UNIVERSITY OF CALIFORNIA, SAN DIEGO

SAN DIEGO STATE UNIVERSITY

A Food Environment Perspective on the Fruit and Vegetable Dietary Behaviors of US Hispanics

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy

in

Public Health (Health Behavior)

by

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2017

The Dissertation of Jennifer C. Sanchez-Flack is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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Chair

University of California, San Diego

San Diego State University

2017

DEDICATION

This dissertation is dedicated to my sister, Maribel, who did not get to see me finish this but who believed in me and provided support throughout this journey. Maribel taught me to never give up and that, “if it’s not painful and you don’t feel like throwing up, you’re not pushing yourself”. She was an inspiring example of strength, determination, bravery and humor; even at her weakest. Love you, Maribel! I know you would be proud of this accomplishment.

EPIGRAGH

You can't make positive choices for the rest of your life without an environment that makes those choices easy, natural, and enjoyable.

-Deepak Chopra

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ACKNOWLEDGEMENTS

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RESEARCH EXPERIENCE

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Institute for Behavioral & Community Health, San Diego, CA.
Doctoral Candidate Research Assistant

Fe en Acción (Faith in Action) P.I.: Elva M. Arredondo, PhD

- An R01 NIH-funded grant examining intervention effects to improve the physical activity behaviors of churchgoing Latina women in San Diego. The primary aim of the study is to increase moderate to vigorous physical activity among churchgoing Latina women.
- Assisted with dissemination activities such as the preparation of scientific manuscripts and participation in weekly manuscript meetings.

Data Manager

El Valor de Nuestra Salud (The Value of Our Health) P.I.: Guadalupe X. Ayala, PhD, MPH

- An R01 NIH-funded grant examining intervention effects due to changes in the food environment of Latino grocery stores to improve fruit and vegetable consumption among customers.
- Led and oversaw all data management activities such as maintenance of data quality control, coding, and entry, developing data codebooks, conducting data verification, preparing syntax for data analysis, and supervising evaluation research assistants.

Principal Investigator

Farm-to-Tienda

- A formative research study conducted to determine the feasibility of sourcing locally grown produce to Latino small Latino food stores in low-income communities to improve the retail food environment in San Diego County.
- Recruited and conducted mixed-methods key informant interviews with nine small food store managers and ten small farmers.
- Conducted quantitative and qualitative analysis for the preparation of a scientific manuscript.

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Child Health & Evaluation Research Unit, University of Michigan Health System, Ann Arbor, MI.

Project Manager

Project for African American Infant Safety P.I.: Kathryn Moseley, MD, MPH

- Project manager for RO1 NIH-funded grant, a culturally-tailored intervention to promote infant supine sleep among African Americans in Detroit, Michigan.
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- Developed a procedure and training manual to guide implementation of the project and ensure compliance. Trained and managed two research assistants in all project related duties.
- Designed recruitment process, created recruitment materials, and coordinated recruitment efforts, including the collection of potential participant information from Henry Ford Health System.

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- American mothers of newborns to inform the tailored brochures and DVDs.
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Center for Managing Chronic Disease. University of Michigan School of Public Health, Ann Arbor, MI.
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- Coded 17 youth interviews and conducted content and policy analysis on food and active living systems for 18 "Systems and Policy Change Stories" and 45 "Systems and Policy Change Forms".
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- Edited youth and youth coordinator interview guide for second round of interviews.
- Developed coding scheme in NVivo and recoded all interviews in NVivo to obtain frequencies.
- Reviewed narrative and data reports from all participating community organizations to monitor progress and compliance.
- Wrote results section for final evaluation report to W.K. Kellogg Foundation.

A Partnership to Enhance Research Related to Chronic Disease Management P.I.: Noreen Clark, PhD

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Prevention Research Center. University of Michigan School of Public Health, Ann Arbor, MI.
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- Conducted preliminary data analysis and maintained data related documents, including SPSS syntax.
- Wrote results and discussion section for a manuscript prepared for peer-reviewed journal.

Men 4 Health P.I.: Derek Griffith, PhD

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May 2009-August2009
MHIRT Program, University of Chile, Santiago, Chile
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- Collected data by completing 85 neighborhood walking audits in Santiago, Chile to survey the social and built environment.
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Risk Factors Associated with Chronic-Fatigue Syndrome and Prognosis P.I.: Lenny Jason, PhD

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Sanchez-Flack, J.C., Baquero, B., Linnan, L.A., Gittelsohn, J., Pickrel, J.L., & Ayala, G.X. (2016). What influences grocery shopping behavior? Perspectives on the small food store environment from managers and employees in San Diego, CA. *Ecology of Food and Nutrition,* 1-19.

Ayala, GX, Baquero, B, Pickrel, JL, Mayer, J, Belch, G, Rock, CL, Linnan, L, Gittelsohn, J, **Sanchez- Flack, J.C.,** Elder, JP (2015). A store-based intervention to increase fruit and vegetable consumption: The El Valor de Nuestra Salud cluster randomized controlled trial. *Contemporary Clinical Trials, 42*, 228-238.

Williams, T.T., Griffith, D.M., Pichon, L.C., Campbell, B., Ober Allen, J., & **Sanchez, J.C.** Involving Faith-Based Organizations in Adolescent HIV Prevention. *Progress in Community Health Partnerships: Research, Education, and Action 5*(4), 425-431.

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ABSTRACT OF THE DISSERTATION

A Food Environment Perspective on the Fruit and Vegetable
Dietary Behaviors of US Hispanics

by

Jennifer C. Sanchez-Flack

Doctor of Philosophy in Public Health (Health Behavior)

Professor Professor Guadalupe X. Ayala, Chair

Background: In the US, 42.5% of Hispanics are obese, which is higher than the national prevalence rate of 34.9%. Diet is a modifiable risk factor for obesity that should be targeted to reduce and prevent disparities within the US Hispanic population. The retail food environment is an important context to study because the greatest contributor to energy intake are from foods and beverages purchased in stores.

Methods: Aim 1 used NHANES data to examine fruit and vegetable (FV) intake by food store type among Hispanics. Differences between customers of various food store type categories were assessed and analyses were performed to estimate associations

between intake and food store type categories. Aim 2 used baseline data from *El Valor de Nuestra Salud* to examine associations between in-store characteristics of product, placement and promotion and FV purchasing among Hispanic customers. Aim 3 used intervention data from *El Valor* to evaluate group by time differences in product, placement and promotion and group differences in FV purchasing post-intervention.

Results: Aim 1 demonstrated that Hispanics who only purchased FVs from convenience stores were younger and more likely to be born in the US. Results also demonstrated that those who primarily purchased from supermarkets/grocery stores reported higher intakes of FVs than those who only purchased from convenience stores ($p<.001$, $p=.005$). Aim 2 indicated that availability of fresh FVs was associated with FV purchasing ($p=.01$). However, when adjusting for placement, availability of fresh FVs was non-significant. Greater shelf space dedicated to FVs ($p=.01$) and fewer fresh FV displays ($p=.01$) was associated with FV purchasing. Analyses also revealed that men reported lower FV purchasing compared to women ($p=.02$). Aim 3 revealed that *El Valor* was successful in increasing the promotion of FVs among intervention stores ($p<.001$) and that intervention store customers reported higher FV purchasing than control store customers ($p=.04$).

Conclusions: The dissertation findings have important implications for practice, policy and research. The results can inform public health interventions to target in-store characteristics to encourage FV purchasing. It is important to understand and build upon the lessons learned to design, implement, and disseminate successful evidence-based programs.

CHAPTER 1

INTRODUCTION

Overweight and Obesity Among Hispanics

Approximately 42.5% of Hispanics in the US are obese, which is higher than the national prevalence rate of 34.9% (Ogden, Carroll, Kit, & Flegal, 2014). This disparity is important to address given that the Hispanic population is projected to comprise more than one-quarter of the total US population by 2060 (Colby & Ortman, 2015). This is of great concern given the evidence on the association between excess weight gain and an increased risk of hypertension, cardiovascular disease, diabetes, and certain cancers (Hruby et al., 2016). Diet is a modifiable risk factor related to obesity and obesity-related chronic diseases that should be targeted to reduce and prevent disparities within the US Hispanic population.

Importance of Fruit and Vegetable Consumption for the Prevention of Overweight and Obesity

Promoting the intake of specific foods, such as fruit and vegetables, is a promising strategy to improve diet and overall health outcomes. Research demonstrates that higher intakes of fruit and vegetables are associated with a lower risk of cardiovascular disease (Bhupathiraju et al., 2013; Sangita, Vik, Pakseresht, & Kolonel, 2013), type 2 diabetes (Carter, Gray, Troughton, Khunti, & Davies, 2010; Li, Fan, Zhang, Hou, & Tang, 2014), and stroke (He, Nowson, & MacGregor, 2006). Fruit and vegetable intake is also associated with a reduction in mortality due to ischaemic heart disease,

cardiovascular disease, and cancer (Crowe et al., 2011; Oyebode, Gordon-Dseagu, Walker, & Mindell, 2014; Wang et al., 2014). Substituting higher calorie foods with fruit and vegetables may also aid in healthy weight management (Tohill, Seymour, & Serdula, 2004). Current dietary guidelines recommend that US American adults consume 1.5-2 cup equivalents of fruit and 2-3 cup equivalents of vegetables daily depending on their age and sex (US Department of Agriculture, 2015a, 2015b). However, US Hispanics are not meeting these recommendations. Per an epidemiological study using data from the National Health and Nutrition Examination Survey (NHANES), the median cup equivalent intake among US Hispanics were 0.78 for fruit and 1.33 for vegetables (Moore et al., 2015).

What is the Community Food Environment Versus the Consumer Food Environment?

Food environments are typically conceptualized as either community food environments or consumer food environments (Glanz, Sallis, Saelens, & Frank, 2005; Ni Mhurchu et al., 2013). Community food environments consist of macro-level factors such as the type, number, and accessibility of food outlets whereas consumer food environments consist of micro-level factors an individual encounters within a retail food environment (Glanz et al., 2005; Gustafson, Hankins, & Jilcott, 2012; Rose, Bodor, Hutchinson, & Swalm, 2010). These micro-level factors include in-store environmental characteristics that are part of the strategic elements of the marketing mix (the 4 P's: product, placement, promotion, and price) (Kotler & Armstrong, 2010). This dissertation focuses on the consumer food environment or in-store environmental characteristics.

Why Fruit and Vegetable Purchasing?

Dietary behaviors occur within social, economic, and physical environmental contexts (Larson & Story, 2009; Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008). The retail food environment is a particularly important context to study given that the greatest contributor to energy intake in the US are from foods and beverages purchased in food stores (Drewnowski & Rehm, 2013). A variety of in-store environmental factors, such as product, placement and promotion influence the food purchasing behaviors of customers (Gittelsohn et al., 2006). Glanz et al.'s (2005) conceptual framework of nutrition environments (Figure 1.1) posits that the environment individuals encounter within a food store, has product and other physical characteristics that influence purchasing decisions and dietary intake such as product placement, product assortment, product quality, price, and marketing. Likewise, Rose et al.'s (2010) multi-dimensional conceptual model (Figure 2.1) suggests that in-store food availability, including shelf space, influences consumers' purchasing behaviors; to the extent that greater shelf space dedicated to unhealthy foods within a store could make these foods more socially acceptable, therefore influencing purchasing behaviors. The influence of these in-store environmental characteristics are especially important to study among Hispanics considering that Hispanics shop for food three times more often than the general US shopper (Food Market Institute, 2005). Additionally, approximately 1/3 of Hispanics' income is spent on food but much of the food purchased is calorie-dense, low in fiber, and high in fat, sodium, and carbohydrates (Cortés, Millán-Ferro, Schneider, Vega, & Caballero, 2013).

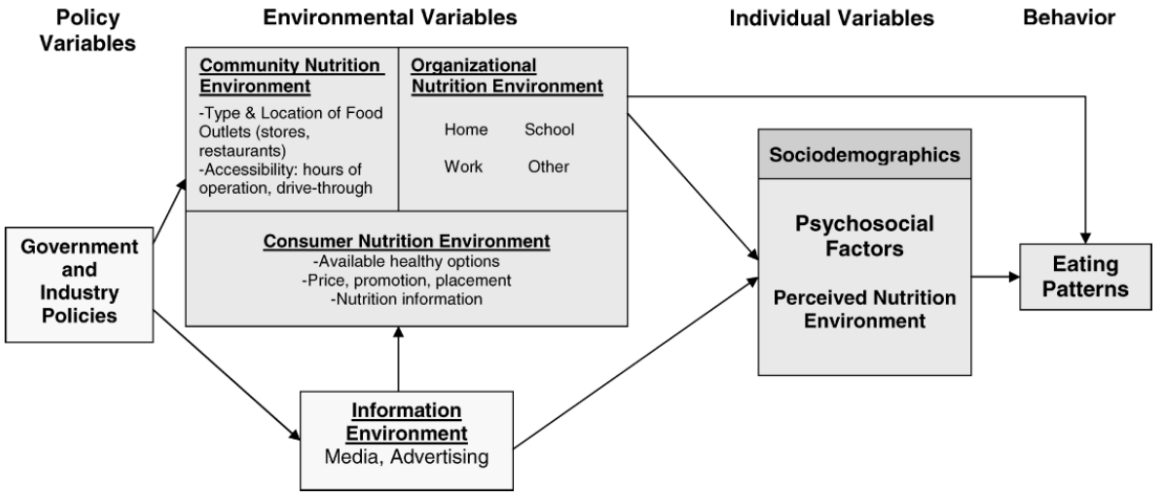

Figure 1.1. Glanz et al.'s (2005) model of community nutrition environments.

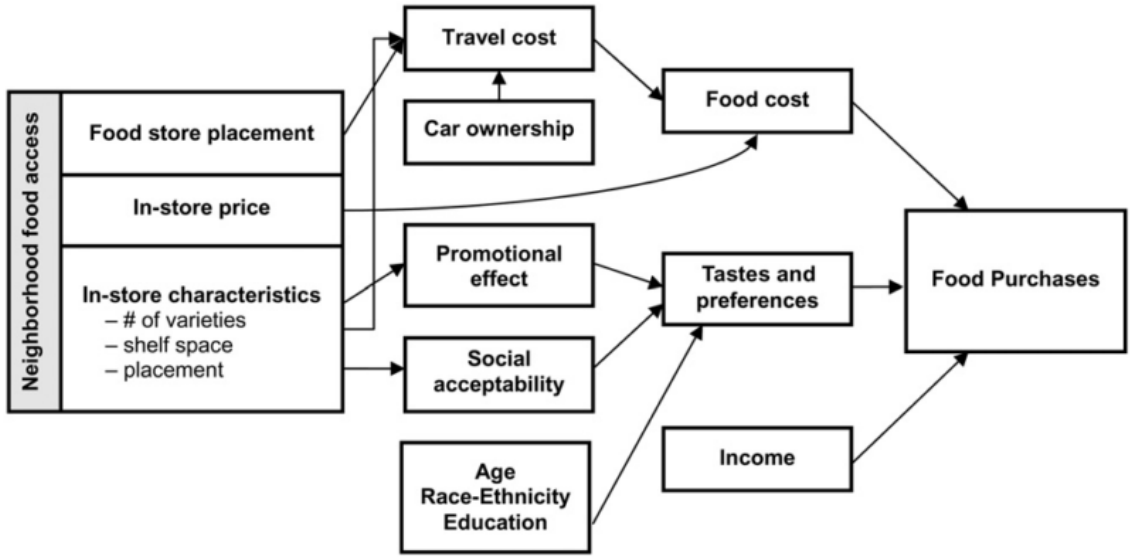

Figure 1.2. Rose et al.'s (2010) multidimensional framework integrating neighborhood food access into a model of consumer choice.

Why Examine Food Store Type and the Marketing Mix?

The Dietary Guidelines for Americans 2015 call for environmental and policy approaches to complement individual-based efforts to improve diet and reduce obesity and other diet-related chronic diseases (US Department of Agriculture, 2015c). The framework of the marketing mix (the 4 'P's): (1) product, (2) placement, (3) promotion, and (4) price, suggests opportunities for adapting the retail food environment's in-store

characteristics to encourage healthy food purchasing (Glanz, Bader, & Iyer, 2012). Such in-store characteristics can vary by type of store (e.g., supermarket versus convenience store), which is why it is important to study whether where one purchases foods and beverages is related to dietary intake. Additionally, in-store characteristics have been shown to be associated with purchasing behavior. Historical and recent marketing research has demonstrated that shelf space (Curhan, 1972), number of displays in a store and the number of locations an item was found in a store (Inman, Winer, & Ferraro, 2009; Wilkinson, Mason, & Paksoy, 1982), as well as advertising (Cairns, Angus, Hastings, & Caraher, 2013; Chandon, Hutchinson, Bradlow, & Young, 2009) influence customers' purchasing of foods and beverages. For example, in terms of display space, Curhan (1972) demonstrated that doubling display space for fruit increased sales by 44%. Such findings have encouraged public health research on the relationship between in-store environmental characteristics and dietary behaviors (Larson & Story, 2009; Story et al., 2008).

Why is the In-Store Environment Important?

With regard to the study of product availability, two studies found that the likelihood of purchasing FVs was higher among Non-Hispanic Blacks and Whites, and Hispanics when there was a greater variety of FVs available in stores (Martin et al., 2012; Ruff, Akhund, & Adjoian, 2016). Similarly, a longitudinal study found that Non-Hispanic White individuals who lived in communities with greater varieties of FVs in stores, showed greater increases in weekly servings of FVs over a 1-year period than individuals who lived in communities with fewer varieties of FVs (Caldwell, Kobayashi, DuBow, & Wytinck, 2008). Interestingly, the availability of healthy foods has also been found to be

associated with the purchasing of unhealthy foods. A study by Ruff et al. (2016) found that In New York City, the association between the likelihood of purchasing a sugar-sweetened beverage decreased with greater availability of FVs located at the front of a store 16).

Research has also examined the placement of food in retail stores, specifically shelf space. One study found an association between the proportion of total shelf space in a store dedicated to red meat, reduced fat-milk, and non-white bread and intake of these foods among 12 communities in California and Hawaii (Cheadle et al., 1991). Similarly, another study found a strong, positive relationship between proportion of total shelf space in a store dedicated to low-fat milk and the prevalence of low-fat milk intake among a predominantly Non-Hispanic White sample (Fisher & Strogatz, 1999). In terms of FVs, one study found that amount of shelf space dedicated to fresh vegetables was associated with vegetable intake; each extra meter of shelf space was associated with an additional intake of 0.35 servings of vegetables per day among Non-Hispanic White and Non-Hispanic Black residents living in New Orleans, LA (Bodor, Rose, Farley, Swalm, & Scott, 2007).

Research has also focused on the influence of displays of food and beverages on purchase behavior. One study found that each additional display location for alcoholic beverages, sugar-sweetened beverages and coffee in a store was associated with greater sales of these beverages (Nakamura, Pechey, Suhrcke, Jebb, & Marteau, 2014). Similarly, a longitudinal study found that individuals in communities with stores that have greater numbers of FV displays showed greater intakes of these foods compared to those living in communities with stores having fewer FV displays (Caldwell et al., 2008).

Lastly, regarding the promotional variable of the marketing mix, research conducted among adolescents found that frequent exposure to alcohol promotions in stores was associated with a 50% increase in the likelihood of ever drinking (Hurtz, Henriksen, Wang, Feighery, & Fortmann, 2006). Additionally, a study conducted in New York City found that stores were more likely to run advertising for sugary drinks a in neighborhoods with higher intakes of sugar-sweetened beverages compared to stores in neighborhoods with lower intakes of sugar-sweetened beverages (Adjoian, Dannefer, Sacks, & Van Wye, 2014). Previous research has also found that among low-income public housing residents, higher counts of alcohol print promotions and lower counts of low-calorie food print promotions in stores and restaurants was associated with higher dietary fat intake (Heinrich et al., 2012).

