants and income-eligible non-participants while
the second calculated the portion explained by all measures. The third
calculated the portion of the gap in HEI-2015 total score explained
solely by socio-demographic measures between SNAP participants and
income-ineligible non-participants while the fourth calculated the
portion explained by all measures.

4. Results

Table 1 displays descriptive characteristics of NHANES 2009–2014
adult respondents. Analyses performed revealed statistically significant
differences by SNAP participation status for all measures of interest. On
average, HEI-2015 total score was lower among SNAP participants
(47.10 ± 0.38) compared to income-eligible non-participants
(49.88 ± 0.42) and ineligible non-participants (53.23 ± 0.28)
(p < 0.0001). SNAP participants were, on average, younger, had more
household members, had a greater BMI, and purchased fewer prepared
meals compared to income-eligible non-participants and income-in-
eligible non-participants. Furthermore, a larger percentage of SNAP
participants were non-Hispanic black, Hispanic, food insecure, un-
insured, and a current smoker compared to income-eligible non-partici-
pants and income-ineligible non-participants.

Table 2 and 3 display results from Oaxaca-Blinder decomposition
analyses that examined the disparity in HEI-2015 total score between
SNAP participants and income-eligible non-participants. The analysis
presented in Table 2 included only socio-demographic measures while
the analysis in Table 3 included all measures. The total gap in HEI-2015
total score between SNAP participants and income-eligible non-parti-
cipants was about 3.24 points. Socio-demographic measures alone ex-
plained 1.14 points (35.51% of the total gap). The measures for His-
ppanic and ≥ a college degree significantly contributed to the explained
gap in this model. All measures combined explained 1.84 points
(56.86% of the total gap). Race/ethnicity, having ≥ a college degree,
BMI, and smoking status significantly contributed to the explained gap
in the model that included all measures.
Like previous literature, we observed that the diet quality of SNAP participants, as measured by HEI, is poorer than income-eligible non-participants and income-ineligible non-participants (Andreyeva et al., 2015; Leung et al., 2012; Gregory et al., 2013). A variety of individual and household-level factors have been linked to poor diet quality in US adults (Hiza et al., 2013; Darmon and Drewnowski, 2008; Monsivais et al., 2012; Leung et al., 2014; Bittoni et al., 2015; Fulkerson, 2018; MacLean et al., 2018; Leung and Villamor, 2010); however, prior to this study, there was limited knowledge of the extent to which socio-demographic, household, and health-related factors were related the disparities in diet quality that exist between SNAP participants and non-participants. Our Oaxaca-Blinder decomposition analyses addressed this gap in knowledge and demonstrated how the diet quality of SNAP participants is predicted to improve if they had similar mean characteristics as non-participants.

5. Discussion

Tables 4 and 5 present results from Oaxaca-Blinder decomposition models that examined the disparity in HEI-2015 total score between SNAP participants and income-ineligible non-participants. The analysis presented in Table 4 included socio-demographic measures only. All measures were included in the analysis presented in Table 5. The total gap in HEI-2015 total score between SNAP participants and income-ineligible non-participants was approximately 6.30 points. Socio-demographic measures alone explained 4.56 points (72.40% of the total gap). The measures age, male sex, Hispanic, marital status, ≥ a college degree and PIR made significant contributions to the explained portion of the gap in this model. The analysis with all measures indicated that all measures combined explained 5.42 points (86.31% of the total gap). Age, sex, Hispanic, marital status, ≥ a college degree, PIR, number of meals prepared away from home, BMI, and smoking status made significant contributions to the explained portion of the gap in this model.

5.1. SNAP participants vs. Income-Ineligible Non-Participants

As hypothesized, differences in socio-demographic characteristics explained a large proportion of the disparity between SNAP participants and income-ineligible non-participants. If SNAP participants had similar mean socio-demographic characteristics as income-ineligible non-participants, their mean HEI-2015 total score would increase by 4.56 points. Several studies, including a national assessment conducted by Hiza and colleagues, reported that socio-demographic characteristics, including age, sex, race/ethnicity, and educational attainment, are highly associated with diet quality among adults (Hiza et al., 2013; Darmon and Drewnowski, 2008; Monsivais et al., 2012). Educational attainment, specifically attaining a college degree, explained much of the disparity we observed between SNAP participants and income-ineligible non-participants. Our Oaxaca-Blinder decomposition analyses addressed this gap in knowledge and demonstrated how the diet quality of SNAP participants is predicted to improve if they had similar mean characteristics as non-participants.

Looking beyond socio-demographics, the household and health-related factors were related the disparities in diet quality that exist between SNAP participants and non-participants. Our Oaxaca-Blinder decomposition analyses addressed this gap in knowledge and demonstrated how the diet quality of SNAP participants is predicted to improve if they had similar mean characteristics as non-participants.
related measures increased the explained portion of the gap in HEI-2015 total score between SNAP participants and income-ineligible non-participants, but not by much (about 14 percentage points). Both smoking status and BMI explained a portion of the disparity between participants, but not by much (about 14 percentage points). Both income and education level, explain most of the disparity in HEI-2015 total score between SNAP participants and income-eligible non-participants (3.24 vs. 6.30 points). Although adding smoking status and BMI explained a portion of the disparity between SNAP participants and income-ineligible non-participants.

