Preventive Medicine 100 (2017) 10–16

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

# Does where you shop or who you are predict what you eat?: The role of stores and individual characteristics in dietary intake

Christine A. Vaughan [a,*], Rebecca Collins [a], Madhumita Ghosh-Dastidar [a], Robin Beckman [a], Tamara Dubowitz [b]

[a] RAND Corporation, 1776 Main St., P.O. Box 2138, Santa Monica, CA 90407-2138, USA
[b] RAND Corporation, 4570 Fifth Avenue, Ste 600, Pittsburgh, PA 15213, USA

ARTICLE INFO

*Article history:*
Received 18 October 2016
Received in revised form 29 January 2017
Accepted 20 March 2017
Available online 22 March 2017

*Keywords:*
Diet
Nutrition

ABSTRACT

Interventions to address diet, a modifiable risk factor for diabetes, cancer, and cardiovascular disease, have increasingly emphasized the influence of the physical environment on diet, while more traditional approaches have focused on individual characteristics. We examined environmental and individual influences on diet to understand the role of both. Household interviews were conducted in 2011 with 1372 individuals randomly selected from two low-income, predominantly African American neighborhoods in Pittsburgh, PA. Participants reported their sociodemographic characteristics, food shopping behavior, and dietary intake. Both food shopping frequency at different types of food stores and sociodemographic characteristics showed significant associations with diet in adjusted regression models. More frequent shopping at convenience and neighborhood stores and being younger, male, without a college degree, and receiving SNAP benefits were associated with greater intake of sugar-sweetened beverages (SSBs), added sugars, and discretionary fats. Being older, male, and having a college degree were associated with greater intake of fruits and vegetables. However, while food shopping behavior and sociodemographic characteristics accounted for similar amounts of nonoverlapping variance in fruit and vegetable intake, food shopping behavior accounted for much less variance, and little unique variance, in SSBs, added sugars, and discretionary fats in models with sociodemographic characteristics. The current study reinforces the need for policies and interventions at both the environmental and individual levels to improve diet in food desert residents. Individual interventions to address food choices associated with certain sociodemographic characteristics might be particularly important for curbing intake of SSBs, added sugars, and discretionary fats.



## 1. Introduction

Diet is a modifiable risk factor for chronic conditions, including diabetes (Hu et al., 2001), cancer (Key et al., 2002), and cardiovascular disease (Hung et al., 2004), and has been identified as a major public health problem (Story et al., 2008). Questions of the role of the local food retail environment – and whether proximity to food selections that are healthy (i.e., fruits and vegetables) vs. unhealthy (i.e., high in added sugar, salt, or discretionary fats or calories) influences diet– have dominated much of the research (Caspi et al., 2012; Larson and Story, 2009; Story et al., 2008) and served as a policy leverage point. A growing body of research has demonstrated that proximity to certain store *types* (e.g., convenience stores versus supermarkets) is associated with diet (Larson et al., 2009; Story et al., 2008). At the same time, residents of low-income communities are more likely to reside in "food deserts," where healthy food options are extremely limited (Larson et al., 2009; Story et al., 2008).

The immediate food environment has been posited to influence diet. Those who live closer to stores with healthy food options may buy and eat healthier food. Some research has documented an association between shopping at corner stores versus other types of stores (e.g., supermarkets) and purchasing foods high in fat and/or sugar (D'Angelo et al., 2011) and between shopping at a supermarket or specialty grocery store and fruit and vegetable (FV) intake (Zenk et al., 2005).

Alternatively, sociodemographic characteristics may influence where shoppers buy food, and shopping at stores that emphasize certain types of foods can encourage purchasing and consumption of those foods. Prior research suggests that higher income and educational attainment are associated with shopping at supermarkets (vs. other store types) and purchasing (D'Angelo et al., 2011; Zenk et al., 2005) and consumption of FV (Casagrande et al., 2007).

Research that has simultaneously examined the effects of shopping at different store types and shoppers' sociodemographic characteristics on diet has produced mixed findings. Some research suggests that shopping at supermarkets and specialty stores (vs. other store types) is

*Abbreviations:* FV, Fruits and vegetables; SNAP, Supplemental Nutrition Assistance Program; SSB, Sugar-sweetened beverages.

* Corresponding author.
*E-mail addresses:* cvaughan@rand.org (C.A. Vaughan), collins@rand.org (R. Collins), bonnieg@rand.org (M. Ghosh-Dastidar), beckman@rand.org (R. Beckman), dubowitz@rand.org (T. Dubowitz).

http://dx.doi.org/10.1016/j.ypmed.2017.03.015
0091-7435/

associated with higher FV intake after controlling for age, income, and education (Zenk et al., 2005). In other research, the poorer dietary quality of residents of low-income, low-access (to food) areas relative to their socioeconomically advantaged peers has not been adequately explained by differences in the food retail channels where they shop; rather, demographic characteristics such as race, education, and income have evidenced a much stronger effect on diet (Rahkovsky and Snyder, 2015).

Disentangling the contributions of the food retail environment and sociodemographic characteristics to diet is critical to shaping nutrition policy. If shopping for food more frequently at stores that offer limited healthy food and more unhealthy food more strongly reduces dietary quality than sociodemographic characteristics, interventions should focus on promoting access to healthy food and de-emphasizing unhealthy food in the environment. However, if associations between food purchasing behavior and consumption are primarily due to individual characteristics, then interventions should focus on improving the food choices of individuals with sociodemographic characteristics associated with unhealthy diet. Alternatively, both environmental and individual influences may make significant, unique contributions to diet. This more complex scenario would suggest the merit of an ecological approach in which dietary interventions must address both individual and environmental influences to exert maximal impact.