What is the Effectiveness of Food Store-Based Interventions?

Food stores represent an ideal setting for interventions aimed at improving food purchasing behaviors. Previous reviews on food store interventions have found strong evidence for implementation feasibility as well as for improving food purchasing behaviors. Typically, food store interventions use point-of-purchase (POP) strategies (e.g., food demonstrations, signs, label), pricing strategies (e.g., coupons, reduced pricing), availability strategies (e.g., provide more healthful food choices), promotion strategies (e.g., advertising, food store tours) or a combination of the aforementioned strategies (Escaron, Meinen, Nitzke, & Martinez-Donate, 2013). Food store interventions that use a combination of strategies are more likely to demonstrate a positive impact on food purchasing behaviors (Gittelsohn, Rowan, & Gadhoke, 2012). A review on small food store interventions indicated that 9 out of 10 studies observed an increase in the

number of targeted healthy food purchases (Gittelsohn et al., 2012). In another review of medium-large food store interventions, 8 of the 13 interventions demonstrated an increased in the number of targeted healthy food purchases (Escaron et al., 2013). Additional systematic reviews have also provided evidence on the effectiveness of in-store interventions on healthy food purchasing (Adam & Jensen, 2016; Langellier et al., 2013; Liberato, Bailie, & Brimblecombe, 2014).

Aims, Hypotheses, and Conceptual Model

Chapter 2 (paper 1) examined fruit and vegetable intake by food store type among US Hispanic adults who participated in the 2011-2012 National Health and Nutrition Examination Survey (NHANES). In this wave of the NHANES, self-reported food store type separated supermarket/grocery stores from convenience stores. Given the existing evidence on the relationship between shopping at convenience stores versus supermarket/grocery stores and fruit and vegetable purchasing and intake, the following was hypothesized:

1. US Hispanics who only (defined as 100% of the time) purchased their fruit and vegetables from convenience stores will report lower intakes of fruit than US Hispanics who purchased any of their fruit and vegetables from supermarket/grocery stores.
2. US Hispanics who only purchased their fruit and vegetables from convenience stores will report lower intakes of vegetables than US Hispanics who purchased any of their fruit and vegetables from supermarket/grocery stores.

For Chapter 3 (paper 2), the strategic elements of the marketing mix (the four P's), specifically product, placement, and promotion, were used as an overarching

conceptual framework. Operationalizations of the three P's used in this chapter were as follows: (1) *product* – the availability of fresh, canned, and frozen FVs and the variety of fresh FVs; (2) *placement* – shelf space dedicated to fresh FVs and number of fresh FV displays; and (3) *promotion* – number of FV promotions, specifically signage, and number of cross-product category advertising. In this chapter, baseline data from the *El Valor de Nuestra Salud* (The Value of our Health) study was used. For this chapter, it was hypothesized that:

1. Each additional 'P' would enhance the explanatory value of the elements of the marketing mix on customers' self-reported FV purchasing, adjusting for price.

The aim for Chapter 4 (paper 3) was to evaluate the effects of an in-store environmental change intervention targeting the marketing mix 'P's of product, placement, and promotion on the FV purchasing of Hispanic customers of small Hispanic-focused food stores, otherwise known as *tiendas* (Ayala, Mueller, Lopez-Madurga, Campbell, & Elder, 2005). The hypotheses for this chapter are:

1. *Tiendas* in the intervention condition will have increased product (operationalized as increases in the availability of fresh, canned, and frozen FVs and varieties of fresh FVs), greater placement (operationalized as increases in shelf space dedicated to fresh FVs and number of fresh FV displays), and greater promotion (operationalized as the number of FV promotions and number of cross-product category advertising) than *tiendas* in the control condition at 6-months post-baseline.

2. Customers who shop in *tiendas* with increased product, greater placement, and greater promotion will report greater FV purchasing than customers who shop in *tiendas* with no or decreased changes in product, placement, or promotion at 6-months post-baseline.

The conceptual model for this dissertation is depicted in Figure 1.3.

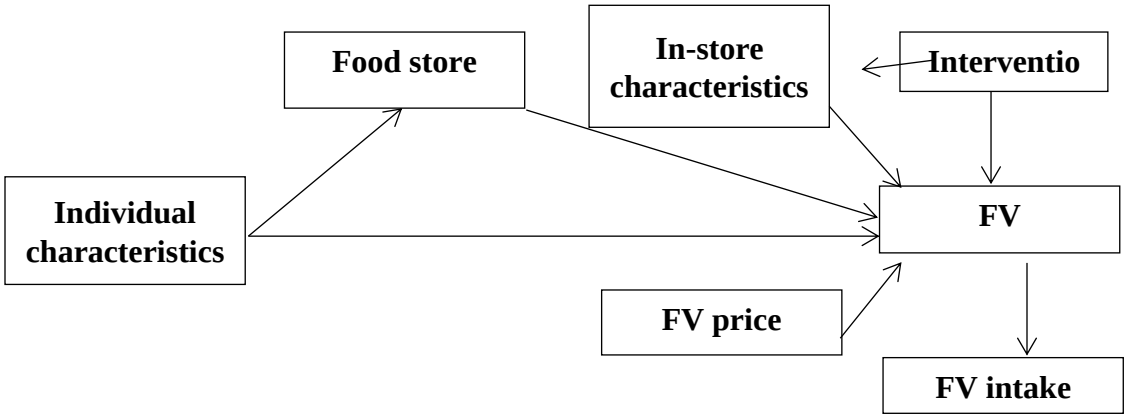

Figure 1.3. Conceptual model of dissertation.

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CHAPTER 2

Association between fruit and vegetable intake of US Hispanics and types of food stores primarily used to purchase fruits and vegetables

ABSTRACT

Objective: Given the evidence between shopping at convenience stores versus supermarkets/grocery stores and fruit and vegetable purchasing and intake, this study sought to examine fruit and vegetable intake by food store type among US Hispanics.

Design: Cross-sectional NHANES 2011-2012 data were used. T-test and chi-square tests were performed to assess for differences between consumers in different food store categories. Negative binomial regression analyses were performed to estimate associations between fruit and vegetable intake by food store category.

Setting: National Health and Nutrition Examination Survey 2011-2012.

Subjects: A total of 837 US Hispanics aged ≥ 20 years who reported consuming any amount of fruit and vegetables and who provided data on type of store.

Results: US Hispanics who only purchased fruits and vegetables from convenience stores tended to be younger and more likely to be born in the US. They had lower intakes of fruits and vegetables than individuals who purchased these foods from supermarket/grocery stores. Negative binomial analyses demonstrated that those who primarily purchased fruits and vegetables from supermarkets/grocery stores had 0.87 ($p <$ .001) greater units of fruit cup equivalents and 0.25 ($p = .001$) greater units of vegetable cup equivalents than those who only purchased fruits and vegetables from convenience stores, adjusting for individual characteristics. No association was found for only purchasing fruits and vegetables from supermarkets/grocery stores and reported consumption.

Conclusions: Results indicate that compared to US Hispanics who primarily purchased their fruit and vegetables from supermarket/grocery stores, US Hispanics who only purchased these foods from convenience stores had significantly lower intakes of both fruit and vegetables.

INTRODUCTION

Promoting the intake of specific dietary patterns, such as those based on high fruit and vegetables intake, is a promising strategy to improve diet and overall health outcomes. Research demonstrates that higher intakes of fruit and vegetables are associated with a lower risk of cardiovascular disease (Bhupathiraju et al., 2013; Sangita, Vik, Pakseresht, & Kolonel, 2013), type 2 diabetes (Carter, Gray, Troughton, Khunti, & Davies, 2010; Li, Fan, Zhang, Hou, & Tang, 2014), and stroke (He, Nowson, & MacGregor, 2006). Fruit and vegetable intake is also associated with a reduction in mortality due to ischaemic heart disease, cardiovascular disease, and cancer (Crowe et al., 2011; Oyebode, Gordon-Dseagu, Walker, & Mindell, 2014; Wang et al., 2014). Substituting higher calorie foods with fruit and vegetables may also aid in healthy weight management (Tohill, Seymour, & Serdula, 2004).

Current dietary guidelines recommend that US American adults consume 1.5-2 cup equivalents of fruit and 2-3 cup equivalents of vegetables daily depending on their age and sex (US Department of Agriculture, 2015a, 2015b). However, US Hispanics are not meeting these recommendations. Per an epidemiological study using data from the National Health and Nutrition Examination Survey (NHANES), the median cup equivalent intake (e.g., defined as one small apple or 12 baby carrots) among US Hispanics was 0.78 for fruit and 1.33 for vegetables (Moore et al., 2015). Another study using California Health Interview Survey data found that English-speaking and limited English-speaking Hispanics had lower vegetable intake, 0.74 and 0.61 times per day respectively, compared to 1.10 times per day among non-Hispanic Whites (Sorkin & Billimek, 2012). Two additional studies examining the dietary intake of US Hispanics

also demonstrated their low intakes of fruit. One study found that fruit intake only contributed 3.6%-6.4% of total energy intake (Carrera, Gao, & Tucker, 2007) while another study demonstrated fruit intake to only be between 0.75-1.5 cups per day depending on Hispanic background (Mattei et al., 2016). However, another study demonstrated favorable fruit intake among limited English speaking Hispanics at 1.21 times per day versus 0.98 times per day among non-Hispanic Blacks (Sorkin & Billimek, 2012). These findings highlight the need to find strategies to increase fruit and vegetable intake among Hispanics.

Dietary behaviors occur within social, economic, and physical environments (Larson & Story, 2009; Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008). The retail food environment, such as the type of food store in which an individual or family shops, is a particularly important context to study given that the greatest contributor to energy intake in the US are from foods and beverages purchased in food stores (Drewnowski & Rehm, 2013). Research is needed to examine the relationship between the food store type in which one purchases food and beverages, and dietary intake. Glanz, Sallis, Saelens, and Frank's (2005) conceptual framework of nutrition environments posits that the environment individuals encounter within a food store, has product and other physical characteristics that influence purchasing decisions and dietary intake such as product placement, product assortment, product quality, price, and marketing. Such characteristics can vary by type of store (e.g., supermarket versus convenience store), which is why it is important to study whether where one purchases foods and beverages is related to dietary intake. Currently, there is limited research examining how purchasing

foods and beverages from different food store types is associated with fruit and vegetable intake, particularly among the US Hispanic population.

Two previous studies, one conducted in Canada and another among US non-Hispanic Blacks, found that individuals who shop at convenience stores report more frequent purchases of unhealthy food (e.g., soda and potato chips) than individuals who shop at supermarkets (D'Angelo, Suratkar, Song, Stauffer, & Gittelsohn, 2011; Minaker et al., 2016). It was also found that those who frequently shopped in convenience stores consumed fruit and vegetables less often than those who did not shop in convenience stores (Minaker et al., 2016). Previous research conducted in the U.K. suggests that shopping in a discount supermarket is associated with 9% fewer fruit and vegetable purchases than shopping in a higher-cost supermarket, even after accounting for socioeconomic status (Pechey & Monsivais, 2015). This finding is consistent with research conducted in Canada and with US non-Hispanic Black and non-Hispanic White populations indicating that shopping at specialty food stores or farmers markets is associated with a higher odds of consuming fruit and vegetables compared to those who never shop in these types of stores or markets or shop in convenience stores or independent grocers (Gustafson, Christian, Lewis, Moore, & Jilcott, 2013; Minaker et al., 2016; Zenk et al., 2005). These findings may be due to the fact that supermarkets generally have the highest availability of fruit and vegetables compared to other retail food outlets such as grocery stores, convenience stores, or farmers markets (Farley et al., 2009; Leone et al., 2011; Millichamp & Gallegos, 2013). Importantly, none of these studies were conducted with a US Hispanic population; however, one study did find that Hispanics purchased higher percentages of fresh fruit and vegetables compared to non-

Hispanic blacks (Cullen et al., 2007). This study fills a gap in the literature regarding how purchasing healthy foods, specifically fruit and vegetables, from different food store types is associated with the fruit and vegetable intake of US Hispanic adults.

Approximately 42.5% of Hispanics in the US are obese, which is higher than the national prevalence rate of 34.9% (Ogden, Carroll, Kit, & Flegal, 2014). This disparity is important to address given that the Hispanic population is projected to comprise more than one-quarter of the total US population by 2060 (Colby & Ortman, 2015). Another reason to address this disparity is the association between excess weight gain and an increased risk of hypertension, cardiovascular disease, diabetes, and certain cancers (Hruby et al., 2016). Diet is a modifiable risk factor related to obesity and obesity-related chronic diseases that should be targeted to reduce and prevent disparities within the US Hispanic population. While individual characteristics, such as taste and preferences, undoubtedly influence purchasing decisions, environmental characteristics such as in-store marketing, availability, quality and pricing also influence purchasing decisions that have implications for long-term dietary health (Bodor, Ulmer, Futrell Dunaway, Farley, & Rose, 2010; Glanz, Bader, & Iyer, 2012; Glanz & Yaroch, 2004).

This study examined fruit and vegetable intake by food store type among US Hispanic adults who participated in the 2011-2012 NHANES. In this wave of the NHANES, self-reported food store type separated supermarket/grocery stores from convenience stores for the first time. Given the existing evidence on the relationship between shopping at convenience stores versus supermarket/grocery stores and fruit and vegetable purchasing and intake, the following is hypothesized:

1. US Hispanics who only (defined as 100% of the time) purchased their fruit and vegetables from convenience stores will report lower intakes of fruit than US Hispanics who purchased any of their fruit and vegetables from supermarket/grocery stores.
2. US Hispanics who only purchased their fruit and vegetables from convenience stores will report lower intakes of vegetables than US Hispanics who purchased any of their fruit and vegetables from supermarket/grocery stores.

METHODS

Data Source

NHANES was designed to assess the health and nutritional status of adults and children in the US. The program began in the early 1960s and has been conducted as a series of surveys focusing on different population groups or health topics. In 1999, NHANES became continuous and has since surveyed approximately 5,000 individuals of all ages each year. Participants are interviewed in their homes and complete a health examination component. The NHANES interview includes demographic, socioeconomic, dietary, and health-related questions. The health examination component consists of medical, dental, and physiological measurements, as well as laboratory tests.

NHANES uses a complex, multistage probability design to sample individuals in all 50 states. Sample selection for NHANES followed these stages: (1) selection of primary sampling units (PSUs), which are counties or small groups of contiguous counties; (2) selection of segments within PSUs that constitute a block or group of blocks containing a cluster of households; (3) selection of specific households within segments;

and 4) selection of individuals within a household. The NHANES study design has changed occasionally to sample larger numbers of certain subgroups of particular public health interest. This was done to ensure reliability in health status indicators for these population subgroups.

The 2011-2012 NHANES data oversampled the following subgroups: Hispanics, Non-Hispanic blacks, Non-Hispanic Asians, Non-Hispanic white and other persons at or below 130 percent of the poverty level and Non-Hispanic white and other persons aged 80 years and older. Approximately 25% of the 2011-2012 NHANES sample identified as Mexican American or Other Hispanic. Further information regarding the NHANES sampling design, questionnaires, clinical measures and individual-level data can be found on its web portal (http://www.cdc.gov/nchs/nhanes.htm).

Dietary Interview

The 2011-2012 NHANES wave incorporated two 24-hour dietary recalls, with the first collected in-person and the second by phone. In both interviews, each food item and its corresponding quantity were recorded. A set of measuring guides, including glasses, bowls, mugs, spoons, measuring cups and spoons, drink boxes and bottles, beanbags, a ruler and thickness sticks were made available to the participant during in-person interviews to report quantity of foods and beverages. Upon completion of the in-person interview, participants were provided with measuring guides and a food model booklet, which contained two-dimensional drawings of the measuring guides, to use for reporting food quantities during the phone interview. Phone interviews were conducted 3-10 days after the in-person interview. The calorie and nutrient contents of each reported food item

were systematically determined with the US Department of Agriculture Food and Nutrient Database for Dietary Studies.

Fruit and Vegetable Intake

Food intake reported in the dietary interview were converted into a Food Patterns Equivalents Database (FPED) (Bowman, Clemens, Friday, Thoerig, & Moshfegh, 2014). The FPED converts foods and beverages into 37 USDA Food Pattern components, including the number of cup equivalents of fruit and vegetables. Total fruit and vegetable intake includes all dietary sources, regardless of form (e.g., whole, juice), processing (e.g., canned, frozen, fresh), or other ingredients. For the purposes of this study, cup equivalents of fruit and vegetables were examined.

Food Store Type and Food Store Type Categories

Dietary interviews asked about where foods and beverages were purchased by inquiring about the type of food store for each individual food and beverage item consumed. In the 2011-2012 wave, food store type separated convenience store from supermarket/grocery store for the first time. For the purposes of this study, food store type was classified into three categories: (1) supermarket and grocery store (coded as 'store – grocery/supermarket'), (2) convenience store (coded as 'store – convenience), and (3) non-store (coded as 'restaurant – fast food', 'restaurant – waiter/waitress', 'bar/tavern/lounge', 'restaurant – no additional information', 'community food program', 'gift', 'dining facility', street vendor', 'vending machine', and 'other source'). Given the low frequency in which fruit and vegetables were purchased from non-store locations (0.2%), these data were not included in the present study.

Participants were categorized based on where they purchased their fruit and vegetables. These food store type categories were created based on the distribution of the data and based on the evidence demonstrating the lack of healthy food availability from convenience stores. The five food store type categories created were: (1) only (defined as 100% of the time) from supermarket/grocery stores, (2) primarily (defined as >50%-99.9% of the time) from supermarket/grocery stores, (3) equally (defined as 50% from convenience stores and 50% from supermarket/grocery stores) between convenience stores and supermarket/grocery stores, (4) primarily from convenience stores (defined as >50%-99.9% of the time), and (5) only (defined as 100% of the time) from convenience stores)

Individual Characteristics

Given observed associations between socioeconomic, acculturation, and dietary intake variables (Ayala, Baquero, & Klinger, 2013; Darmon & Drewnowski, 2008; Dubowitz et al., 2008), the analyses adjusted for the following individual characteristics, based on bivariate analyses, in the final models: age (continuous), sex (categorical: female, male), education (categorical: college education and above, high school education or lower), marital status (categorical: married, not currently married), household income level (categorical: income to poverty ratio (IPR) < 130%, 130% ≤ IPR < 300%, and IPR ≥ 300%), household size (continuous), country of birth and length of time in the US (categorical: born in US, born outside of US and spent less than 15 years in the US, born outside of the US and spent 15 years or more in the US).

Statistical Analyses

Descriptive statistics on the individual characteristics of US Hispanic fruit and vegetable consumers in the 2011-2012 NHANES and characteristics for each food store type category were obtained. Descriptive statistics for fruit and vegetable cup equivalent intake were also obtained. To examine differences in individual characteristics between food store categories, the PROC SURVEYFREQ procedure was used to calculate the Rao-Scott F adjusted chi-square statistic for categorical variables and the PROC SURVEYMEANS procedure was used to examine mean differences for continuous variables. The unadjusted relationship between individual characteristics and cup equivalents of fruit and vegetable intake were evaluated via a series of bivariate analyses using PROC SURVEYREG to identify individual characteristics to adjust for in the final models. Individual characteristics with a $p < 0.20$ value were included in the final models. Control variables included in the fruit cup equivalent intake model were: age and country of birth and length of time in the US. The vegetable cup equivalent intake model controlled for age.