5.2. SNAP participants vs. Income-Eligible Non-Participants

As expected, the disparity in HEI-2015 total score between SNAP participants and income-eligible non-participants was substantially smaller than the disparity between SNAP participants and income-ineligible non-participants (3.24 vs. 6.30 points). Although adding smoking status and BMI explained a portion of the disparity between SNAP participants and income-eligible non-participants remained unexplained. It is clear that observable characteristics, such as income and education level, explain most of the disparity in HEI-2015 total score between SNAP participants in income-ineligible non-participants. Since SNAP participants and income-eligible non-participants are demographically similar, it is likely that unobserved characteristics are explaining the disparity in diet quality between these two groups.

5.3. Limitations

It is important to note the limitations of Oaxaca-Blinder decomposition analysis. First, these findings do not imply causation. They simply show how selected measures are explaining the calculated HEI-2015 total score differential. Much of the differential was unexplained by the selected measures. It is likely that the unexplained portion is due to measurement error and/or omitted measures.
between SNAP participants and non-participants: geographic access to a portion of the disparity between SNAP participants and income-ineligible non-participants may exist. This measure in the analysis could have increased the explained household, which imply they have limited access to healthy food resources can vary substantially between SNAP participants and non-participants, this measure may introduce measurement error to the analysis.

As previously mentioned, unobserved measures omitted from the analysis may explain the unexplained gap (Jann, 2008). Several measures may offer further explanation for the disparity in diet quality between SNAP participants and non-participants: geographic access to a supermarket, stress, social support, etc. NHANES does not collect information on each respondent’s proximity to retailers that sell healthy food, such as large chain supermarkets, so we could not include this measure in the analysis. Studies have shown that low-income households are more likely to reside in food deserts compared to higher income household, which imply they have limited access to healthy food retailers (Larson et al., 2009). Thus, including a measure for geographic access to a supermarket the analysis could have increased the explained portion of the disparity between SNAP participants and income-ineligible non-participants (Caspi et al., 2012). Psychosocial factors such as stress and social support have been linked to dietary intake (Issai et al., 2015; Strom and Egede, 2012). If SNAP participants and income-eligible non-participants experience varying levels of stress and social support, these two factors may be contributing to the unexplained portion of the disparity in diet quality between these two groups.

Unfortunately, Oaxaca-Blinder decomposition analysis does not provide any insight to what specifically factors contribute to the unexplained portion of the disparity.

Several limitations to our analysis are related to the data. We only analyzed day 1 of the 24-hour recall data because several participants were missing data for day 2. While analyzing two days of dietary intake can provide insight into the dietary intake of an individual or small subsamples, random errors associated with dietary recall are generally understood to cancel out in sufficient sample sizes (Ahluwalia et al., 2016). In the methods section, we mentioned that NHANES participants may be misclassified by SNAP eligibility and participation status. To be specific, if SNAP participants failed to report that they, or a member of their household, received benefits in the prior 12 months, it is likely that they are included in one of the groups for non-participants. If this is true, the mean differential in HEI-2015 total score between SNAP participants and both groups of non-participants is smaller than we estimated. On the other hand, income-eligible non-participants may have been misclassified as income-ineligible non-participants because SNAP uses other factors, such as disability status, to determine eligibility. Assuming income-eligible participants have poorer diet quality compared to income-ineligible participants, it is likely that the observed disparity in HEI-2015 total score between SNAP participants and income-ineligible non-participants is greater than we estimated.

Other limitations to this research should be noted. Self-selection bias may have affected our findings. Because low-income households are able to self-select SNAP participation, evaluating the influence of SNAP participation on health outcomes is difficult. Studies have shown

### Table 5

Results from Oaxaca-Blinder Analysis Decomposing the Disparity in HEI-2015 Total Score between SNAP Participants and Income-Ineligible Non-Participants (All Measures).