Prior work is limited in that it has mostly analyzed food shoppers within mutually exclusive categories of stores based on where they do most of their food shopping. However, individuals may buy food from multiple store types, and so assignment of individuals' shopping behavior to just one store type may yield miscalculated conclusions. Simultaneous examination of the effects of food shopping at multiple store types on diet is necessary to obtain a more comprehensive understanding of food shopping behavior.

The current study was designed to strengthen the evidence base by examining the unique, relative contributions of food shopping frequency at several store types and sociodemographic characteristics to diet of residents of two low-income, predominantly African American neighborhoods that are food deserts. In addition, we used a high-quality measure of diet, the 24-h dietary recall. Building on a larger study of the dietary impact of adding a grocery store to one of the neighborhoods, we analyzed household interview data on sociodemographic characteristics, food shopping behavior, and diet and used food store audit data to describe the availability and prominence of healthy and unhealthy food in the local retail environment.

## 2. Methods

### 2.1. Design and sample

The Pittsburgh Hill/Homewood Research on Eating, Shopping, and Health (PHRESH) is a 5-year quasi-experimental study of two predominantly African American, low-income "food deserts" in Pittsburgh, Pennsylvania, one of which was slated to acquire a new full-service supermarket (intervention neighborhood). These neighborhoods were sociodemographically and geographically matched to permit clearer attribution of differences observed at follow-up to the new supermarket. For both neighborhoods, 95% of residents were African American, and the mean self-reported annual household income was less than $15,000. Before the new supermarket opened, the closest supermarket was, on average, 1.73 miles (SD = 0.35) and 1.45 miles (SD = 0.35) from residents of the intervention and comparison neighborhoods, respectively.

PHRESH participants were recruited from a random sample of households drawn from a complete list of residential addresses in both neighborhoods generated by the Pittsburgh Neighborhood and Community Information System, with sampling in the intervention neighborhood stratified by distance to the planned supermarket. Trained data collectors went door-to-door to 4002 sampled addresses, determined that 2900 of these were not vacant, and reached a household member in 1956 addresses. Of these members, 1649 were over 18 and the primary household food shopper and therefore eligible to participate; 1434 (87%) of eligible residents agreed to participate. After excluding 62 residents who provided incomplete or unusable data, the final sample comprised 1372 households. Before the new supermarket opened, data collectors administered in-home interviews to each household's primary food shopper between May and December 2011 and audited food purchasing venues in the local retail environment. More details on study procedures are available in the main paper describing the quasi-experimental evaluation (Dubowitz et al., 2015). The study protocol was approved by the RAND Human Subjects Protection Committee.

### 2.2. Household interviews

Household interviews assessed participants' sociodemographic and other characteristics. Annual household income was measured with a nine-category ordinal scale and recoded to the interval midpoint, and missing values were imputed with the software IVEWare in SAS macros. Adjusted income was the ratio of household income to household size. Body mass index (BMI) (or weight in kg/height in $m^2$) was calculated from interviewer-measured height to the nearest eighth inch using a carpenter's square (triangle) and an 8-ft folding wooden ruler marked in inches and weight to the nearest tenth of a pound using the SECA Robusta 813 digital scale (without shoes). We defined obesity as BMI of at least 30 (Centers for Disease Control and Prevention, 2016).

Diet was assessed with the automated self-administered 24 h recall (ASA-24), once during the household interview and again seven to 10 days later by telephone (Subar et al., 2012). The ASA-24 estimates nutrients values based on the USDA's Food and Nutrient Database for Dietary Studies and the MyPyramid Equivalents Database. The ASA-24 has been shown to produce comparable dietary intake estimates relative to interviewer-administered 24 h recalls in a racially/ethnically diverse sample of adults (Thompson et al., 2015). Moreover, web-based 24 h recalls have been validated in black adults using the objective biomarker of the doubly-labeled water method for estimating total energy expenditure (Arab et al., 2011). For this study, we analyzed kilocalories of sugar-sweetened beverages (SSBs), teaspoons of added sugars, grams of discretionary (solid) fats (i.e., fats that are solid at room temperature, such as butter, lard, and shortening), and cups of FV. The ASA-24 automatically estimates all of these except for kilocalories of SSBs, which were estimated by 1) reviewing codes for beverages to create a subcategory for SSBs, and 2) using kilocalories calculated by the ASA-24 to compute kilocalories from SSBs for each person. Dietary indicators were computed as the average of both dietary recalls.

Frequency of food shopping was assessed for each store type with a single question: "In general, when you buy food, how often do you go to…" followed by a list that included convenience stores, neighborhood stores, dollar stores, discount grocery stores, supercenters, wholesale clubs, full-service supermarkets, specialty grocery stores, and FV stores or farm stands. We classified stores based on definitions from the Food Marketing Institute (FMI) and the North American Industry Classification System (NAICS) and confirmed our classifications with our Community Advisory Board, comprised of key resident stakeholders in each neighborhood. Local examples were provided to clarify the definition of each store type. Response options ranged from *never* (1) to *often* (4).

### 2.3. Store audits

We audited all 24 food stores in the study neighborhoods and 14 food venues outside both neighborhoods where residents reported doing major food shopping. We compiled a complete list of food stores in the neighborhoods from in-person neighborhood scans and feedback from data collectors, all of whom were study neighborhood residents,