Tests for multicollinearity were conducted to assess for linear relationships among control variables. Given that all variance inflation factor values were less than ten, all individual characteristic control variables identified in bivariate analyses were included in the final models. Two models were estimated by negative binomial regression models (using PROC GENMOD) to examine the association between food store categories and fruit and vegetable cup equivalent intake, separately, while controlling for individual characteristics (Hale, Thompson, & Darden, 2013). Separate linear regression models, by fruit cup equivalent intake and vegetable cup equivalent intake, were also estimated

(using PROC SURVEYREG), but due to the binomial distributions of both fruit cup equivalent intake and vegetable cup equivalent intake, the negative binomial models were more appropriate (A. C. Cameron & Trivedi, 1998; Slymen, Ayala, Arredondo, & Elder, 2006). An alpha level of $p < .05$ was used for all statistical tests.

Given the complex sampling design of the 2011-2012 NHANES, all descriptive statistics, bivariate analyses, and the multivariate regressions analyses were survey-weighted to account for the survey design. All statistical analyses were performed using SAS software, Version 9.4 of the SAS System for Windows (SAS Institute Inc., Cary, NC, USA). Analyses of publicly available federal data are exempt from human subject review by San Diego State University and the University of California at San Diego.

RESULTS

Sample Population

Table 2.1 displays the individual characteristics and fruit and vegetable cup equivalent intake for the US Hispanic adult sample (20 years old and older) in the 2011-2012 NHANES with complete fruit and vegetable intake data (N = 837), as well as for individuals by each food store category. There was equal representation of males and females in the full NHANES sample. Individuals in the full sample were about 40 years old. About a third of the full sample was either born in the US (36%), born outside of the US and have spent less than 15 years in the US (30%) or were born outside of the US and have spent 15 years or more in the US (34%). Almost half of respondents had an IPR less than 130%, most reported being married or living with a partner, and more than half reported no more than a high school education. For all respondents, the mean intake for

fruit was 1.12 (*SE* = 0.06) cup equivalents and for vegetables it was 1.65 (*SE* = 0.04) cup equivalents.

Food Store Type Category Differences

Table 2.1 also displays the overall *p*-values for the PROC SURVEYFREQ and PROC SURVEYMEANS procedures used to test for differences between food store type categories on individual characteristics. Significant differences were found for age, country of birth and length of time in the US, and fruit and vegetable intake. Compared to individuals who purchased from supermarkets/grocery stores, those who only purchased from convenience stores (*M* = 36.67, *SE* = 1.20, $p < .001$) and those who primarily purchased from convenience stores (*M* = 38.15, *SE* = 0.89, *p* = .002) were significantly younger. Differences were also seen for country of birth and length of time in the US. Approximately, 48% of individuals who only purchased from convenience stores were born in the US, whereas 30% of individuals who only purchased from supermarkets/grocery stores were born in the US (*p* = .002).

Patrons of the various food store categories also differed in their intakes of fruit. Those who only purchased consumed fruit and vegetables from convenience stores had significantly lower intakes of fruit (*M* = 0.65, *SE* = .14, $p < .001$) compared to consumers in every other food store category. Additionally, those who primarily purchased from convenience stores (*M* = 1.33, *SE* = .16, $p < .016$) and those who equally purchased between convenience stores and supermarket/grocery stores (*M* = 1.23, *SE* = .15, $p < .023$) had significantly lower intakes of fruit compared to those who primarily purchased from supermarkets/grocery stores *M* = 1.74, *SE* = .11). Individuals who primarily

purchased from supermarkets/grocery stores had higher intakes of fruit than those who only purchased from supermarkets/grocery stores (M = 1.08, SE = .07, p < .001).

Significant differences were also found for vegetable intake. Those who only purchased from convenience stores had lower intakes of vegetables (M = 1.60, SE = .11) compared to those who primarily purchased from supermarkets/grocery stores (M = 2.05, SE = .11, p = .007). However, those who primarily purchased from convenience stores (M = 1.95, SE = .15, p = .018) and those who primarily purchased from supermarkets/grocery stores (M = 2.05, SE = .11, p < .001) had significantly higher intakes of vegetables than those who only purchased from supermarkets/grocery stores (M = 1.47, SE = .05).

Fruit and Vegetable Intake by Food Store Type Categories

Results from the negative binomial regression analyses on the association between cup equivalents of fruit and vegetable intake by food store type category, controlling for individual characteristics, are presented in Table 2.2. The results demonstrate that those who primarily purchased from supermarkets/grocery stores had 0.87 (p < .001) greater units of fruit cup equivalents compared to those who only purchased from convenience stores, controlling for age, country of birth and length of time in the US. Additionally, those who equally purchased between convenience stores and supermarkets/grocery stores had 0.60 (p = .004) greater units of fruit cup equivalents and .69 (p = .001) greater units for those who primarily purchased from convenience stores as compared to those who only purchased from convenience stores. It was also found that foreign born individuals who reported spending more than 15 years in the US had .36 (p = .001) greater units of fruit cup equivalents than individuals born in the US.

As for vegetable intake, those who primarily purchased from supermarkets/grocery stores had .25 (p = .005) greater units of vegetable cup equivalents as compared to those who only purchased from convenience stores, controlling for age. Although non-significant, those who primarily purchased from convenience stores had .10 greater units of vegetable cup equivalents (p = .053).

DISCUSSION

Findings from this study indicate that consumers from each food store type category differed on several individual characteristics. Those who only purchased fruit and vegetables from convenience stores tended to be younger and were more likely to be born in the US compared to those who only or primarily purchased their fruit and vegetables from supermarkets/grocery stores. This finding is consistent with previous research demonstrating that US born Hispanics spend less money at supermarket/grocery stores than those born outside of the US (Langellier, Brookmeyer, Wang, & Glik, 2015). Other research has segmented Hispanic shoppers by individual characteristics for different food store types (Ayala, Mueller, Lopez-Madurga, Campbell, & Elder, 2005) but not specifically by the food store types presented in this study nor by fruit and vegetable intake. The overall findings of this study, illustrating that US Hispanics shop in multiple food store types, provide evidence that US Hispanics are following the purchasing patterns of other consumers in the US. For example, national consumer data from the Food Marketing Institute shows that US shoppers are increasingly relying on multiple food stores for their groceries and no longer claiming one store type as their primary food store (Food Marketing Institute, 2016). Similar findings were seen in a

study examining Nielsen Homescan data, which showed that Hispanics had a higher, although non-significant, probability of being classified into a multiple food store type group than non-Hispanic whites (Stern, Robinson, Wen Ng, Gordon-Larsen, & Popkin, 2015).

Additionally, results from this study reveal that US Hispanics who only purchased fruit and vegetables from convenience stores had lower intakes of fruit and vegetables compared to individuals who also shopped in supermarket/grocery stores, even after accounting for individual characteristics. Specifically, results indicated that compared to US Hispanics who primarily purchased their fruit and vegetables from supermarket/grocery stores, US Hispanics who only purchased them from convenience stores had significantly lower intakes of both fruit and vegetables. These findings are consistent with previous research demonstrating that shopping in convenience stores is associated with decreased fruit and vegetable purchasing and intake (Minaker et al., 2016). This negative relationship may be due to the high availability of energy-dense foods in convenience stores, which may be more tempting to shoppers (Gittelsohn, Laska, Karpyn, Klingler, & Ayala, 2014; Gittelsohn, Rowan, & Gadhoke, 2012). Additionally, the association between primarily shopping in supermarkets/grocery stores and increased fruit and vegetable intake is consistent with previous research conducted both in the US and the UK (Minaker et al., 2016; Pechey & Monsivais, 2015; Zenk et al., 2005). However, the findings illustrating the association between primarily purchasing fruit and vegetables from convenience stores or primarily from supermarket/grocery stores and intakes of fruit and vegetables is somewhat unique to the literature. Although previous research has examined associations between food store type and fruit and

vegetable intake, no studies to our knowledge have reported the association between shopping for fruit and vegetables in multiple store types and its influence on intake. These unique findings may mean that there are benefits to purchasing fruit and vegetables from various store types and that each store type may have their own health promoting or inhibiting aspects in terms of influencing healthy purchasing behavior. For instance, one study found that because of limited space, convenience stores were more likely to display fruit and vegetables at the front of the store, which was associated with a decrease in Hispanic and Non-Hispanic Black consumers' purchases of unhealthy beverages (Ruff, Akhund, & Adjoian, 2016). Additionally, they found that the odds of purchasing fruit and vegetables from a convenience store decreased as the number of fruit and vegetable varieties decreased (Ruff et al., 2016). This illustrates a convenience stores' potential to be both a health promoting or inhibiting environment, which is important to note given that from 2015 to 2016 there has been a 3% increase in the number of US consumers reporting fairly often or almost always shopping in a convenience store for grocery type items (Food Marketing Institute, 2016).

There was no association between only purchasing at supermarket/grocery stores and fruit and vegetable intake, which was unexpected. This lack of association may be due to the fact that although supermarket/grocery stores have greater availability of fruit and vegetables than convenience stores, supermarket/grocery stores also have a greater availability of unhealthy foods and at potentially lower prices than convenience stores potentially making unhealthy foods more enticing (Block & Kouba, 2005). Previous research has shown that supermarkets have the greatest number of fruit and vegetable displays compared to other store types yet supermarkets also have the greatest number of

energy-dense snack foods displays (Cohen, Collins, Hunter, Ghosh-Dastidar, & Dubowitz, 2015; Miller, Bodor, & Rose, 2012). This may mean that the increased exposure to unhealthy foods in supermarkets, despite the exposure to fruit and vegetables, may be limiting fruit and vegetable purchases and increasing the purchases of unhealthy foods. In fact, one study found that the introduction of a new supermarket in a food desert was not associated with increased intakes of fruit and vegetables but was associated with an increase in percentage of kilocalories from solid fats, added sugars, and alcohol consumed (Dubowitz et al., 2015). Additionally, individuals who shop at supermarkets shop less frequently than those who shop in convenience stores, which may mean these individuals are purchasing greater amounts of processed foods as opposed to fruit and vegetables that have a shorter shelf life (A. J. Cameron, Waterlander, & Svastisalee, 2014).

Limitations and Strengths

The present study does have a few limitations. Purchases and intake of fruit and vegetables were examined; therefore, these findings may not generalize to other dietary behaviors, such as the purchasing and intake of energy dense foods. Analyses are based on cross-sectional data and therefore cannot be used to determine causal relationships. Dietary intakes in NHANES were self-reported and subject to measurement error and social desirability bias (Hebert et al., 2008). In addition, intake was documented for 24-hour periods so it likely does not fully represent participants' dietary behaviors nor the full spectrum of food store types in which they obtained fruit and vegetables. Additionally, self-reported food store type for the foods and beverages reported in the dietary interview may be affected by recall error. Also, this study could not account for

variation between store types or within store types (Vernez Moudon et al., 2013). Although analyses controlled for individual characteristics, the present study could not account for unobserved differences in psychosocial variables such as knowledge and attitudes towards eating fruit and vegetables (Guillaumie, Godin, & Vezina-Im, 2010). Another limitation is the inability to account for distance to stores or access to transportation, such as car access, for food shopping trips (Gustat, O'Malley, Luckett, & Johnson, 2015).

Strengths of the present study include the large sample size and its use of data from a representative sample of the US. Additionally, this study fills a research gap as it focuses its analyses on the US Hispanic sample within NHANES. Also, the current study examines the influence of purchasing fruit and vegetables from multiple food store types, which has been not been well represented in the literature. This study also identified differences among Hispanic consumers of multiple food store types allowing one to segment shoppers by individual characteristics, which is useful for future nutrition interventions.

Implications

Findings from the present study have important implications for practice, policy and future research. As indicated in the findings, purchasing even some fruit and vegetables from supermarket/grocery stores is associated with higher intakes of these foods than only purchasing these foods from convenience stores. This suggests encouraging US born Hispanics to shop at supermarket/grocery stores, even infrequently for their foods, may lead to greater intake of fruit and vegetables. To encourage this behavior, it is important to consider their level of acculturation and how acculturation

influences decisions on where to purchase foods (Ayala et al., 2013; Batis, Hernandez-Barrera, Barquera, Rivera, & Popkin, 2011; Pérez-Escamilla, 2009). Intervention strategies should be developed that support US born Hispanics' ability to maintain some of the healthier food behaviors practiced in their Hispanic culture such as purchasing foods from more traditional food store types such as supermarket/grocery stores (Langellier et al., 2015). Also, to aid individuals' ability to shop at supermarket/grocery stores may mean increasing their access to these food stores. One potential strategy to improve access is to increase public transportation options to assist individuals in getting to supermarkets/grocery stores (Larson, Story, & Nelson, 2009). However, this study demonstrates that only purchasing fruit and vegetables from supermarkets/grocery stores is not associated with better dietary outcomes so it is important to identify how these stores affect diet (Dubowitz et al., 2015). Additionally, more research is needed on how purchasing foods from multiple food store types influences dietary behavior. This research could examine the environmental characteristics of various types of stores to identify their own unique health promoting characteristics.

Additionally, results from this study illustrate the individual characteristics for consumers of different food store types. These results support the need for more targeted food store interventions strategies. For example, with the information that those who only purchase from convenience store tend be younger than those who only or primarily purchase from supermarket/grocery stores, social marketing campaigns can be developed in convenience stores that are targeted to a younger demographic to promote healthy food purchasing (Stead, Gordon, Angus, & McDermott, 2007). Lastly, potential policy implications, which should be supported by additional research, suggest that more needs

to be done to change the convenience store environment to promote fruit and vegetable purchases. For instance, such policy strategies could include the mandating of minimum fruit and vegetable stocking requirements (Laska, Caspi, Pelletier, Friebur, & Harnack, 2015; Laska & Pelletier, 2016).

CONCLUSION

The results from this study suggest that purchasing fruit and vegetables in multiple food store types, particularly if some are purchased from supermarket/grocery stores, is associated with greater intake of fruit and vegetables. Purchasing fruit and vegetables only from supermarket/grocery stores is not associated with the intake of these foods thereby indicating a somewhat protective factor of shopping in both convenience stores and supermarket/grocery stores. These findings provide evidence regarding the relationship of purchasing foods from multiple food store types on fruit and vegetable intake. Cross-sectional and longitudinal studies are needed to further examine what individuals purchase from multiple food store types and how shopping at multiple store types influences the dietary behavior for healthy and unhealthy foods. Additionally, future studies should also study this phenomenon among other racial/ethnic populations to identify what segments of the population shop in multiple food store types and how doing so affects their diet.

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Table 2.1. Characteristics of Hispanic who Consume Fruits and Vegetables Consumers by Food Store Type: 2011-2012 NHANES

	Full sample (N=837)	Only supermarket/ grocery store (N=407)	Primarily supermarket/ grocery store (N=106)	Equal convenience stores and supermarket/ grocery store (N=78)	Primarily convenience store (N=92)	Only convenience store (N=152)	
	% (Weighted N) Mean (SE)						*p*
Individual characteristics							
Age	40.63 (0.63)	43.48 (1.02)	40.65 (1.84)	38.58 (1.40)	38.15 (0.89)	36.67 (1.20)	.001
Sex							.445
Male	50.98 (419)	47.49 (192)	54.61 (58)	51.86 (38)	49.79 (45)	57.39 (86)	
Female	49.02 (418)	52.51 (215)	45.39 (48)	48.14 (40)	50.21 (47)	42.61 (66)	
Education							.941
High school education or less	62.91 (542)	63.08 (267)	65.98 (69)	58.80 (47)	63.67 (59)	61.78 (98)	
College education or greater	37.09 (295)	36.92 (140)	34.02 (37)	41.20 (31)	36.33 (33)	38.22 (54)	
Marital status							.684
Not currently married	52.04 (420)	51.12 (205)	46.56 (49)	51.84 (38)	55.90 (47)	55.78 (79)	
Married or living with partner	47.96 (417)	48.88 (202)	53.44 (57)	48.16 (40)	44.10 (45)	44.22 (73)	
Household Income level							.696
IPR < 130%	46.23 (392)	50.41 (204)	48.65 (52)	42.58 (33)	43.79 (42)	38.00 (59)	
130% ≤ IPR < 300%	29.82 (256)	26.33 (114)	30.30 (32)	33.25 (27)	31.15 (30)	35.18 (53)	
IPR ≥ 300%	23.95 (189)	23.26 (89)	21.05 (22)	24.17 (18)	25.06 (20)	26.82 (40)	
Household size	3.76 (0.09)	3.70 (0.09)	3.65 (0.25)	3.93 (0.19)	3.76 (0.17)	3.85 (0.12)	.621
Country of birth and length of time in US[a]							.002
US born	35.94 (266)	30.44 (109)	26.61 (27)	36.37 (26)	46.74 (36)	48.01 (68)	
Foreign born and less than 15 years in US	30.25 (226)	29.63 (105)	35.45 (32)	34.35 (23)	28.57 (26)	26.85 (39)	
Foreign born and more than 15 years in US	33.80 (343)	39.93 (193)	37.94 (47)	29.28 (29)	24.69 (30)	25.14 (43)	
Fruit and vegetable intake[c]							
Fruit (mean cup equivalent)	1.12 (0.06)	1.08 (0.07)	1.74 (0.11)	1.23 (0.15)	1.33 (0.16)	0.65 (0.14)	<.0001
Vegetables (mean cup equivalent)	1.65 (0.04)	1.47 (0.05)	2.05 (0.11)	1.77 (0.14)	1.95 (0.15)	1.60 (0.11)	.001

[a] Refusal rate = .2% [b] Missing store information for 2 participants

Table 2.2. Association between Fruit/Vegetable Intake and Food Store Type

	Fruit (cup equivalent) intake			Vegetable (cup equivalent) intake		
	Beta (SE)	95% CI	*p*	Beta (SE)	95% CI	*p*
Food store categories						
Only convenience store	Ref			Ref		
Primarily convenience store	.69 (.20)	(.299, 1.08)	.001	.20 (.10)	(-.00, .40)	.053
Equal convenience stores and supermarket/grocery store	.60 (.21)	(.197, 1.01)	.004	.10 (.13)	(-.15, .36)	.433
Primarily supermarket/grocery store	.87 (.21)	(.45, 1.3)	<.0001	.25 (.09)	(.08, .42)	.005
Only supermarket/grocery store	.41 (.23)	(-.03, .87)	.066	-.08 (.08)	(-.24, .08)	.321
Individual characteristics						
Age	-.00 (.00)	(-.00, .01)	.726	-.00 (.00)	(-.00, .00)	.909
Country of birth and length of time in US						
US born	Ref			-	-	-
Foreign born and less than 15 years in US	.29 (.18)	(-.07, .65)	.113	-	-	-
Foreign born and more than 15 years in US	.36 (.11)	(.15, .57)	.001			

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CHAPTER 3

Examination of In-Store Environmental Influences on Fruit and Vegetable Purchasing among Hispanics

ABSTRACT

Retail food environments have received increased attention for their influence on dietary behaviors and for their nutrition intervention potential. To improve dietary behaviors, such as fruit and vegetable (FV) purchasing, it is important to understand how in-store environmental characteristics are associated with FV purchasing. This study used baseline data from the *El Valor de Nuestra Salud* (The Value of our Health) study to examine how in-store environmental characteristics of product availability, placement and promotion are associated with FV purchasing among Hispanic customers in San Diego County. Mixed linear regression models indicated that product availability, specifically availability of fresh FVs, is associated with an increase of 0.36 in FV purchasing, before the introduction of placement variables (p=.01). Placement, specifically greater shelf space dedicated to FVs (p=.01) and fewer fresh FV displays (p=.01), was associated with a 0.03 and -0.32 respectively in FV purchasing, even after accounting for all in-store characteristics and individual characteristics. Promotion, or the number of FV promotions, was non-significant in the final model. Analyses also revealed that men reported 3.69 fewer dollars in FV purchasing compared to women, after accounting for all in-store characteristics (p=.02). The results can help inform interventions to target in-store environmental characteristics to encourage FV purchasing among Hispanics. Additionally, results indicated that targeted nutrition interventions are needed for Hispanic men.