| Characteristic: | Coefficient SNAP Participants | Standard Error | Coefficient Income-Ineligible Non-Participants | Standard Error | Contribution to “Explained Gap” | Contribution to “Unexplained Gap” |
|----------------|-------------------------------|----------------|-----------------------------------------------|----------------|-----------------------------|---------------------------------|
| Demographics   |                               |                |                                               |                |                             |                                 |
| Age            | 0.14***                      | 0.02           | 0.11***                                       | 0.01           | 0.82***                     | -0.96                           |
| Male Sex       | -0.11                        | 0.58           | -1.42***                                      | 0.30           | -0.07***                    | -0.59                           |
| Race/Ethnicity:|                               |                |                                               |                |                             |                                 |
| Non-Hispanic White | REF                          | REF            | REF                                           | REF            | REF                         | REF                             |
| Low-Income Households | REF                          | REF            | REF                                           | REF            | REF                         | REF                             |
| Hispanic       | 3.98***                      | 0.90           | 1.20                                          | 0.65           | 0.03                        | -0.49                           |
| Other           | 2.97*                        | 1.48           | 1.71**                                       | 0.61           |                             | -0.08                           |
| Married or Living with Partner | -0.07            | 0.72           | 0.91                                          | 0.53           | 0.19*                       | 0.47                            |
| Educational Attainment: |                           |                |                                               |                |                             |                                 |
| < High School  | 0.39                         | 0.67           | 0.58                                          | 0.65           | -0.11                       | 0.03                            |
| High School or Equivalent | REF                          | REF            | REF                                           | REF            | REF                         | REF                             |
| Some College   | 1.74                         | 0.91           | 1.82**                                        | 0.46           | 0.03                        | 0.02                            |
| ≥ College Degree | 6.88**                      | 1.67           | 5.23***                                       | 0.71           | 1.84**                      | -0.19                           |
| Poverty-to-Income Ratio | 0.24                      | 0.26           | 0.58**                                        | 0.17           | 1.56**                      | 0.32                            |
| Household      |                               |                |                                               |                |                             |                                 |
| Number of Household Members | -0.06                      | 0.20           | -0.18                                         | 0.18           | 0.13                        | -0.40                           |
| Food Security Status: |                               |                |                                               |                |                             |                                 |
| Food Secure    | REF                          | REF            | REF                                           | REF            | REF                         | REF                             |
| Marginal Food Security | 0.65                      | 0.90           | -1.59                                         | 1.16           | 0.13                        | -0.33                           |
| Low Food Security | 1.08                        | 0.76           | -2.28*                                        | 1.00           | 0.16                        | -0.49**                         |
| Very Low Food Security | 2.43*                      | 1.04           | -3.57*                                        | 1.51           | 2.43*                       | -0.53***                        |
| Number of Meals Prepared Away from Home, past 7 days | -0.12                      | 0.12           | -0.47**                                       | 0.05           | -0.52**                     | -1.03*                          |
| Health         |                               |                |                                               |                |                             |                                 |
| BMI            | -0.16***                     | 0.04           | -0.28**                                       | 0.03           | 0.44**                      | -3.57*                          |
| Health Insured | 0.15                         | 0.69           | -0.72                                         | 0.59           | -0.13                       | -0.41                           |
| Current Smoker | -3.64***                     | 0.49           | -3.11**                                       | 0.61           | 0.91**                      | 0.14                            |
| Predicted Value of HEI-2015 Total Score | 47.11                   | 0.41           | 53.40                                         | 0.27           |                             |                                 |

BMI: Body Mass Index; HEI: Healthy Eating Index; SNAP: Supplemental Nutrition Assistance Program.

*p-value < 0.05, **p-value < 0.01, ***p-value < 0.001.
that food insecure low-income household are more likely to enroll in SNAP (Nord and Golla, 2009). Although we included a measure for food security status in the Oaxaca-Blinder decomposition analysis, it is likely that self-selection bias is still an issue. Many of the measures we analyzed were collected via self-report, so they may be subject to reporting errors. Lastly, NHANES measures may not represent a participant’s usual behavior and characteristics because of the cross-sectional nature of the study. For example, a participant’s diet, health behaviors, and SNAP participation status may fluctuate over the course of a year.

6. Conclusion

In summary, we observed disparities in diet quality between SNAP participants and non-participants. This is a key public health concern that has garnered much attention in recent years (Andreyeva et al., 2015; Leung et al., 2012; Mulik and Haynes-Maslow, 2017; Collins and Klerman, 2017). The results from the Oaxaca-Blinder decomposition analyses offers additional insight to what factors may explain disparities in diet quality between SNAP participants and non-participants. Overall, the findings demonstrate that there is an ongoing need for programs that aim to improve the education, health behaviors, and dietary intake of SNAP participants. This study highlights the paucity of information in the scientific literature on income-eligible non-participants. Future research should examine differences in the behaviors, attitudes, and beliefs between SNAP participants and eligible non-participants. This presents a promising line of continued research for those who examine factors that influence SNAP participation among low-income individuals in the U.S.

CRediT authorship contribution statement

Chelsea R. Singleton: Conceptualization, Methodology, Software, Formal analysis, Writing - original draft. Sabrina K. Young: Formal analysis, Writing - review & editing. Nicollette Keesee: Data curation, Formal analysis. Sparkle E. Springfield: Writing - original draft. Bisakha Sen: Supervision, Writing - review & editing.

Declaration of Competing Interest

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.

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Author contributions

C.R.S conceptualized the research project. S.K.Y. analyzed the NHANES 24-hour recall data to calculate HEI-2015 scores. C.R.S. performed the Oaxaca-Blinder decomposition analysis. BS oversaw the statistical analyses. C.R.S. and N.K. led the writing of the manuscript. All authors were involved in developing the final content presented in this manuscript. All authors were involved in editing and approving the final version for submission.

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