INTRODUCTION

Retail food environments, such as grocery and other food stores, have received increased attention for their influence on dietary behaviors and for being a place to possibly promote healthful eating interventions (Glanz & Yaroch, 2004). These environments are situated between individuals and the foods and beverages they consume, making them an opportune setting to improve dietary behaviors to prevent obesity and promote health (Glanz, Bader, & Iyer, 2012). Typically, the relationship between retail food environments and dietary behaviors is studied in two ways: by examining the neighborhood environment (e.g., density of food stores in a census tract) or by examining the in-store environment (e.g., availability of items in a food store) (Glanz, Sallis, Saelens, & Frank, 2005; Rose, Bodor, Hutchinson, & Swalm, 2010). The present study examined the relationship between the in-store environment and dietary behaviors.

Glanz et al.'s (2005) Model of Community Nutrition Environments considers the nutrition environment from an ecological perspective; identifying four types of nutrition environments that need to be studied, including the in-store environment. Characteristics of the in-store environment is important to the study of dietary behaviors as factors such as the availability and promotion of healthy and unhealthy foods and beverages can have an indirect or direct influence on dietary behaviors (Glanz et al., 2005). Likewise, Rose et al.'s (2010) multi-dimensional conceptual model also considers the in-store environment and proposes that in-store food availability, including shelf space, influences consumers' purchasing behaviors. Additionally, Social Cognitive Theory proposes a reciprocal relationship between environmental factors and personal characteristics to explain

behavior, with environmental factors representing situational influences (e.g., availability of healthy or unhealthy foods) on behaviors, such as food purchasing (Bandura, 1986). These models, in conjunction with the key strategic elements of the marketing mix (the 4 P's: product, placement, promotion, and price) (Kotler & Armstrong, 2010), were used as frameworks to examine the relationship between in-store environmental characteristics and fruit and vegetable (FV) purchasing.

Numerous studies in marketing research have shown that the in-store environment affects the dietary behaviors of customers. Historical research has demonstrated that the amount of shelf space (Curhan, 1972), number of displays in a store and the number of locations an item was found in a store (Inman, Winer, & Ferraro, 2009; Wilkinson, Mason, & Paksoy, 1982), as well as in-store advertising and promotions (Cairns, Angus, Hastings, & Caraher, 2013; Chandon, Hutchinson, Bradlow, & Young, 2009) influence customers' purchasing of foods and beverages. For example, in terms of display space, Curhan (1972) found that doubling display space for fruit increased sales by 44%. Such findings have encouraged public health research on the relationship between in-store environmental characteristics and dietary behaviors (Larson & Story, 2009; Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008).

In-Store Characteristics and Behaviors: Intake and Purchasing

With regard to the study of product availability, two studies found that the likelihood of purchasing FVs was higher among Non-Hispanic Blacks and Whites, and Hispanics when there was a greater variety of FVs available in stores (Martin et al., 2012; Ruff, Akhund, & Adjoian, 2016). Similarly, a longitudinal study found that Non-Hispanic

White individuals who lived in communities with greater varieties of FVs in stores, had greater increases in weekly servings of FVs over a 1-year period than individuals who lived in communities with fewer varieties of FVs (Caldwell, Kobayashi, DuBow, & Wytinck, 2008). Interestingly, the availability of healthy foods has also been found to be associated with the purchasing of unhealthy foods. In New York City, the association between the likelihood of purchasing a sugar-sweetened beverage decreased with greater availability of FVs located at the front of a store (Ruff et al., 2016). Another study found that lower availability of healthy food in stores, assessed using the Nutrition Environment Measures Survey, was associated with a low quality diet, as measured by a 120-item food frequency questionnaire, among adults in Baltimore, MD (Franco et al., 2009). However, the association became non-significant when analyses were adjusted for race/ethnicity (Franco et al., 2009). Other studies have not found a significant relationship between availability of FVs in stores and intake of these foods (Sharkey, Johnson, & Dean, 2010; Thornton, Crawford, & Ball, 2010).

Research has also examined the placement of food in retail stores, specifically shelf space. One study found an association between the proportion of total shelf space in a store dedicated to red meat, reduced fat-milk, and non-white bread and intake of these foods among 12 communities in California and Hawaii (Cheadle et al., 1991). Similarly, another study found a strong, positive relationship between proportion of total shelf space in a store dedicated to low-fat milk and the prevalence of low-fat milk intake among a predominantly Non-Hispanic White sample (Fisher & Strogatz, 1999). In a more recent study, researchers found that the amount of shelf space dedicated to fresh vegetables was associated with vegetable intake; each extra meter of shelf space was associated with an

additional intake of 0.35 servings of vegetables per day among Non-Hispanic White and Non-Hispanic Black residents living in New Orleans, LA (Bodor, Rose, Farley, Swalm, & Scott, 2008). However, no significant relationship was found between shelf space dedicated to fruit and fruit intake (Bodor et al., 2008).

Research has also focused on the influence of in-store displays of food and beverages on purchasing behavior. One study found that each additional display location for alcoholic beverages, sugar-sweetened beverages and coffee in a store was associated with greater sales of these beverages (Nakamura, Pechey, Suhrcke, Jebb, & Marteau, 2014). Similarly, a longitudinal study found that individuals in communities with stores that have greater numbers of FV displays showed greater intakes of these foods compared to those living in communities with stores having fewer FV displays (Caldwell et al., 2008). However, a study conducted in Pittsburgh, PA found no association between exposure to displays of sugar-sweetened beverages, snack foods, and nutritious foods and intake of sugar-sweetened beverages and FVs (D. A. Cohen, Collins, Hunter, Ghosh-Dastidar, & Dubowitz, 2015).

Regarding promotions, most research has focused on the influence of television advertising of food products on children's and adults' dietary behaviors (Mills, Tanner, & Adams, 2013; Sadeghirad, Duhaney, Motaghipisheh, Campbell, & Johnston, 2016). Limited research has been conducted on the influence of in-store promotional materials and more specifically, print promotions or signage (e.g., flyers, posters, banners, etc.) in stores. Research conducted among adolescents found that frequent exposure to alcohol promotions in stores was associated with a 50% increase in the likelihood of ever drinking (Hurtz, Henriksen, Wang, Feighery, & Fortmann, 2006). Additionally, a study

conducted in New York City found that stores were more likely to display sugary drinks promotions in neighborhoods with higher intakes of sugar-sweetened beverages compared to stores in neighborhoods with lower intakes of sugar-sweetened beverages (Adjoian, Dannefer, Sacks, & Van Wye, 2014). Lastly, previous research has also found that among low-income public housing residents, higher counts of alcohol print promotions and lower counts of low-calorie food print promotions in stores and restaurants was associated with higher dietary fat intake (Heinrich et al., 2012).

Given the evidence supporting the relationship between in-store environment characteristics and dietary behaviors, additional research is needed within specific understudied racial/ethnic groups, including Hispanics. Although Hispanics have been shown to purchase more FVs than Non-Hispanic Blacks (Cullen et al., 2007), Hispanics are not meeting recommended dietary guidelines for FVs. The current USDA dietary guidelines recommend US American adults consume 1.5-2 cup equivalents (e.g., one small apple) of fruits and 2-3 cup equivalents of vegetables daily (e.g., 12 baby carrots) (US Department of Agriculture, 2015a, 2015b). Recent estimates from the National Health and Nutrition Examination Survey indicate that the median cup equivalent intake for Hispanics are 0.78 for fruits and 1.33 for vegetables (Moore et al., 2015). Understanding how in-store environment characteristics are associated with Hispanics' FV purchasing is important for identifying ways to improve their dietary intake and nutrition.

Hispanics in Southern California have been shown to shop in Hispanic-focused grocery stores, otherwise known as *tiendas* (Ayala, Mueller, Lopez-Madurga, Campbell, & Elder, 2005). These *tiendas* offer a variety of high-quality and affordable FVs. In fact,

one study demonstrated that *tiendas* offered FVs at a lower cost than supermarkets in the same region; resulting in a savings of over $US 3/week for a diet of 2000 kcal/day (Emond et al., 2011). Given that FVs in *tiendas* may be offered at lower prices than supermarkets, suggests that price alone is not the driving factor in Hispanics' low FV intake. Therefore, studying other in-store environment characteristics in *tiendas* such as availability of and shelf space dedicated to FVs may provide valuable insight into the role that the in-store environment plays in Hispanics not meeting recommended dietary guidelines for FVs.

The strategic elements of the marketing mix, specifically product availability, placement, and promotion, were used as an overarching conceptual framework to organize the present the study. The present study focused on these marketing mix elements and used price as a covariate in the final models because intervention strategies can more easily target these environmental characteristics versus modifying the price of food (Gittelsohn, Rowan, & Gadhoke, 2012). Operationalizations of these marketing mix elements were as follows: (1) *product availability* – the availability of fresh, canned, and frozen FVs and the variety of fresh FVs; (2) *placement* – shelf space dedicated to fresh FVs and number of fresh FV displays; and (3) *promotion* – number of FV promotions, specifically signage, and number of cross-product category promotion locations. Using baseline data from the *El Valor de Nuestra Salud* (The Value of our Health) study, it was hypothesized that each additional marketing mix element would enhance the explanatory value of the elements of the marketing mix on customers' self-reported FV purchasing, adjusting for price.

METHODS

Data Source

The baseline data were collected during the *El Valor de Nuestra Salud* study; a cluster randomized-controlled trial with 16 *tiendas* in San Diego County, California. San Diego County is located on the US-Mexico border where approximately 33% of the population is of Hispanic origin (United States Census Bureau, 2015).

Tiendas were systematically sampled following an extensive enumeration process. The systematic enumeration was conducted using five sources: (1) county food permits, (2) the county health department registry, (3) the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program, (4) the Supplement Nutrition Assistance Program (SNAP), and (5) a previous observational study conducted in the target area (Saelens et al., 2012). Duplicates, non-food stores, and stores identifiable as not a *tienda* through internet and phone verification (e.g., super centers, liquor stores, etc.) were removed. Next, zip codes where 2000 US Census data indicated that the proportion of Hispanic residents was less than 20% were excluded in addition to San Diego's South county because of competing intervention activities, leaving 339 entries in the enumeration list.

Given time and resource constraints, the study team identified four additional zip codes, using 2010 Census data, near the study offices that contained census tracts representing at least a 20% Hispanic population. From these areas, additional entries were added to the previously enumerated list of possible *tiendas,* which resulted in 382 entries available for verification. Store audits were conducted to determine if stores met *tienda* eligibility criteria. Eligibility criteria were as follows: (1) customer-base was primarily

Hispanic, (2) employees were bilingual (English/Spanish language) or Spanish-speaking, and (3) in-store product signage and promotions were bilingual and/or Spanish language. In addition, *tiendas* were required to have a butcher and fresh FV department. Of the 382 entries left on the enumeration list, 273 were not eligible and six (1.5%) were duplicates. An additional 26 stores were identified from ground truthing, leaving 129 in the recruitment pool. From among the final list of *tiendas*, 84 were approached for participation. Possible pair-matched *tiendas* were identified that were located at least one mile away from a recruited *tienda* to minimize the potential for cross-contamination. At baseline, the sixteen *tiendas* were similar on several dimensions including number of aisles, cash registers, employees, and store departments.

Hispanic customers were recruited from these *tiendas* to participate in an evaluation cohort (N=23/store). Eligibility criteria for participation included: 18 years of age or older; visited the *tienda* at least once a week and shops for food there; planned to remain in the area for the one-year study duration; did not grocery shop at another study *tiendas*; not on a medically prescribed diet; and consumed four or fewer cups of FVs per day. Only one participant per household could participate to minimize interdependent data. Following the eligibility screening and informed consent processes, participants took part in a 45-minute in-person interview. The interview consisted of the administration of dietary screeners, assessment of psychosocial, socio-cultural, demographic characteristics and measurement of weight. A total of 6,488 customers were approached for participation; 4,270 (66%) refused to be screened for eligibility upon approach, three (.05%) requested to be screened by phone but attempts to reach these customers by phone were unsuccessful, leaving 2,215 (34%) customers screened for

eligibility. Of those who were screened, 1,259 (57%) were deemed ineligible, three (.14%) declined to complete screener, and five (.23%) customers were excluded for other reasons (e.g., unknown eligibility incomplete screener). Of the 948 eligible customers, 24 (3%) were identified as ineligible before or during the interview (e.g., lived in the same household as another participant), 239 (25%) customers refused to participate, 307 (32%) were excluded for other reasons (e.g., unable to schedule interview appointment), and nine (.99%) were dropped due to incomplete baseline data or dropping of the store. Our final sample size was 369 customers (n=23/store).

Audit data of the in-store FV environment were collected by trained research assistants. Store audits collected data on availability of fresh, canned, frozen, and prepared FVs, variety of fresh FVs, price of fresh FVs, shelf space dedicated to fresh FVs, number of fresh FV displays, FV promotions, and size of store. To assess inter-rater reliability, 100% of baseline store audit data were collected by two research assistants on the same day. Additional details on the *El Valor de Nuestra Salud* study are described elsewhere (Ayala et al., 2015). This study was approved by the Institutional Review Board at San Diego State University.

Measures

Outcome: FV Purchasing

During interviews, participants were asked: “In a typical week, about how much do you spend on FVs?” and “You said that in a typical week you spend about $ (answer provided in previous question on FVs. How much of this spent here at THIS store?”). “This store” refers to the *tienda* from which the participant was recruited. For the

purposes of this study, the outcome variable of interest is participants' self-reported dollars spent on FVs at the *El Valor de Nuestra Salud tienda* (continuous).

In-Store Environment Characteristics: Product availability

Availability of fresh, canned, and frozen FVs. A store audit was conducted to assess the availability of fresh, canned, and frozen FVs. Data on the availability (categorical: yes [coded as '1']/no [coded as '0']) of fresh, canned, and frozen FVs were collected for a predetermined list, based on previous evidence, of 73 fresh FVs, 16 frozen FVs, and 28 canned FVs, including frozen and canned mixed FVs (Baquero et al., 2009; Glanz, Sallis, Saelens, & Frank, 2007; Sanchez-Flack et al., 2016). In the current study, availability was defined as follows: (1) the total number of fresh FVs (e.g., apple, banana, avocado, carrots); (2) the total number of frozen FVs (e.g., strawberries, broccoli; and (3) the total number of canned FVs (e.g., applesauce, beets). Availability scores were computed by summing the available fresh FVs, frozen FVs, and canned FVs (continuous) (Farley et al., 2009). Given the high correlation between canned FVs and frozen FVs (r = .803), these two variables were summed to create a single score of total number of canned and frozen FVs (continuous).

Fresh FV variety. Store audits also assessed the variety of fresh FVs stocked within a *tienda* for each unique fresh FV available. For example, if apples were stocked within the *tienda*, the number of unique varieties of apples were counted (e.g., gala, honeycrisp, granny smith, fuji apples). A total variety score was computed by summing the total number of FV varieties combined (all continuous) (Bodor et al., 2008). A strong correlation between availability of fresh FVs and varieties of fresh FVs (r = .974) was found and therefore, varieties of fresh FVs was not included the model building process.

In-Store Characteristics: Placement

Shelf space dedicated to fresh FVs. A "Produce Display Measurement Form", developed by the study team, was used to assess the amount of shelf space dedicated to fresh FVs. Data on the number of shelves for each display, shelf measures (continuous: length and width in feet) and level of stock (categorical: >0-1/3, >1/3-2/3, >2/3-1) within the display were collected. If the display contained items that were not FVs, the length and width for these areas were also recorded and later subtracted to obtain an accurate measurement of shelf space solely dedicated to fresh FVs. All measurements were rounded to the nearest inch and then recorded in feet. Displays that only stocked prepared or cooked FVs were not measured (e.g., fruit salad with yogurt). To determine the total amount of shelf space dedicated to fresh FVs, a variable was computed summing shelf measures for the entire *tienda* (continuous) (Thornton et al., 2013).

Fresh FV displays. Data were collected on the number (categorical: present [coded as '1']/not present [coded as '0']) and type (categorical: one-sided, pallet, island, promotion, other) of fresh FV displays using a "Produce Display Tracking Form" developed by the study team. Displays that only stocked prepared or cooked FVs were not counted (e.g., chunky salsa). To capture the number of FV displays present, a variable was computed summing the total number of displays present at baseline for each *tienda* (continuous) (Miller, Bodor, & Rose, 2012).

In-Store Characteristics: Promotions

FV promotions. Promotions of fresh, canned and frozen FVs were assessed using a "Fruit and Vegetable Promotions Form", which captured detailed information on materials used to promote FVs within *tiendas*. Data collected assessed the location of

promotions (categorical: outside of store, aisles, checkout, endcaps, entrance, island, edge, or other open space), product category of the item closest to the promotion (categorical: FV, cereal and breakfast foods, snack foods, sugar-sweetened beverages, grains and dried beans, canned foods, dairy, butcher, frozen foods, alcoholic beverages, prepared foods, deli, bakery, tortillas, other grocery, non-food, and other), and the type of promotion (categorical: price promotions, flyer, hand-out, package add-on, theme, signage, other), and number of promotions (continuous). Similar to previous research examining the influence of promotion exposure on dietary behaviors, the total number of FV promotions present was summed for each *tienda* (continuous) (Heinrich et al., 2012). Given the influence of cross-product marketing on purchasing, a third variable was created to capture cross-product category promotion location (categorical: product category location of FV promotion is non-fresh FV, product category location of fresh FV promotion is FV) (Leeflang & Parreño-Selva, 2012). A total for the number of cross-product category promotion locations variable was computed by multiplying the number of instances FV promotions were located near a non-fresh FV product category and the total number of FV promotions in the *tienda* (continuous). However, given the strong positive correlation between cross-product category promotion location and number of FV promotions (r = .967), cross-product category promotion location was not included in the model building process.

In-Store and Customer Characteristics: Covariates

Store size and price of fresh FVs. Given the association between store size and in-store environment characteristics such as the availability of foods (Andreyeva, Blumenthal, Schwartz, Long, & Brownell, 2008; Connell et al., 2007; Krukowski, West,

Harvey-Berino, & Elaine Prewitt, 2010; Laska, Borradaile, Tester, Foster, & Gittelsohn, 2009), the current study initially considered the total square footage of the *tienda* (continuous) as a confounder in the model building process. However, given the strong correlation between store size and shelf space dedicated to fresh FVs (r = .805), store size was not included in final models. Analyses were adjusted for the price of FVs given the relationships observed between price of FVs, purchasing, and intake (Ball et al., 2015; Caldwell et al., 2008; Powell, Zhao, & Wang, 2009). During the store audits, research assistants collected data on the current price for a pre-determined list of preferred fresh FVs available in the *tienda*. Price data were collected as 'price per pound(s) (lb)' or 'price by unit(s)' depending on how the *tienda* priced the fresh FVs. When prices were not given per lb, estimated weights were derived using standard food weights from the US Department of Agriculture National Nutrient Database for Standard Reference (US Department of Agriculture, 2016). Standard food weights are provided in grams but were converted to lbs for the current study. If the weight was not available through the database, three samples of the item were weighed within a store and the average was used. Price per unit was converted to price per lb by dividing an item's price by its typical weight ((price/lb)/# of lbs or items) (Thornton et al., 2010). A store-level mean price for all fresh FVs was computed for each *tienda* (Zenk et al., 2005).

Customer characteristics. The following customer characteristics were considered in the model building process given previous evidence supporting the association between individual characteristics, socioeconomic status, acculturation, and dietary behavior, including food purchasing (Ayala, Baquero, & Klinger, 2013; Pollard, Kirk, & Cade, 2002; Turrell, Hewitt, Patterson, Oldenburg, & Gould, 2002): age

(continuous); gender (categorical: female, male); education (categorical: high school graduate, 7^{th} – 11^{th} grade, 6^{th} grade or less); marital status (categorical: married or living together as married, not married); poverty threshold according to the US Census Bureau poverty threshold in 2013 using reported income and household size data (categorical: above poverty level, below poverty level); food assistance program participation (categorical: participating in WIC or SNAP, does not participate in WIC or SNAP); household size (continuous), and generation status (categorical: born in US, born outside of US). Length of time in the US was considered but due to missing data, length of time in the US was not included in the final models.

Statistical Analyses

Analyses were performed using SAS software, Version 9.4 of the SAS System for Windows (SAS Institute, Cary, NC, USA). Descriptive statistics on FV purchasing, all in-store characteristics, and confounders were obtained. To assess inter-rater reliability of store audit data, Cohen's Kappa statistics were computed for binary variables (J. Cohen, 1960) and intraclass correlations (ICCs) were computed for continuous variables (McGraw & Wong, 1996) for a random sample of 50% of store audits with reliability data.

A series of bivariate analyses were conducted to assess the unadjusted relationship between customer characteristics and FV purchasing. Customer characteristics with a $p < 0.20$ were included in the final model. These variables included: gender, marital status, household size, poverty status, and generation status. Prior to estimating the final mixed models, tests for multicollinearity among all in-store characteristics and identified customer characteristics from bivariate analyses were

examined to assess for linear relationships among independent variables. Variables with variance inflation factors greater than 10 were examined further using Pearson's correlation coefficients. Highly correlated variables were excluded in the final mixed models to avoid the problem of multicollinearity.

Given the normal distribution of customers' self-reported FV purchasing and the data structure of customers nested in 16 *tiendas,* a linear regression model was estimated using PROC MIXED with a random statement to account for the nested structure within each *tienda*. The mixed models were estimated under the conceptual framework of the marketing mix elements. The first model estimated the association between product availability and FV purchasing, adjusting for price and customer characteristics. The second model introduced placement variables and estimated the association between product, placement, and FV purchasing, adjusting for covariates. The final model introduced promotion variables and estimated the association between product availability, placement, promotion and FV purchasing, adjusting for covariates.

RESULTS

Inter-Rater Reliability Analyses

Kappa coefficients ranged from 0.42-1, with the majority of Kappa coefficients above .8., for product availability (availability of canned and frozen FVs), and placement (number of fresh FV displays) variables indicating moderate to perfect agreement (Landis & Koch, 1977). ICCs ranged from .97-1.00 for product (availability and variety of fresh FVs), placement (shelf space dedicated to fresh FVs), and promotion (number of FV

promotions) variables indicating excellent agreement between research assistants (McGraw & Wong, 1996).

Customer, Tienda, and In-Store Characteristics

Descriptive characteristics of customers are presented in Table 3.1. More than half (70%) of the sample was female with a mean age of 42 years. Almost all customers (88%) were born outside of the US and 71% lived below the poverty threshold with a mean household size of about 5 (*SD = 1.88*). About 36% of customers reported at least a high school education and 60% reported being employed full-time, part-time or seasonally. Approximately half reported participating in a food assistance program. The mean reported weekly dollars per week spent on FVs at the *tienda* was $16.41 (*SD* = $13.77).

Descriptive characteristics of *tiendas* and of the in-store characteristics are presented in Table 3.2. In terms of store size, the median square footage of sales floor was 2508.08 square feet (range = 648.38-12,639.43) and the median number of cash registers was 3 (range: 1-5). For product availability variables, the mean number of fresh FVs available was about 48 and the mean number of canned and frozen FVs available was about 25. In terms of placement, the median shelf space dedicated to FVs was 289 square feet (range = 125.28-860.44) and the median number of fresh FV displays available was 9 (range = 2-36). Lastly, for promotions, the median number of FV promotions in *tiendas* was about 4 (range = 0–103). The large range in the number of FV promotions is because a couple of *tiendas* had existing resources and experience using their own FV-related signage.

In-store characteristics and FV Purchasing

Linear regression mixed models estimating the adjusted relationship between in-store characteristics and FV purchasing are presented in Table 3.3. Results from model one, which estimated the association between product availability variables and FV purchasing, indicated a significant positive relationship between the availability of fresh FVs and FV purchasing. Each additional fresh FV available was associated with an additional 0.36 dollars spent on FVs, adjusting for price and customer characteristics. In model two, placement variables indicated that each additional square foot of shelf space dedicated to FVs was associated with an additional 0.02 dollars spent on FVs. Also, each additional fresh FV display was associated with a 0.29 decrease in dollars spent on FVs. In model two, the product availability variable of availability of fresh FVs became non-significant. Model three introduced the promotion variable of FV promotions; it was not significantly associated with purchasing. However, the two placement variables remained significant, demonstrating that shelf space dedicated to fresh FVs was associated with greater FV purchasing whereas number of fresh FV displays was associated with less FV purchasing. In all three models, there was a significant association between gender and FV purchasing. Compared to women, men reported fewer dollars spent on FVs, even after adjusting for all in-store characteristics and other customer characteristics.

DISCUSSION

This study examined the relationship between in-store characteristics and FV purchasing among Hispanics who are customers of *tiendas* in San Diego County, CA. We

found that availability of fresh FVs was significantly associated with FV purchasing, however, after controlling for the influence of shelf space dedicated to FVs and the number of fresh FVs displays, the relationship was no longer significant. The number of FV promotions did not have a significant relationship with FV purchasing. Additionally, it was found that men report fewer dollars spent on FVs compared to women.

These findings support previous research which found a positive relationship between shelf space dedicated to specific foods and purchase behavior for healthy foods (Bodor et al., 2008; Cheadle et al., 1993; Fisher & Strogatz, 1999). Similar to the present study, Bodor et al. (2008) found that the amount of shelf space dedicated to fresh vegetables was a significant and positive predictor of vegetable intake. However, the negative association between number of fresh FV displays and FV purchasing in our study is surprising. A possible explanation for this finding may be due to the vast number of foods available within a store. The number of fresh FVs displays within a *tienda* may reflect an overabundance of displays for all foods, which may be creating an over-stimulating environment for customers that hinders their purchasing decisions (Cohen & Babey, 2012). Previous research suggests that having too many choices within one product category may result in customers not choosing any item within that product category or being less satisfied with what they choose (Schwartz, 2004).

Another finding consistent with previous research is the relationship between fresh FV availability and purchasing (Martin et al., 2012; Ruff et al., 2016), however, this association no longer persisted after the introduction of placement variables. Additionally, promotion was not related to FV purchasing in the last model, which is consistent with previous intervention research conducted among Hispanics that found no

improvement in FV purchasing after intervention efforts targeting the promotion of FVs through print materials (Ortega et al., 2016). Although the availability and promotion of foods is important in determining purchasing behavior, the accessibility and prominence of these foods, as measured by shelf space, have an important impact on purchasing behavior (Farley et al., 2009).

Significant associations were also found for gender and FV purchasing, with men reporting fewer dollars spent on FVs than women. This finding aligns with FV dietary intake research indicating that men are less likely to meet dietary guidelines for FVs than women (National Cancer Institute, 2014). Limited research is available on the purchasing behaviors of men. However, previous research has demonstrated that men are less likely to shop for food with a grocery list, which is important to note given that shopping without a grocery list is associated with impulse purchases (Bassett, Beagan, & Chapman, 2008). Often times, impulse purchases are for unhealthy foods such as sugary or salty snacks (Thornton, Cameron, McNaughton, Worsley, & Crawford, 2012). In fact, food manufacturers of such foods pay retailers 'slotting allowances' to obtain specific retail shelf spaces in stores that are known to increase sales (Marx & Shaffer, 2009). This may mean that men in the present study were susceptible to impulse purchasing of unhealthy foods versus FVs, despite the product, placement, and promotion of FVs in a *tienda*. A recent report from the Food Marketing Institute revealed that men conduct at least 50% of the grocery shopping for their households (Food Marketing Institute, 2016). Given these findings, it is important to further understand their purchasing behaviors.

Limitations and Strengths

This study does have several limitations. FV purchasing was examined. As such, inferences about actual consumption is not possible. In addition, we are unable to generalize findings to the purchases of other foods such as sweet and savory snacks. Due to difficulties in retrieving sales data from *tienda* owners, data on purchases of FVs were self-reported, which are subject to measurement and recall error. Furthermore, FV purchasing was self-reported for a one-week period so it likely does not fully represent customers' FV purchasing over a longer time period. Although the analyses controlled for individual characteristics, the study did not consider factors such as product knowledge and attitudes towards purchasing and consuming FVs (Guillaumie, Godin, & Vezina-Im, 2010). Additionally, the type of fresh FV display was not considered, therefore the analyses did not account for differences in types of displays such as end-caps versus islands and its influence on FV purchasing (D. A. Cohen & Babey, 2012). Lastly, analyses were based on cross-sectional data, therefore causality cannot be determined. Strengths of the present study include its large sample size and its use of objective measurements of the in-store environment. Additionally, this study fills a research gap as it focused on Hispanic shoppers of *tiendas,* a racial/ethnic group and retail food environment that has not been well represented in the literature in terms of FV purchasing.

Implications

Findings from this study have important implications for practice and policy as well as future research. As indicated, in-store placement was significantly associated with FV purchasing, even after adjusting for product availability, promotion, price and

customer characteristics. Specifically, more shelf space dedicated to FVs was associated with more dollars spent on FVs, whereas more fresh FV displays in a *tienda* were associated with fewer dollars spent on FVs. Therefore, from a merchandising perspective, expanding the amount of shelf space dedicated to FVs may be more effective than increasing the number of FV displays as a strategy for increasing the purchasing of these foods.

In intervention research, this may mean utilizing existing displays in stores to minimize the chances of inundating customers with an over-abundance of displays. One potential strategy for utilizing existing displays is through choice architecture nutrition interventions. This type of nutrition intervention includes moving displays so they are immediately visible to customers and arranging shelves so that promoted products are located at eye level (Thorndike, Bright, Dimond, Fishman, & Levy, 2016). Such strategies have been shown to be successful for healthy food purchases, even among low-income Hispanic families (Thorndike et al., 2016; Thorndike, Sonnenberg, Riis, Barraclough, & Levy, 2012). In addition to increasing the visibility of FVs, it may be effective to decrease the visibility of unhealthy foods to minimize temptation. Developing policies or regulations, based on future research, that oversee the nutrient profile of foods placed in prominent locations in stores may mean increased purchases for healthy foods such as FVs (D. A. Cohen & Babey, 2012).

This study also found that men reported significantly fewer purchases of FVs than women even after accounting for all in-store characteristics and customer characteristics. More research is needed on the food purchasing behaviors of men given the limited research available. Nutrition interventions targeting the purchasing behaviors of men are

needed given that they are less likely to meet the dietary guidelines of FVs as compared to women and given that men have become more involved with household grocery shopping. An in-store nutrition intervention may be effective for men given that they are apprehensive of interpersonal interventions and more receptive to worksite and community-based interventions (Taylor et al., 2013).

Conclusions

Results suggests that shelf space dedicated to FVs, even after accounting for product availability, promotion, price, and customer characteristics, was associated with more dollars being spent on FVs. Longitudinal studies are needed to further examine the influence of the product availability, placement and promotion on the purchasing of healthy and unhealthy foods. Future studies should consider these in-store characteristics in unique store environments such as *tiendas* and among other racial/ethnic populations.

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Table 3.1. *El Valor de Nuestra Salud* (The Value of Our Health) Baseline Customer Characteristics (N=369)

	Baseline n (%) or Mean (SD)	Missing n (%)
Age	42.18 (12.00)	
Female	259 (70.19%)	
Married or living as married	262 (71.00%)	
Above poverty threshold	102 (28.49%)	11 (3.00%)
Employed full-time, part-time or seasonal	223 (60.43%)	
Education		
6th grade or less	114 (30.89%)	
7th – 11th grade	124 (33.60%)	
High school or more	131 (35.50%)	
Household size	4.71 (1.88)	
Participating in either SNAP or WIC	175 (47.55%)	1 (0.30%)
Foreign born	325 (88.08%)	
Years in the US (among foreign born)	19.25 (9.90)	
Dependent variable		
Self-reported dollars spent on FVs at *tienda* in a typical week	16.41 (13.77)	3 (0.80%)

Table 3.2. *El Valor de Nuestra Salud* (The Value of Our Health) Baseline *Tienda* and 'P' Characteristics (N=16)

	Baseline	Baseline
	Mean (SD)	Median (Range)
Store size		
Number of cash registers	3.00 (1.41)	3 (1-5)
Number of aisles	4.56 (1.93)	4 (2-9)
Sales floor square footage	4083.35 (3694.33)	2508.08 (648.38-12639.43)
Product		
Number of fresh FVs available	48.75 (9.33)	48.00 (32.00-63.00)
Number of canned and frozen FVs available	25.19 (11.08)	26.00 (7.00-44.00)
Variety of fresh FVs available	73.69 (20.83)	70.50 (42.00-115.00)
Placement		
Shelf space dedicated to fresh FVs (square feet)	380.05 (230.18)	289.31 (125.28-860.44)
Number of fresh FV displays	11.69 (8.83)	9.00 (2.00-36.00)
Promotion		
Number of FV promotions (all types)	14.44 (25.95)	3.50 (0-103.00)
Number of cross-product category promotions	10.85 (20.30)	4.00 (0-76.00)

Table 3.3. Linear Regression Mixed Models Examining the Adjusted Relationship between Customer-Reported FV Purchasing and Product, Placement, and Promotion Variables, N=366*.

	Model 1			**Model 2**			**Model 3**		
	Beta (SE)	95% CI	*p*	Beta (SE)	95% CI	*p*	Beta (SE)	95% CI	*p*
Marketing mix (4 P's)									
Product									
Availability of fresh FVs	0.36 (0.12)	(0.10, 0.63)	0.01	0.10 (0.16)	(-0.24, 0.45)	0.54	0.12 (0.17)	(-0.24, 0.49)	0.48
Availability of canned and frozen FVs	0.07 (0.11)	(-0.16, 0.31)	0.51	-0.08 (0.09)	(-0.27, 0.12)	0.41	-0.07 (0.09)	(-0.27, 0.13)	0.47
Placement									
Shelf space dedicated to FVs				0.02 (0.01)	(0.01, 0.04)	0.01	0.03 (0.01)	(0.01, 0.04)	0.01
FV displays				-0.29 (0.12)	(-0.52, -0.06)	0.01	-0.32 (0.13)	(-0.58, -0.05)	0.02
Promotion									
FV promotions							-0.02 (0.05)	(-0.12, 0.08)	0.71
Adjustment variables									
Customer Characteristics									
Gender									
Female		Ref			Ref			Ref	
Male	-3.73 (1.53)	(-6.75, -0.71)	0.02	-3.62 (1.52)	(-6.61, -0.64)	0.02	-3.69 (1.53)	(-6.69, -0.68)	0.02
Poverty status									
Above poverty threshold		Ref			Ref			Ref	
Below poverty threshold	1.87 (1.56)	(-1.20, 4.94)	0.23	1.66 (1.55)	(-1.39, 4.70)	0.29	1.65 (1.55)	(-1.39, 4.69)	0.29
Household size	0.21 (0.38)	(-0.54, 0.95)	0.58	0.22 (0.38)	(-0.53, 0.96)	0.57	0.22 (0.38)	(-0.52, 0.97)	0.56
Marital status									
Not married		Ref			Ref			Ref	
Married/living as married	2.67 (1.60)	(-0.48, 5.82)	0.10	2.15 (1.60)	(-1.00, 5.31)	0.18	2.12 (1.61)	(-1.04, 5.28)	0.19
Foreign born									
No		Ref			Ref			Ref	
Yes	2.41 (2.16)	(-1.84, 6.66)	0.27	2.89 (2.16)	(-1.35, 7.13)	0.18	2.87 (2.16)	(-1.37, 7.11)	0.18
Store characteristics									
Price of fresh FVs (mean $s)	0.29 (3.20)	(-6.57, 7.16)	0.93	2.83 (2.72)	(-2.93, 8.59)	0.31	3.25 (2.91)	(-2.92, 9.41)	0.28

*13 customers missing because of poverty and FV purchasing variables.

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CHAPTER 4

Evaluation of an In-Store Intervention on Environmental Changes and Fruit and Vegetable Purchasing among Hispanics

ABSTRACT

Introduction: A strategy for improving fruit and vegetables (FV) purchasing is through in-store interventions. The objective of the current study was to evaluate intervention effects, from the *El Valor de Nuestra Salud* study, on in-store environment changes and on FV purchasing among Latino/Hispanic customers.

Design: Cluster RCT.

Settings/participants: Latino/Hispanic customers (N=369) of Latino/Hispanic-focused food stores (*tiendas*) in San Diego County.

Methods: Sixteen *tiendas* were randomly assigned to either: (1) a 6-month environmental and communication intervention; or (2) wait-list control.

Main outcome measure: FV purchasing was measured at baseline and 6-month post-baseline. Store-level measures of product availability, placement, and promotion were assessed monthly from baseline through 6-months post-baseline. Multilevel mixed effects models were used to test for between-group differences in FV purchasing and linear mixed effects models were used to test for group by time differences in store-level measures.

Results: At 6-months post-baseline, customers of intervention group *tiendas* reported greater FV purchasing than customers of control group *tiendas* (p=0.04). Results from store-level analyses demonstrated that the intervention was successful at increasing the number of FV promotions (p<0.001) and the number of non-fresh FV cross product category promotion locations (p<0.001) among *tiendas* in the intervention group over the 6-month intervention period.

Conclusions: In-store environment interventions are a potential to promote FVs and to increase FV purchasing. It is important to understand and build upon the lessons learned from these types of interventions to design, implement, and disseminate successful evidence-based programs more widely and effectively.

INTRODUCTION

Fruit and vegetable (FV) intake is an important component to overall diet quality (Crowe et al., 2011; Muraki et al., 2013; Wang et al., 2014). In the US, most FVs are purchased from food stores (Glanz & Yaroch, 2004). Thus, one strategy for improving diet quality, particularly the purchasing of FVs, is through in-store interventions. Systematic reviews on in-store interventions provide evidence for the feasibility of implementation, but data on their effectiveness to positively influence purchasing behaviors is mixed (Adam & Jensen, 2016; Escaron, Meinen, Nitzke, & Martinez-Donate, 2013; Gittelsohn, Rowan, & Gadhoke, 2012; Langellier et al., 2013; Liberato, Bailie, & Brimblecombe, 2014).

For instance, three interventions that used information-only strategies (e.g., shelf labels, posters) led to an increase in sales of targeted foods, including FVs; however one study found no intervention effect on sales of FVs (Adam & Jensen, 2016). Furthermore, interventions that increased the availability of FVs did not always find increased purchases of these foods (Langellier et al., 2013). Despite these mixed results, a different systematic review concluded that multipronged strategies to increase both the supply (e.g., increasing availability of healthy foods) and demand (e.g., strategies to encourage purchasing at the point-of-purchase (POP)) of FVs were more likely to increase purchases of FV among customers than in-store interventions using single strategies (Gittelsohn et al., 2012). In addition, the previously-mentioned systematic review found that in-store interventions conducted in racial/ethnic communities increased sales of FVs (Langellier et al., 2013). Thus, in-store interventions may be meaningful approaches to improve the FV purchasing of racial/ethnic populations.

In-store interventions are often conceptualized using the Model of Community Nutrition Environments (Glanz, Sallis, Saelens, & Frank, 2005). This model postulates that in-store environmental characteristics, such as the availability and promotion of healthy and unhealthy foods and beverages, may have direct or indirect influences on food purchasing (Glanz et al., 2005). Likewise, Rose et al.'s multi-dimensional conceptual model posits that in-store environmental characteristics can influence food purchasing through methods such as increasing shelf space for targeted products (Rose, Bodor, Hutchinson, & Swalm, 2010). These models, in conjunction with the key strategic elements of the marketing mix (the 4 P's: product, placement, promotion, and price) (Kotler & Armstrong, 2010), are often used to inform in-store interventions targeting the purchase of healthy foods such as FVs.

The efficacy of interventions is further supported by cross-sectional studies which have demonstrated that the in-store environment influences food purchasing behaviors. For example, shelf space (Curhan, 1972), number of displays in a store (Inman, Winer, & Ferraro, 2009; Wilkinson, Mason, & Paksoy, 1982), and in-store advertising (Cairns, Angus, Hastings, & Caraher, 2013; Chandon, Hutchinson, Bradlow, & Young, 2009) have been shown to influence customers' purchasing of foods and beverages. However, limited research has examined the impact of in-store marketing related interventions on FVs and how interventions targeting in-store characteristics impact FV purchasing among customers. Understanding which in-store characteristics are most amendable to change and identifying how changes in these characteristics and/or which characteristics are most influential is important to improve FV purchasing (Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008).

The objective of the current study was to evaluate intervention effects on the in-store environment and the extent to which there are concurrent changes in FV purchasing among Latino/Hispanic customers. The in-store environment was conceptualized using the marketing mix elements of product availability, placement, and promotion as a framework. The study occurred in Hispanic-focused food stores, otherwise known as *tiendas* (Ayala, Mueller, Lopez-Madurga, Campbell, & Elder, 2005). The present study hypotheses are:

- There will be group by time effects for in-store environment changes; *tiendas* in the intervention group will have increased product availability (i.e., increases in the availability of overall and targeted fresh, canned, and frozen FVs and varieties of fresh FVs), greater placement (i.e., increases in shelf space dedicated to fresh FVs and number of fresh FV displays), and greater promotion of FVs (i.e., number of FV promotions and number of cross-product category promotion locations) than *tiendas* in the control group from baseline to 6-months post-baseline (assessed via store audit data collected monthly).
- The intervention group will have a direct effect on customers' FV purchasing; customers in the intervention group will report greater FV purchasing at 6-months post-baseline than customers in the control group.

METHODS

Design and Setting

El Valor de Nuestra Salud (The Value of Our Health) was a cluster randomized controlled trial that used environmental and communication intervention strategies to modify the physical and social environments of food stores to improve FV consumption among Hispanic customers (Ayala et al., 2015). The trial included 16-pair matched *tiendas* in San Diego County, California where approximately 33% of the population is of Latino/Hispanic origin (United States Census Bureau, 2015). *Tiendas* were match on store size characteristics including number of aisles, registers, and employees. Pair-matched *tiendas* were randomized to a 6-month intervention or a wait-list control group. Customers who met eligibility criteria were recruited (N=23/*tienda*) to serve on an evaluation cohort and participated in three interviews at baseline, 6-months and 12-months post-baseline (the latter not reported here). Store audits of the *tienda* FV environment were conducted every four weeks for the duration of the *tienda's* involvement in addition to the baseline and 6-month post-baseline assessments. The trial occurred between October 2011 – October 2014 and study protocols were approved by San Diego State University's Institutional Review Board. Reporting of the trial follows the CONSORT statement.

Intervention Description

In *El Valor de Nuestra Salud*, environmental and communication intervention strategies were implemented within the *tienda* environment and involved the *tiendas* owners/managers and employees. Additional intervention details (Ayala et al., 2015) and primary outcome results are described elsewhere (Pickrel et al., 2016). Because our

interest here was to determine whether the intervention was effective at modifying the targeted in-store characteristics, only strategies designed to modify the *tienda's* physical environment were examined. To increase the availability and variety of FVs, managers and employees received training on merchandizing FVs throughout the store. For example, they also received training on how to incorporate FV pairings within the butcher department (e.g., raw fajitas that included chicken, onions, and bell peppers. To promote placement of FVs throughout the *tienda*, managers received $2,000 to purchase new equipment. Decisions on what equipment to purchase were made by the *tienda* manager and the research intervention coordinator. They were encouraged to purchase new fresh FV displays (e.g., cold food bars to promote the sale of ready-to-eat FVs) and/or hardware to improve existing FV displays (e.g., shelf extensions). The promotion strategies involved a 4-month FV campaign directed at the customers and included nine bi-weekly food demonstrations (latter not discussed here). The POP materials included: (a) shelf-danglers; (b) aisle violators; (c) posters; (d) a banner; (e) a produce fact sheet; (f) recipe cards; and (g) blank signs (with the *El Valor de Nuestra* logo) the *tienda* managers and employees could use to promote or price FVs. Some of the POP materials remained in place for the 4-month period while other POP materials were rotated every 2-weeks to highlight the *El Valor de Nuestra* recipe and the FV item promoted at the food demonstration. POP materials were placed within and outside of the fresh FV department to cross-market FV with other product categories (e.g., POP materials placed in cereal department to promote eating fruit with cereal). For example, some POP materials were used in the butcher department to promote the meat-vegetable pairings.

Tienda Recruitment and Procedure

Tiendas were systematically sampled following an extensive enumeration process. The systematic enumeration was conducted using five sources: (1) county food permits, (2) the county health department registry, (3) the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program, (4) the Supplement Nutrition Assistance Program (SNAP), and (5) a previous observational study conducted in the target area (Saelens et al., 2012). After the removal of duplicates, non-food stores, stores identifiable as not a *tienda* (e.g., super centers, liquor stores, etc.), and excluding zip codes where 2000 Census data indicated that the proportion of Hispanic residents was less than 20%, as well as excluding San Diego's South County because of competing intervention activities, 339 entries were included in the enumeration list to be verified.

Over time, demographic shifts occurred in the ethnic composition of neighborhoods in the county from what was indicated in the 2000 Census data. Given time and resource constraints, during the final phases of recruitment, the study team identified four additional zip codes near the study offices that contained census tracts representing at least a 20% Hispanic population, using 2010 US Census data. From these areas, additional entries were added to the previously enumerated list of possible *tiendas*. After removing entries identified as non-food stores, 382 entries were available for verification.

An in-person eligibility assessment was conducted to determine if the store met *tienda* eligibility criteria to participate in the study. Eligibility criteria for *tiendas* were based on the following: (1) customer-base was majority Hispanic, (2) some employees were bilingual (English/Spanish language) or Spanish-speaking, (3) stores used bilingual

(English-Spanish) and/or Spanish language in their in-store product signage, and (4) had a butcher and fresh FV department. Of the 382 entries left on the enumeration list, 71% were not eligible and 1.5% were duplicates, and 26 additional stores were identified from ground truthing, leaving 129 in the recruitment pool. Given resource constraints, recruitment and enrollment of *tiendas* occurred in three waves. To minimize sources of variance across study groups, *tiendas* were pair-matched on several characteristics prior to baseline data collection and randomization to study group (e.g., number of registers, aisles, and employees) and at least one mile away from the other *tienda* to minimize the potential for cross-contamination). At baseline and across study groups, the sixteen *tiendas* were similar on several dimensions including number of aisles and cash registers (see Table 4.1).

Tienda Data Collection Procedures

Store audits were conducted by trained research assistants. Longer assessments were conducted at baseline and 6-months post-baseline and abbreviated assessments were conducted in between these two time-points every four weeks. The data captured the availability of fresh, canned and frozen FVs, shelf space dedicated to FVs, the number of fresh FVs displays available, and the promotions of FVs. To assess inter-rater reliability, 100% of baseline and 50% of 6-month and 12-month post-baseline store audit data were conducted independently by two research assistants at the same time and compared.

Product availability: availability of fresh, canned and frozen FVs and variety of fresh FVs

The store audit assessed the availability of fresh, canned, and frozen FVs at all time-points. Data on the availability (categorical: yes [coded as ‘1’]/no [coded as ‘0’]) of

fresh, canned, and frozen FVs were collected for a predetermined list of 73 fresh FVs, 16 frozen FVs, and 28 canned FVs, including frozen and canned mixed FVs (Glanz, Sallis, Saelens, & Frank, 2007). In the current study, availability was defined as follows: (1) the total number of fresh FVs available (e.g., papaya, banana, avocado, zucchini); (2) the total number of frozen FVs available (e.g., strawberries, broccoli); and (3) the total number of canned FVs available (e.g., peaches, beets). Availability scores were computed by summing the available fresh FVs, frozen FVs, and canned FVs (continuous) (Farley et al., 2009). An additional availability score was computed to capture the availability of FV items targeted in the intervention (continuous). These items were used in the demonstrated recipes and included in their associated POP materials: apples, bananas, grapes, mangos, oranges, strawberries, bell peppers, broccoli, cabbage, carrots, celery, corn, garlic, green beans, green onions, lettuce, mushroom, onions, peas, spinach, squash and tomato. To compute this variable, all available forms of fresh, canned, and frozen targeted FVs were summed to account for the various forms in which customers could purchase these targeted FVs. For example, if fresh, canned, and frozen spinach were available in a *tienda*, this was counted as three. This operationalization is consistent with research demonstrating that customers are influenced by multiple exposures to a food item versus just a single exposure (Baker, Parasuraman, Grewal, & Voss, 2002; Bava, Jaeger, & Dawson, 2009).

Store audits at all time-points also assessed the variety of fresh FVs stocked within a *tienda* for each unique fresh FV available. For example, if apples were stocked within the *tienda*, the number of unique varieties of apples were counted (e.g., gala, honeycrisp, granny smith, fuji apples). A total variety score was computed by summing

the total number of varieties of fresh FVs (all continuous) (Bodor, Rose, Farley, Swalm, & Scott, 2008).

Placement: Shelf Space Dedicated to Fresh FVs and Fresh FV Displays

A "Produce Display Measurement Form", developed by the study team, was used to assess the amount of shelf space dedicated to fresh FVs at all time-points. Data on the number of shelves for each display, shelf measures (continuous: length and width in feet) and level of stock (categorical: >0-1/3, >1/3-2/3, >2/3-1) within the display were collected. If the display contained items that were not FVs, the length and width for these areas were also recorded and later subtracted to obtain an accurate measurement of shelf space solely dedicated to fresh FVs. All measurements were rounded to the nearest inch and then recorded in feet. Displays that only stocked prepared or cooked FVs were not measured (e.g., potato salad). Total amount of shelf space dedicated to fresh FVs was computed by summing shelf measures for the entire *tienda* (continuous) (Thornton et al., 2013).

Data also were collected on the number (categorical: present [coded as '1']/not present [coded as '0']) and type (categorical: one-sided, pallet, island, promotion, other) of fresh FV displays using a "Produce Display Tracking Form" developed by the study team; data were collected at all time-points. Displays that only stocked prepared or cooked FVs were not counted (e.g., fruit salad with yogurt). Number of FV displays present was computed by summing the total number of displays observed (continuous) (Miller, Bodor, & Rose, 2012).

In-Store Promotion: FV Promotions

In-store promotions of fresh, canned and frozen FVs were assessed using a "Fruit and Vegetable Promotions Form" at all time-points. The form captured detailed information on signage and other promotional materials for FVs both inside and immediately outside the *tiendas*. Data collected assessed the location of signage and promotional materials (categorical: outside of store, aisles, checkout, endcaps, entrance, island, or other open space), product category of the item adjacent to the promotional material (categorical: FV, cereal and breakfast foods, snack foods, sugar-sweetened beverages, grains and dried beans, canned foods, dairy, butcher, frozen foods, alcoholic beverages, prepared foods, deli, bakery, tortillas, other grocery, non-food, and other), and promotion type (categorical: price promotions, flyer, hand-out, package add-on, theme, signage, other), and number of promotions (continuous). Similar to previous research examining the influence of exposure to promotional signage on dietary behaviors (Heinrich et al., 2012), the total number of FV promotions present was summed for each *tienda* (continuous). Given the influence of cross-product marketing on purchasing, a second variable was created to capture cross-product category advertising (categorical: product category location of FV promotion is non-fresh FV, product category location of FV promotion is fresh FV) (Leeflang & Parreño-Selva, 2012). This variable was then used to compute a percentage of cross-product category advertising score. A total number of cross-product category promotion locations variable was computed by multiplying the number of instances FV promotions were located near a non-FV product category and the total number of FV promotions in the *tienda* (continuous).

Covariates: Store Size and Price of Fresh FVs

Given the association between store size and in-store environmental characteristics such as the availability of foods (Andreyeva, Blumenthal, Schwartz, Long, & Brownell, 2008; Connell et al., 2007; Krukowski, West, Harvey-Berino, & Elaine Prewitt, 2010; Laska, Borradaile, Tester, Foster, & Gittelsohn, 2009), the current study considered the total square footage of the *tienda* (continuous) as a covariate in the model building process. In addition, analyses adjusted for the price of FVs at 6-months post-baseline, given the relationships observed between price of FVs, purchasing, and intake (Ball et al., 2015; Caldwell, Kobayashi, DuBow, & Wytinck, 2008; Powell, Zhao, & Wang, 2009). During the store audits, data collectors recorded the current price of all available fresh FVs. Price data were collected as 'price per pound(s) (lb)' or 'price by unit(s)' depending on how the *tienda* priced the fresh FVs. When prices were not given per lb, estimated weights were derived using standard food weights from the US Department of Agriculture National Nutrient Database for Standard Reference (US Department of Agriculture, 2016). Standard food weights provided in grams were converted to lbs. If the weight was not available in the database, three samples of the item were weight within a store and the average of those weights were used. Price per item was converted to price per lb by dividing an item's unit price by its standard weight ((price/lb)/# of lbs or items) (Thornton, Crawford, & Ball, 2010). A store-level mean price for all available fresh FVs was computed for each *tienda* (Zenk et al., 2005).

Evaluation Cohort Recruitment and Procedures

Male and female Hispanic customers were recruited from *tiendas* to participate in an evaluation cohort (N=23/store). Eligibility criteria for participation included: 18 years

of age or older; visited the *tienda* at least once a week and shops for food there; planned to remain in the area for the one year study duration; did not grocery shop at another study *tienda* once per month or more; not on a medically prescribed diet; and consumed four or fewer cups of FVs per day. Only one customer per household could participate to minimize interdependent data. Following the eligibility screening and informed consent processes, customers took part in a 45-minute in-person interview immediately at the store or later at a location convenient for the customer. The interview consisted of assessments of diet, psychosocial, socio-cultural, and demographic characteristics, and measurement of weight. A similar assessment was conducted at the 6-month post-baseline assessment.

A total of 6,488 customers were approached for participation; 4,270 (66%) refused to be screened for eligibility upon approach, three (0.05%) requested to be screened by phone but attempts were unsuccessful, leaving 2,215 (34%) customers screened for eligibility. Of those who were screened, 1,259 (57%) were ineligible, three (0.14%) declined to complete screener, and five (0.23%) customers were excluded for other reasons (e.g., unknown eligibility due to incomplete screener). Of the 948 customers who were eligible after screening, 24 (3%) were later deemed ineligible (e.g., lived in the same household as another customer), 239 (25%) customers refused to participate, 307 (32%) were excluded for other reasons (e.g., unable to schedule interview appointment), and nine (0.99%) were dropped due to incomplete baseline data or dropping of the store. Our final sample size at baseline was 369 customers (N=23/store). Retention strategies were utilized to minimize attrition including phone calls to schedule

the 6-month interview at a convenient location (e.g., at the *tienda* or customer's home), reminder post-cards, and greeting cards at holidays.

Customer Interview Procedures and Measures

The present study used customer interview data from baseline and 6-months post-baseline.

FV Purchasing

Customers were asked: "In a typical week, about how much do you spend on FVs?" and "You said that in a typical week you spend about $ (answer provided in previous question on FVs. How much of this did you spend here at THIS store?"). "This store" refers to the *tienda* from which the customer was recruited. In this study, the outcome variable of interest is customers' self-reported dollars spent on FVs at the *El Valor de Nuestra Salud tienda* (continuous).

Customer Characteristics

The following baseline customer characteristics were considered in the model building process given previous evidence supporting the association between socioeconomic status, acculturation, and food purchasing (Ayala, Baquero, & Klinger, 2013; Pollard, Kirk, & Cade, 2002; Turrell, Hewitt, Patterson, Oldenburg, & Gould, 2002): age (continuous); gender (categorical: female, male); education (categorical: high school graduate, 7^{th} – 11^{th} grade, 6^{th} grade or less); marital status (categorical: married or living together as married, not married); poverty threshold according to the US Census Bureau poverty threshold in 2013 using reported income and household size data (categorical: above poverty level, below poverty level); food assistance program participation (categorical: participating in WIC and/or SNAP, does not participate in WIC

and/or SNAP); household size (continuous), and generation status (categorical: born in US, born outside of US). Length of time in the US was considered but due to missing data, length of time in the US was not included in the final models.

Statistical Analyses

All analyses were conducted using an intent-to-treat approach with *tiendas* analyzed per the group to which they were randomized; analyses were adjusted for the potential clustering effects of *tiendas*. Data imputations were conducted for missing store audit data for three *tiendas* for the last monthly audit prior to the 6-month post-baseline assessment. In these cases, values from the previous data collection point were imputed for a conservative estimate of each 'P' dimension. For this study, baseline, monthly abbreviated assessments collected during the intervention period (months 3-6), and 6-month post-baseline data were used to examine intervention effects as they were occurring in the *tienda*. Analyses were performed using SAS software, Version 9.4 of the SAS System for Windows (SAS Institute, Cary, NC, USA).

Descriptive statistics were obtained on FV purchasing, availability of fresh, canned and frozen FVs, variety of fresh FVs, availability of targeted FVs, shelf space dedicated to fresh FVs, fresh FV displays, FV promotions, *tienda* size characteristics, and customer characteristics. Study group differences in baseline customer and *tienda* characteristics were analyzed using *t*-test for continuous variables and χ^2 statistics for categorical variables. A p value of $< .05$ was used as the level of significance for all analyses. A series of bivariate analyses were conducted to assess the unadjusted relationship between customer characteristics and FV purchasing at baseline. Customer characteristics with a $p < .20$ were included in the final model for hypothesis two. To

assess inter-rater reliability of store audit data, Cohen's Kappa statistics were computed for binary variables (Cohen, 1960) and intraclass correlations (ICCs) were computed for continuous variables (McGraw & Wong, 1996) for 50% of randomly selected store audits with reliability data.

Hypothesis 1

To test the first hypothesis, linear mixed effect models, using SAS PROC MIXED, were estimated to examine group-by-time effects in the observed values for the in-store characteristics. For this analysis, each case was the data collection timepoint for each store (six timepoints per store; n=96). The variability in in-store characteristics was plotted prior to running analyses to determine which time-dependent term(s) were appropriate. Based on the plots, the models included a linear time-dependent term. All models were adjusted for square footage of *tienda*.

Hypothesis 2

To test the second hypothesis regarding whether the intervention had a direct effect on FV purchasing, a linear mixed effect model was estimated to examine differences in FV purchasing between intervention and control groups at the 6-month post-baseline time-point, adjusting for customers' baseline FV purchasing, the *tiendas'* price of FVs, and relevant customer characteristics (those associated with FV purchasing at $p < 0.20$).

RESULTS

Customer Characteristics and Retention Rates

The study groups were similar on most customer demographic variables. More than half (70%) of the sample was female with a mean age of 42 years (Table 4.1). Almost all customers (88%) were born outside of the US and had a mean household size of about 5 (*SD = 1.88*). About 36% of customers reported a high school education or more and 60% reported being employed full-time, part-time or seasonally. Approximately half of the sample reported participating in at least one food assistance program. Only one baseline difference was observed; a greater percentage of control group customers lived above the poverty level (35.4%) compared with customers in the intervention group (21.9%).

At 6-months post-baseline, 337 of 369 customers (91%, *n*=171 intervention, *n*=166 control) were interviewed (Figure 4.1). In the intervention group, 16 customers did not complete this assessment. Of these customers, 14 were due to unsuccessful scheduling attempts and two refused. In the control group, 15 did not complete the 6-months post-baseline assessment because of unsuccessful scheduling attempts. In the control group, one was lost to follow-up. For analyses, of those who completed the 6-month post-baseline assessment, 23 were excluded from the intervention group and 24 excluded from the control group because of missing FV purchasing data. This left a sample size of 322 to be analyzed.

Store Characteristics and Retention Rates

At baseline, there were no significant differences between intervention and control *tiendas* in in-store characteristics or in store size (Table 4.1). In terms of store

size, the mean square footage of the sales floor was 4083.4 (SD = 3694.3) and the mean number of cash registers was 3 (SD= 1.4). At 6-months post-baseline, all *tiendas* were retained and all data were collected.

Inter-Rater Reliability

Kappa coefficients for baseline and 6-months post-baseline store audit data ranged from 0.63-1.00 for product (availability of canned and frozen FVs), and placement (number of fresh FV displays) variables indicating substantial to perfect agreement (Landis & Koch, 1977). ICCs ranged from 0.97-0.99 for product (availability and variety of fresh FVs), placement (shelf space dedicated to fresh FVs), and promotion (number of FV promotions) variables indicating excellent agreement between research assistants (McGraw & Wong, 1996).

Hypothesis 1

Table 4.2 shows baseline store audit data values, mean values during the intervention period (months 3-6), and 6-month post-baseline values for each of the in-store characteristics by study group. Also shown are results from mixed models estimating group-by-time effects for the in-store characteristics (or the in-store marketing mix elements). Significant group-by-time effects were observed on FV promotions ($p<.001$) and non-fresh FV cross product category promotion locations ($p<.001$) (Figures 4.2 and 4.3). During the intervention period, the mean number of FV promotions was about 71 in the intervention stores and 18 in the control stores. During this same period, the mean number of non-FV cross product category promotion locations was 39 in the intervention stores versus 13 in the control stores. No other group-by-time interactions were observed.

Hypothesis 2

Results from the mixed effects models examining group-by-time effects in FV purchasing are presented in Table 4.3. Results demonstrate that customers in the intervention group reported spending an additional $2.90 dollars on FVs at 6-months compared with customers in the control group (p=0.05), adjusting for customers' baseline FV purchasing, customer characteristics of gender, poverty status, household size, martial status, and generation status, and price of FVs.

DISCUSSION

El Valor de Nuestra Salud was an in-store intervention aimed at increasing the purchasing and consumption of FVs among Hispanics in San Diego County. Study results demonstrate that the intervention was successful in increasing the presence of in-store FV promotions and non-FV cross product category promotion locations in intervention stores. However, no group-by-time effects were observed for the overall availability of fresh, canned, and frozen FVs, variety of FVs, availability of targeted FVs, shelf space dedicated to FVs or fresh FV displays. The intervention was also effective at increasing FV purchasing among customers in the intervention versus control group.

These findings support previous intervention research demonstrating that in-store interventions can successfully impact food purchasing (Foster et al., 2014; Gamburzew et al., 2016; Gittelsohn et al., 2007; Gittelsohn et al., 2010; Holmes, Estabrooks, Davis, & Serrano, 2012; Thorndike, Bright, Dimond, Fishman, & Levy, 2016). Additionally, these findings support research demonstrating that changing the environment of food stores by increasing the presence of marketing materials such as signage, banners and other promotions items is feasible (Dannefer, Williams, Baronberg, & Silver, 2012;

Gamburzew et al., 2016; Gittelsohn et al., 2007; Gittelsohn et al., 2010; Martínez-Donate et al., 2015; Milliron, Woolf, & Appelhans, 2012). However, unlike other intervention studies, *El Valor de Nuestra Salud* was not successful in changing other aspects of other in-store characteristics such as the availability of fresh, canned, and frozen FVs, shelf space dedicated to FVs, and fresh FV displays (Ayala, Baquero, Laraia, Ji, & Linnan, 2013; Dannefer et al., 2012; Foster et al., 2014; Holmes et al., 2012; Lawman et al., 2015; Thorndike et al., 2016). Regarding the latter, this may be due to spatial constraints such as the lack of space to house additional FV displays, which was stated as a barrier in other small store interventions as well (Curran et al., 2005; Dannefer et al., 2012; Gittelsohn et al., 2012). However, these in-store interventions overcame these barriers by working closely with store owners/manager and by starting with small changes. For example, one intervention had store owners/managers commit to stocking just 1-3 additional FV varieties (Dannefer et al., 2012).

The present study does have several limitations. Self-reported FV purchasing was examined. Although correlations are high between reported purchasing and consumption of FVs in previous research (Appelhans, French, Tangney, Powell, & Wang, 2017), inferences about what customers consumed is not possible. Furthermore, self-reported measures are subject to measurement and recall error. Additionally, this study did not account for differences locations of FV promotions, which may have varying degrees of influence on FV purchasing (Sigurdsson, Larsen, & Gunnarsson, 2011). A valuable next step would be to examine how changes in the in-store environment are associated with changes in purchasing however this was not possible because of inadequate sample size to conduct a multi-level mediation analysis. Strengths of the present study include the

sample size of both stores and customers, its cluster randomized controlled design, and its use of objective measurements of the in-store environment. Additionally, this study fills a research gap as it focused on Hispanic customers of *tiendas*, a racial/ethnic group and food environment that has not been well represented in the literature in terms of FV purchasing.

Directions for Future Research, Practice, and Policy

Results suggest that an in-store intervention conducted in *tiendas* is successful at increasing FV purchasing over 6-months. Studies are needed to further examine the influence of the in-store characteristics, or marketing mix elements, on the purchasing of healthy and unhealthy foods. Additionally, formative research should be conducted to understand how to influence product availability and placement within stores given previous evidence demonstrating the relationship between these dimensions and dietary behaviors (Bodor et al., 2008; Foster et al., 2014; Gittelsohn et al., 2012). As seen in systematic reviews, utilizing multipronged strategies is the most effective way to increase healthy food purchasing, and ultimately healthy food intake (Gittelsohn et al., 2012a). One potential way to effectively manipulate multiple aspects of the in-store environment is by involving multiple partners (Mikkelsen, Novotny, & Gittelsohn, 2016). For example, FV distributors and/or farmers could provide store owners/managers with technical assistance and trainings in acquiring and maintain fresh FVs. Such a strategy can help build partnerships between important players in the food industry, build the capacity of stores to properly stock fresh FVs, and also foster sustainable changes (Wallerstein & Duran, 2010).

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Table 4.1. *El Valor de Nuestra Salud* (The Value of Our Health) Baseline Customer and Store Characteristics

	Intervention	**Control**	**All**	***p*-value**[a]
Customer characteristics	**(n=187)**	**(n=182)**	**(N=369)**	
Age, years, mean (SD)	41.3 (11.0)	43.1 (13.0)	42.2 (11.9)	0.133
Female, no. (%)	133 (71.1)	126 (69.2)	259 (70.2)	0.691
Married or living as married, no. (%)	140 (74.9)	122 (67.0)	262 (71.0)	0.097
Above poverty threshold, no. (%)[b]	40 (21.9)	62 (35.4)	102 (28.5)	**0.004**
Employed full-time, part-time or seasonal, no. (%)	116 (62.0)	107 (58.8)	223 (60.4)	0.524
Education, no. (%)				0.874
6th grade or less	59 (31.6)	55 (30.2)	114 (30.9)	
7th – 11th grade	64 (34.2)	60 (33.0)	124 (33.6)	
High school or more	64 (34.2)	67 (36.8)	131 (35.5)	
Household size, mean (SD)	4.9 (2.0)	4.5 (1.8)	4.7 (1.9)	0.112
Participating in either SNAP or WIC, no. (%)[b]	92 (50.3)	80 (45.7)	172 (48.0)	0.247
Foreign born, no. (%)	169 (90.4)	156 (85.7)	325 (88.1)	0.167
Years in the US (among foreign born), mean (SD)	18.3 (9.5)	20.3 (10.0)	19.3 (10.0)	0.066
Store characteristics	**(n=8)**	**(n=8)**	**(n=16)**	
Number of cash registers, mean (SD)	3.1 (1.4)	2.9 (1.5)	3.0 (1.4)	0.737
Number of aisles, mean (SD)	4.8 (2.2)	4.4 (1.8)	4.6 (1.9)	0.712
Sales floor square footage, mean (SD)	3899.7 (3187.7)	4267.0 (4359.7)	4083.4 (3694.3)	0.850
'P' dimensions				
<u>Product</u>				
Number of fresh FVs available	50.1 (7.1)	47.4 (11.5)	48.8 (9.3)	0.57
Number of canned and frozen FVs available	22.6 (8.2)	27.8 (13.4)	25.2 (11.1)	0.37
Variety of fresh FVs available	74.1 (14.2)	73.3 (27.0)	73.7 (20.8)	0.94
Number of targeted FVs available (all forms)	26.9 (3.9)	25.5 (5.4)	26.2 (4.6)	0.57
<u>Placement</u>				
Shelf space dedicated to fresh FVs (sq.ft.)	390.5 (220.0)	371.4 (252.8)	380.1 (230.2)	0.87
Number of fresh FV displays	11.5 (6.6)	11.9 (11.1)	11.7 (8.8)	0.94
<u>Promotion</u>				
Number of FV promotions (all types, intervention and non-intervention)	10.9 (10.5)	18.0 (36.1)	14.4 (25.9)	0.60
Number of cross-product category promotions	7.4 (5.9)	14.8 (30.2)	10.9 (20.3)	0.64

[a] *t*-test for continuous variables, χ^2 test for categorical variables
[b] Missing data not included in descriptives.

Table 4.2. Group-by-Time Effects for In-Store Characteristics Between Baseline and 6-months Post-Baseline [a]

	Intervention			**Control**			Group*Time
	Baseline	Intervention period (months 3-6)	6-month post-baseline	Baseline	Intervention period (months 3-6)	6-month post-baseline	*p*-value
		Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)	
<u>Product</u>							
Number of fresh FVs available	50.1 (7.1)	49.3 (9.3)	48.1 (8.6)	47.4 (11.5)	47.9 (11.2)	48.8 (12.6)	ns [b]
Number of canned and frozen FVs available	22.6 (8.2)	22.0 (6.7)	22.1 (5.6)	27.8 (13.4)	28.3 (13.3)	28.6 (14.2)	ns
Variety of fresh FVs available	74.1 (14.2)	73.9 (18.4)	73.0 (17.6)	73.3 (27.0)	73.6 (24.9)	75.4 (29.1)	ns
Number of targeted FVs available (all forms)	26.9 (3.9)	26.7 (4.3)	27.1 (4.4)	25.5 (5.4)	26.6 (5.1)	27.5 (5.2)	ns
<u>Placement</u>							
Shelf space dedicated to fresh FVs (sq.ft.)	390.5 (220.0)	383.5 (217.4)	385.5 (238.6)	371.4 (252.8)	383.9 (241.0)	391.2 (261.9)	0.38
Number of fresh FV displays	11.5 (6.6)	10.5 (4.6)	10.4 (3.8)	11.9 (11.1)	12.6 (10.8)	12.6 (12.4)	0.81
<u>Promotion</u>							
Number of FV promotions (all types, intervention and non-intervention)	10.9 (10.5)	70.8 (35.0)	84.0 (19.1)	18.0 (36.1)	17.7 (27.9)	21.0 (31.7)	<0.001
Number of cross-product category promotions	7.4 (5.9)	38.9 (23.2)	42.6 (16.4)	14.8 (30.2)	13.3 (19.2)	17.8 (22.0)	<0.001

[a] Models adjusted for sales floor square footage

Table 4.3. Multi-Level Mixed Effects Models Examining FV Purchasing at 6-Months Post-Baseline, N=322

	Model		
	Beta (SE)	(95% CI)	*p*
Study group			
Intervention	2.9 (1.4)	(0.1, 5.7)	0.04
Control		Ref	
Customer-level covariates			
FV purchasing (at baseline)	0.5 (0.0)	(0.4, 0.6)	<.001
Gender			
Female		Ref	
Male	-3.0 (1.6)	(-6.1, 0.1)	0.06
Poverty status			
Above poverty threshold		Ref	
Below poverty threshold	2.8 (1.6)	(-0.3, 6.1)	0.07
Household size	-0.5 (0.4)	(-1.2, 0.3)	0.20
Marital status			
Not married		Ref	
Married/living as married	2.1 (1.7)	(-1.2, 5.3)	0.21
Foreign born			
No		Ref	
Yes	-0.4 (0.4)	(-4.9, 4.1)	0.86
Store-level covariates			
Price of fresh FVs at 6-months post-baseline (mean $s)	2.8 (2.2)	(-1.5, 7.1)	0.20

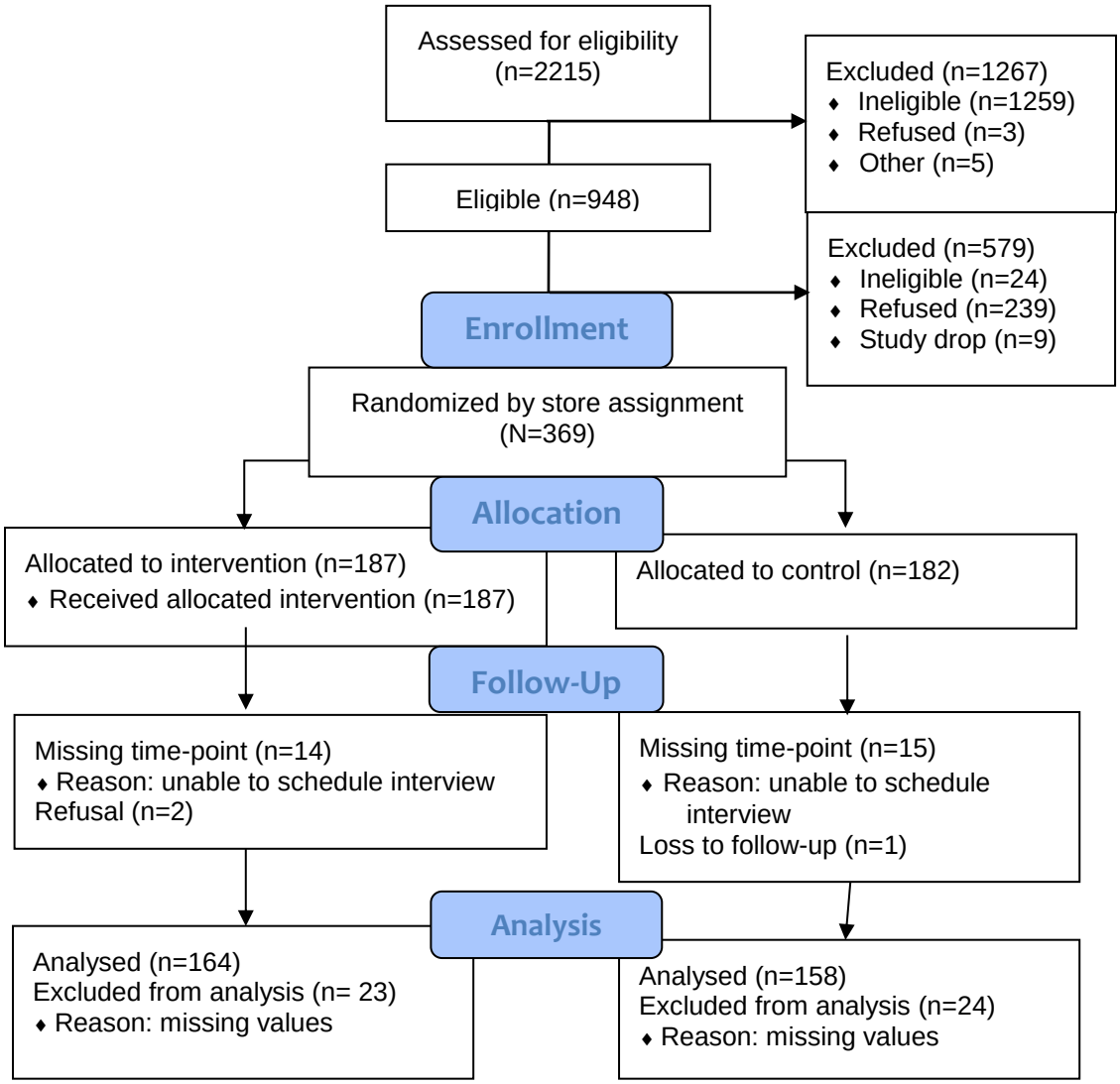

Figure 4.1. CONSORT 2010 flow diagram.

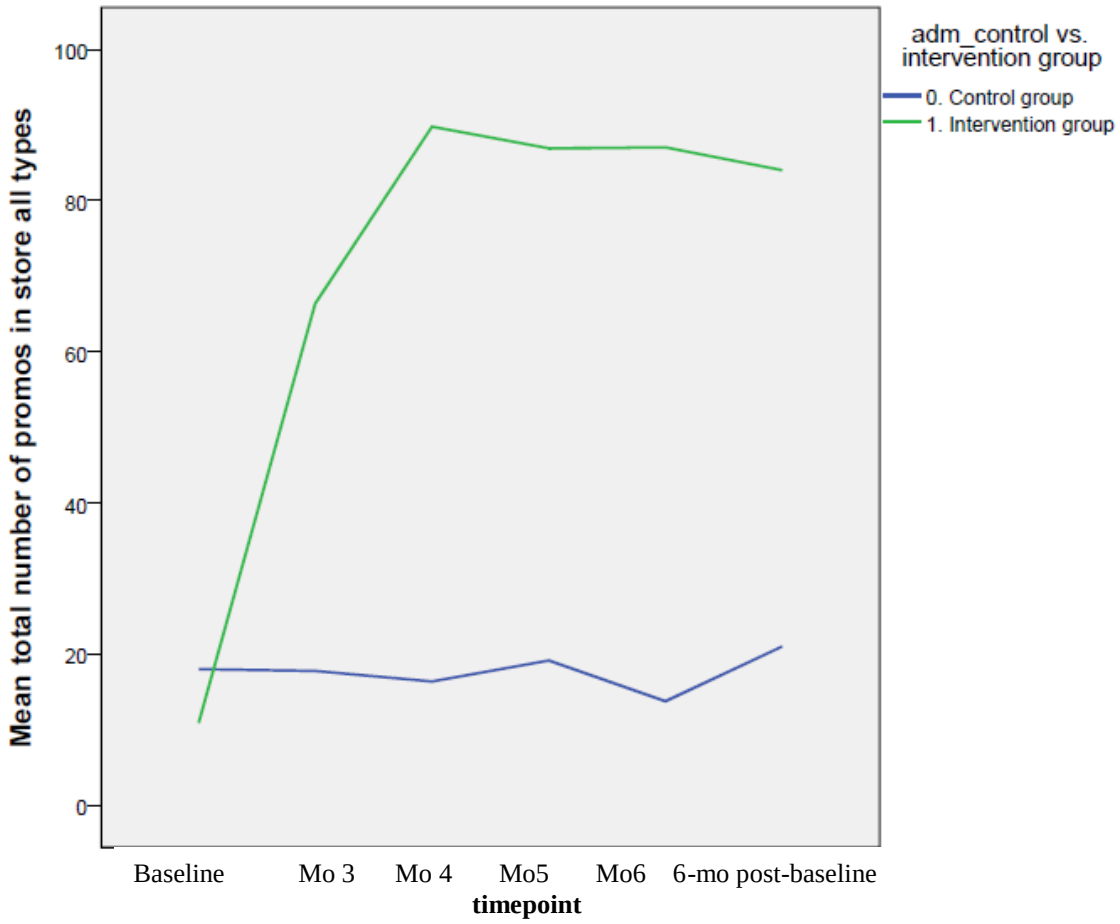

Figure 4.2. Group*Time differences for FV promotions.

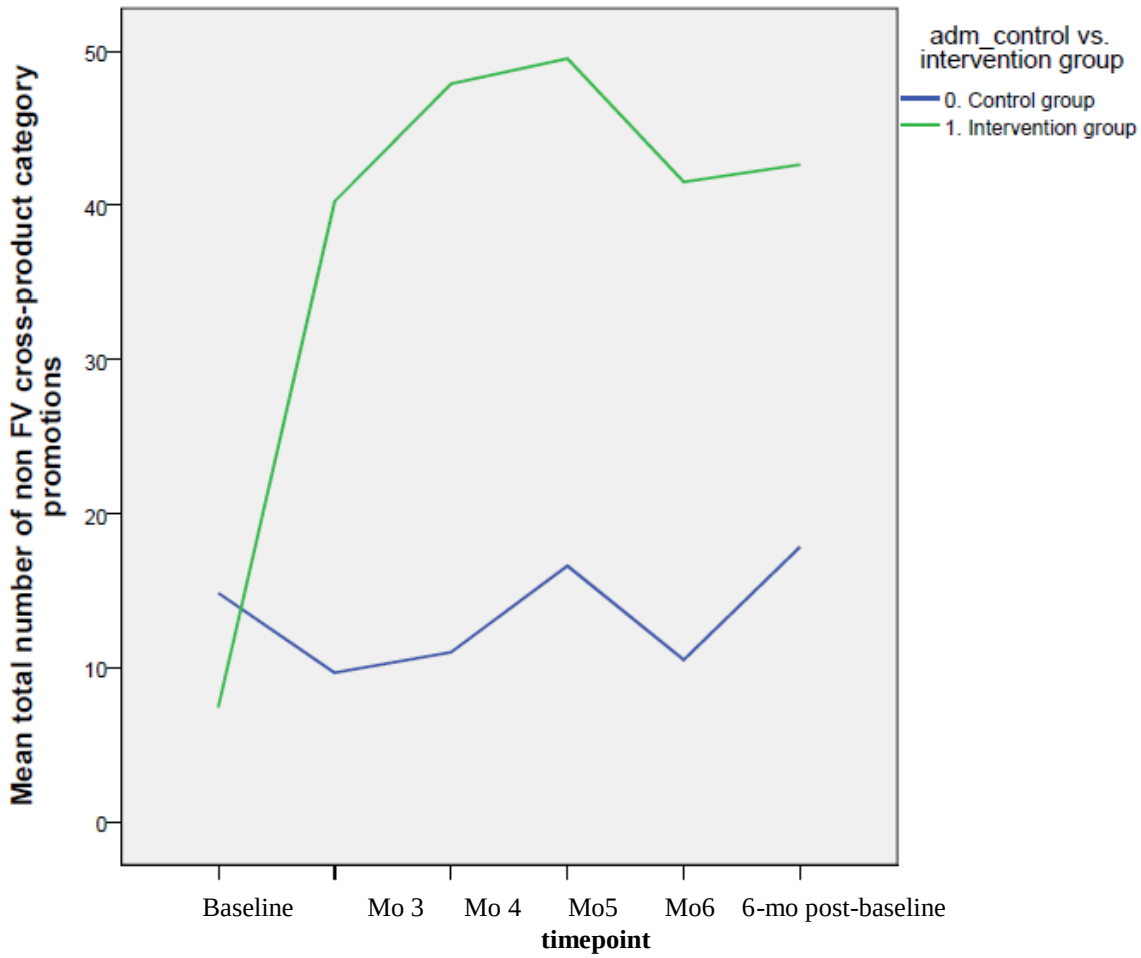

Figure 4.3. Group*Time differences for non-FV cross product category promotions.

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CHAPTER 5

DISCUSSION

This dissertation used a food environment perspective to understand the fruit and vegetable dietary behaviors of purchasing and intake among Hispanics in the US. The dissertation used two secondary data sources to conduct cross-sectional and intervention effect analyses. The first data source used was the National Health and Nutrition Examines Survey (NHANES). The NHANES data was used to examine (1) differences between customers of multiple food store types and (2) fruit and vegetable intake by type of food store among US Hispanics. The second data source was the *El Valor de Nuestra Salud* (The Value of Our Health) study from which cross-sectional and intervention analyses were conducted. Cross-sectional analyses examined how in-store characteristics of *product*, *placement*, and *promotion* are related to fruit and vegetable purchasing among Hispanic customers. Intervention analyses were conducted to examine changes in *product*, *placement*, and *promotion* among intervention group *tiendas* versus control group *tiendas*. Intervention analyses were also conducted to examine differences in fruit and vegetable purchasing post-intervention between customers of intervention group *tiendas* versus control group *tiendas*. In combination, this body of work illustrates how the food environment influences the fruit and vegetable dietary behaviors of US Hispanics. Results from this dissertation have important implications for practice, research and policy.

Summary of Findings and Recommendations

Paper 1: Fruit and Vegetable Intake of US Hispanics by Food Store Type

Paper 1 used t-test and chi-square analyses to assess r differences between consumers in different food store categories. Negative binomial regression analyses were performed to estimate associations between fruit and vegetable intake by food store category. Results demonstrated that US Hispanics who only purchased fruit and vegetables for consumption from convenience stores tended to be younger and more likely to be born in the US. Individuals who only purchased from convenience stores also had lower intakes of fruit and vegetables than individuals who purchased some of these foods from supermarket/grocery stores. Adjusting for individual characteristics, negative binomial analyses demonstrated that those who primarily purchased fruit and vegetables from supermarkets/grocery stores reported consuming more fruit and vegetable cup equivalents than those who only purchased from convenience stores.

These findings provide evidence regarding the relationship of purchasing foods from multiple food store types on fruit and vegetable intake. Additional research is needed to further examine what individuals purchase from different types of food stores, who shops in these food store types, and how shopping at different store types influences purchase behavior for healthy and unhealthy foods. Such research can help to inform targeted food store interventions. For example, this dissertation demonstrated that those who only purchased fruits and vegetables from convenience stores are younger. Social marketing campaigns can be developed in convenience stores that are targeted to a

younger demographic to promote healthy food purchasing (Stead, Gordon, Angus, & McDermott, 2007).

Additionally, results show that purchasing even some fruit and vegetables from supermarket/grocery stores is associated with higher intakes of these foods. This suggests that encouraging US born Hispanics to shop at supermarket/grocery stores for their foods, even infrequently, may lead to greater intake of fruit and vegetables. To encourage this behavior it is important to consider their level of acculturation and how acculturation influences decisions on where to purchase foods (Ayala, Baquero, & Klinger, 2013; Batis, Hernandez-Barrera, Barquera, Rivera, & Popkin, 2011; Pérez-Escamilla, 2009). Targeted intervention strategies should be developed that support US born Hispanics' ability to maintain some of the healthier food behaviors practiced in their Hispanic culture such as purchasing foods from more traditional food store types such as supermarket/grocery stores (Langellier, Brookmeyer, Wang, & Glik, 2015). Also, improving individuals' ability to shop at supermarket/grocery stores will increase their access to healthier food options such as fruits and vegetables. One way to improve access is to increase public transportation options to assist individuals in getting to supermarkets/grocery stores (Larson, Story, & Nelson, 2009). However, this study demonstrates that only purchasing fruit and vegetables from supermarkets/grocery stores is not associated with better dietary outcomes, consistent with previous research, so it is important to identify how these stores affect diet (Dubowitz et al., 2015). Additionally, more research is needed on how purchasing foods from multiple food store types influences dietary behavior. This research could examine the environmental

characteristics of various types of stores to identify their own unique health promoting or inhibiting characteristics.

Paper 2: Examination of In-Store Environmental Influences on Fruit and Vegetable Purchasing among Hispanics

Paper 2 used linear mixed models to examine how in-store environmental characteristics of *product*, *placement* and *promotion* are associated with fruit and vegetable purchasing among Hispanic customers of *tiendas* in San Diego County. Results demonstrate that *product* availability of fresh fruit and vegetables, is associated with greater purchasing of these items. However, availability of fresh fruit and vegetables was non-significant in models that included placement and *promotion* variables. *Placement*, specifically greater shelf space dedicated to fruit and vegetables and fewer fresh fruit and vegetable displays, was associated with fruit and vegetable purchasing, even after accounting for *product, promotion,* price and individual characteristics. *Promotion,* or the number of in-store messages promoting fruit and vegetables, was not statistically significant in the final, full model. Analyses also revealed that men reported less FV purchasing compared to women, after accounting for all in-store environmental characteristics.

This study found that more shelf space dedicated to fruit and vegetables was associated with more dollars being spent on these items, whereas more fresh fruit and vegetable displays in a *tienda* were associated with fewer dollars spent on them. Therefore, from a merchandising perspective, expanding the amount of shelf space dedicated to fruit and vegetables may be more effective than increasing the number of fruit and vegetable displays as a strategy for increasing the purchasing of these foods.

One potential strategy for utilizing existing displays is through "choice architecture" nutrition interventions. This type of nutrition intervention includes moving displays so they are immediately visible to customers and arranging shelves so that promoted products are located at eye level (Thorndike, Bright, Dimond, Fishman, & Levy, 2016). Such strategies have been shown to be a successful way to increase healthy food purchases, even among low-income Hispanic families (Thorndike et al., 2016; Thorndike, Sonnenberg, Riis, Barraclough, & Levy, 2012). In addition to increasing the visibility of fruit and vegetables, it may be important to decrease the visibility of unhealthy foods to minimize temptation. Developing policies or regulations that oversee the nutrient profile of foods placed in prominent locations in stores may mean increased purchases for healthy foods such as fruit and vegetables (Cohen & Babey, 2012).

This study also found that men reported significantly fewer purchases of fruit and vegetables than women, even after accounting for in-store characteristics and customer characteristics. More research is needed on the food purchasing behaviors of men given the limited research available. Nutrition interventions targeting the purchasing behaviors of men are needed given that they are less likely to meet the dietary guidelines of fruit and vegetables as compared to women and given that men have become more involved with household grocery shopping. An in-store nutrition intervention may be effective for men given that they are apprehensive of interpersonal interventions and more receptive to worksite and community-based interventions (Taylor et al., 2013).

Paper 3: Evaluation of an In-Store Intervention on Environmental Changes and Fruit and Vegetable Purchasing among Latinos/Hispanics

Paper 3 used multilevel linear mixed effect models to estimate group-by-time differences in store-level measures of *product, placement,* and *promotion* among intervention group versus control group *tiendas.* Additionally, multilevel linear mixed effects models were used to estimate between-group differences in fruit and vegetable purchasing among customers of intervention group versus control group *tiendas*. Results demonstrated that post-intervention, customers of intervention group *tiendas* reported greater FV purchasing than customers of control group *tiendas* (p=0.04). Results from store-level analyses demonstrated that the intervention was successful at increasing the number of promotional messages for FVs (p<0.001) and the number of non-FV cross product category promotions(p<0.001) among *tiendas* in the intervention group over the 6-month intervention period.

Results suggests that an in-store intervention conducted in *tiendas* is successful at positively changing the in-store characteristics of *promotion* and at increasing fruit and vegetable purchasing among Hispanic customers. Formative research should be conducted to understand how to influence *product* availability and *placement* within stores given previous evidence demonstrating the relationship between these characteristics and dietary behaviors (Bodor, Rose, Farley, Swalm, & Scott, 2007; Foster et al., 2014; Gittelsohn, Rowan, & Gadhoke, 2012). As demonstrated in a previous systematic review of in-store interventions, utilizing multipronged strategies is the most effective way to increase healthy food purchasing, and ultimately healthy food intake (Gittelsohn et al., 2012). One potential way to effectively manipulate various components of the in-store environment is by involving multiple partners (Mikkelsen, Novotny, & Gittelsohn, 2016). For example, fruit and vegetable distributors and/or

farmers could provide store owners/managers with technical assistance and trainings in acquiring and maintain fresh fruit and vegetables. Such a strategy can help build partnerships between important players in the food industry, build the capacity of stores to properly stock fresh fruit and vegetables, and also foster sustainable changes (Wallerstein & Duran, 2010).

Conclusion

The food environment has become increasingly recognized as an important area of research. In fact, the Dietary Guidelines for Americans 2015 call for environmental and policy approaches to complement individual-based efforts to improve diet and reduce obesity and other diet-related chronic diseases (United States Department of Agriculture, 2015). Therefore, this dissertation represents an important area of research. as it focused on an important at-risk population given that approximately 42.5% of Hispanics in the US are obese, which is higher than the national prevalence rate of 34.9% (Ogden, Carroll, Kit, & Flegal, 2014), and that the Hispanic population is projected to comprise more than one-quarter of the total US population by 2060 (Colby & Ortman, 2015).

Additionally, this research contributes to the existing body of literature regarding the consumer food environment and the influence of in-store characteristics on purchasing behaviors. Two previous studies found that the likelihood of purchasing fruit and vegetables was higher among Non-Hispanic Blacks and Whites, and Hispanics when there was a greater variety of fruit and vegetables available in stores (Martin et al., 2012; Ruff, Akhund, & Adjoian, 2016). Similarly, a longitudinal study found that Non-Hispanic White individuals who lived in communities with greater varieties of fruit and vegetables in stores, showed greater increases in weekly servings of fruit and vegetables over a 1-

year period than individuals who lived in communities with fewer varieties of these foods (Caldwell, Kobayashi, DuBow, & Wytinck, 2008). In paper 2, it was found that the availability of fruit and vegetables was associated with purchasing. However, in the final, full model that included *placement* and *promotion* variables, availability of fruits and vegetables was no longer significant. These mixed results fit into both the literature indicating a positive relationship between availability and dietary behaviors as well as with literature indicating no significant relationship between availability of fruit and vegetables in stores and dietary behaviors (Sharkey, Johnson, & Dean, 2010; Thornton, Crawford, & Ball, 2010).

Other studies have demonstrated that *placement* characteristics of the in-store environment influence purchase behavior, which is consistent with paper 2. One study found an association between the proportion of total shelf space in a store dedicated to red meat, reduced fat-milk, and non-white bread and intake of these foods among 12 communities in California and Hawaii (Cheadle et al., 1991). Similarly, another study found a strong, positive relationship between proportion of total shelf space in a store dedicated to low-fat milk and the prevalence of low-fat milk intake among a predominantly Non-Hispanic White sample (Fisher & Strogatz, 1999). In terms of fruit and vegetables, one study found that amount of shelf space dedicated to fresh vegetables was associated with vegetable intake; each extra meter of shelf space was associated with an additional intake of 0.35 servings of vegetables per day among Non-Hispanic White and Non-Hispanic Black residents living in New Orleans, LA (Bodor et al., 2007). Lastly, one study found that each additional display location for alcoholic beverages, sugar-

sweetened beverages and coffee in a store was associated with greater sales of these beverages (Nakamura, Pechey, Suhrcke, Jebb, & Marteau, 2014).

Regarding *promotion*, research conducted among adolescents found that frequent exposure to alcohol promotions in stores was associated with a 50% increase in the likelihood of ever drinking (Hurtz, Henriksen, Wang, Feighery, & Fortmann, 2006). Additionally, a study conducted in New York City found that stores in neighborhoods with higher intakes of sugar sweetened beverages were more likely to display sugary drink promotions compared to stores in neighborhoods with lower intakes of sugar sweetened beverages (Adjoian, Dannefer, Sacks, & Van Wye, 2014). Previous research has also found that among low-income public housing residents, higher counts of alcohol print promotions and lower counts of low-calorie food print promotions in stores and restaurants were associated with higher dietary fat intake (Heinrich et al., 2012). Although paper 2 found no relationship between *promotion* intensity and fruit and vegetable purchasing, paper 3 demonstrated that changes in *promotion* levels were effectively implemented among intervention group *tiendas* and that customers of these *tiendas* had increased fruit and vegetable purchasing post-intervention.

Additional, research is needed on how in-store characteristics of *product*, *placement*, and *promotion* vary by food store types and how variation in these marketing elements influence purchasing behavior. As shown in paper 1, US Hispanics shop for fruit and vegetables in multiple food store types, including supermarket/grocery stores and convenience stores. Previous research has demonstrated that supermarkets generally have the highest availability of fruit and vegetables compared to other retail food outlets such as grocery stores, convenience stores, or farmers markets (Farley et al., 2009; Leone

et al., 2011; Millichamp & Gallegos, 2013). These findings suggest that supermarket/grocery stores are the healthiest consumer food environment. However, prior research has also demonstrated that although the greatest number of fruit and vegetable displays are in supermarkets, these types of stores also have the highest number of energy-dense snack foods displays (Cohen, Collins, Hunter, Ghosh-Dastidar, & Dubowitz, 2015; Miller, Bodor, & Rose, 2012). Thus, consumer shopping in supermarkets have a high exposure to both healthy and unhealthy foods. In fact, one study found that the introduction of a new supermarket in a food desert was not associated with increased intakes of fruit and vegetables but was associated with increased intakes in percentage of kilocalories from solid fats, added sugars, and alcohol consumed (Dubowitz et al., 2015). It is important that future research examine the in-store characteristics of various types of food stores to identify their own unique health promoting characteristics.

From paper 3, it was shown that an in-store intervention is effective at increasing fruit and vegetable purchasing among customers shopping in *tiendas*. Therefore, in-store interventions may be an effective strategy for promoting healthy purchasing behaviors. however, it is important to understand how in-store characteristics vary by food store type and how these variations influence purchasing. In addition to this type of research, formative research should be conducted with owners/managers of multiple food store types to effectively develop methods to manipulate these targeted in-store characteristics to promote healthy purchasing behaviors.

This dissertation also demonstrates the need for developing targeted interventions for specific segments of the US Hispanic population. In paper 1, it was found that only

convenience store shoppers were younger and more likely be US born. This is an important group to note given that only convenience store shoppers had lower intakes of fruit and vegetables compared to other food store categories. Additionally, paper 2 demonstrated that men reported fewer dollars spent on fruit and vegetables compared to women. Although in-store interventions typically target all customers of a specific store; care should be taken into crafting intervention strategies that target specific segments, particularly those most "at risk". Mixed methods research should be conducted to understand how in-store characteristics affect younger customers, Hispanics born in the US, and men. Quantitative methods could include objective measurement of the in-store environment by food store type. Using these data, associations could be estimated between in-store characteristics and purchasing outcomes of these segments. qualitative methods should also be employed (e.g., key informant interviews) to provide contextual information to the quantitative data and to ensure that interventions strategies are developed that these segments will be receptive to.

This dissertation also provides evidence to support policy-level strategies. All three papers demonstrate that the consumer food environment influences both purchasing and intake. Therefore, policy-level strategies are recommended for all food store types that target important in-store characteristics. For instance, potential policy implications based on the current findings suggest that more needs to be done to change the convenience store environment to promote fruit and vegetable purchases. For instance, such policy strategies could include the mandating of minimum fruit and vegetable stocking requirements (Laska, Caspi, Pelletier, Friebur, & Harnack, 2015; Laska & Pelletier, 2016). It may also be important to decrease the visibility of unhealthy foods to

minimize temptation. Developing policies or regulations that oversee the nutrient profile of foods placed in prominent locations in stores may lead to increased purchases of healthy foods such as FVs (Cohen & Babey, 2012). Lastly, policy strategies should be developed to limit the marketing of unhealthy foods in-stores to adults. There has been an abundance of support of limiting marketing of unhealthy foods to children but this support should extend to adults as well (Gortmaker et al., 2011).

Lastly, this dissertation only focused on in-store marketing elements of *product*, *placement*, and *promotion* and did not consider *price*, although in papers 2 and 3, analyses were adjusted for *price*. This dissertation only focused on these marketing elements since they are aspects of the in-store environment, which are amendable to in-store intervention changes. However, research should be conducted to examine how *price* varies by food store type and how monetary-type interventions can influence purchase and dietary behaviors.

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