# The Effects of Perceived Barriers to Healthy Eating on Dietary Consumption among Parents of Elementary-School Aged Children

by

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ABSTRACT

**Background:** Healthy eating plays critical roles in the prevention of many chronic diseases, but there are many barriers in life that prevent people from adopting and maintaining healthy diets. Thus, identifications of barriers that people perceive they have in trying to eat healthy can guide the strategies for dietary behavior change interventions by taking account of the barriers. **Objective:** The purpose of this study was to identify and quantify the perceived barriers to healthy eating (PBHE), to investigate the relationship between socioeconomic factors and PBHE, and to explore the associations between PBHE and dietary intake among parents of elementary-school aged children living in South Phoenix, AZ. **Methods:** Socioeconomic factors and PBHEs were obtained via survey and diet was assessed by two interviewer-assisted 24 h diet recalls. The associations between employment and PBHEs, education and PBHEs, and household monthly income and PBHEs were analyzed by Mann-Whitney Test, Kruskal Wallis Test, and Spearman's correlation test, respectively. The relationship between PBHEs and dietary intake were analyzed by Spearman's correlation test. Linear regression was used to assess the associations between total PBHE, and dietary intake (including added sugar, fruit and vegetable), adjusted by covariates (including socioeconomic status, birth country, age and gender). **Results:** Of 149 participants who completed the survey (mean age = 38.47±7.08 y), 136 completed the 24 h diet recalls. The mean reported total, social support, emotions and daily mechanics PBHE scores were 2.63±0.91, 2.52±1.16, 2.71±1.06, and 2.58±0.95, respectively, out of a 5-point scale. Daily fruit, vegetable, sugar-sweetened beverage, sweetened foods, and added sugar intake were reported as 1.66±1.56 servings, 2.45±1.43 servings, 1.19±1.30 servings, 2.02±2.12 servings and

49.93±31.17 g, respectively. Employment status was significantly associated with total PBHE (Z = -2.28, p=0.023), and support PBHE (Z = -2.623, p=0.009). Education was significantly related to total PBHE ($\chi^2$ = -7.987, p=0.046), and daily mechanics PBHE ($\chi^2$= 11.735, p=0.008). Household monthly income levels were significantly correlated to daily mechanics PBHE (r = -0.265, p=0.005). Added sugar was positively correlated with total PBHE (r=0.202, p=0.020), emotions PBHE (r=0.239, p=0.006), and daily mechanics PBHE (r=0.179, p=0.040). Sugar sweetened beverage intake was significantly related to emotions PBHE (r=0.183, p=0.035). When adjusting for socioeconomic factors in the regression analysis, there was no significant association between PBHE and diet intake. **Conclusion:** Overall, results suggest PBHEs listed in this study are mainly associated with socioeconomic factors, but they are not related to diet intake. Future studies will focus on the precise role of overcoming some identified barriers in improving healthy eating behaviors, and the causality between barriers and healthy eating.

# DEDICATION

This thesis is dedicated to my parents, for all their love and support. I also dedicate this thesis to my beloved husband who encouraged me to build motivation in all my life.

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# CHAPTER 1

# INTRODUCTION

The United States (US) is a developed country with the typical eating patterns of high calories and low fruits and vegetables, which do not align with the Dietary Guidelines for Americans [1]. According to the 2015 Behavioral Risk Factor Surveillance System data [2], and 2015-2010 National Health and Nutrition Examination Survey (NHANES) data [3], more than half of the total US population did not meet the recommendations for fruit and vegetable intake and exceeded the recommendation for added sugar. Eating behaviors can be impacted by many factors, including but not limited to age, gender, and socioeconomic status as well as ethnicity.

Hispanics are the largest ethnic minority group in the US. In 2015 the Hispanic population reached 56.6 million [4] constituting about 17.6% of the total US population [5]. It is estimated that Hispanics will constitute 24.8% of the total US population by 2035 [6] and 28.6% by 2060 [7, 8]. Hispanics have made and continue to make great contributions to the US in various areas, such as health, education, economy, and culture. However, they are disproportionately affected by unhealthy lifestyle behaviors (poor nutrition, lack of regular physical activity, tobacco use, and alcoholism), chronic disease intermediate risks (obesity, hypertension, high glucose levels and abnormal blood lipids), and chronic diseases (cardiovascular disease, diabetes, and cancer).

It has been documented that Hispanics in the US consume less healthy diets than other ethnic groups. For example, according to the data from the National Health and Nutrition Examination Survey (NHANES), Kirkpatrick et al. [9] found that fewer Hispanic adults in the US met the recommendations for dark green (1.1%) or starchy

vegetables (25.3%) compared with White (6.4%, 39.7%) and Black (6.8%, 39.4%) people. O'Neil et al. [10] reported that beverages contributed a greater percentage of added sugar for Hispanics (57.2%) than for Whites (41.7%). Hispanics also consumed more energy (9,587 kJ) than Whites (9,310 kJ) and Blacks (8,991 kJ).

These diet problems were reported as important risk factors for chronic diseases. Added sugar consumption contributes to the increased risk of cardiovascular disease mortality among US adults [3]. Sugar-sweetened beverages, which are the main source of added sugars in the US, are not only related to weight gain in adults but also type 2 diabetes mellitus and metabolic syndrome [11]. In a prospective cohort study among more than 50,000 women who were followed for 8 years, consuming more than one sugar-sweetened drink daily increased the relative risk for type 2 diabetes by 183%, compared with those who took less than one sugar-sweetened drink monthly [12].

However, diet also had positive effects on chronic disease. Previous studies have found various benefits of fruit and vegetable intake on chronic disease risk [13-15]. Multiple population-based epidemiological studies have helped to clarify the role of a healthy diet in the prevention of chronic disease. Bazzano et al. [16] explored the relationship between fruit and vegetable intake and the risk of cardiovascular disease among 25-74 year old adults who were free of cardiovascular disease at the time of baseline and were followed in the study. Researchers found that people consuming fruits and vegetables more than three times per day had 27% lower cardiovascular disease mortality compared with people consuming fruits and vegetables less than one time per day. Moreover, consuming fruits and vegetables three times per day was associated with

24% lower ischemic heart disease mortality compared with eating fruits and vegetables less than once per day [16].

It was reported that Hispanics were less likely than White people to have access to medical care and health insurance [17], which could lead to Hispanics being less likely to seek and receive health care and preventive services than non-Hispanics, and result in inadequate disease detection and management, poor health status, and high rates of morbidity and mortality [18]. For example, in 2013-2015 among US adults 18 years or older, the age-adjusted incidence of diabetes in Hispanics (8.4 per 1,000 persons) was higher than Whites (5.7 per 1,000 persons) [19]. Compared with Whites, Hispanics were 45% more likely to die from diabetes during 2010 [20]. Hispanics had higher prevalence of obesity than White peers (42.5% vs. 34.5%), and obesity prevalence among Hispanics has been increasing since 1999 [20].

In order to achieve a healthy diet and reduce the mortality and morbidity of chronic disease, there is a need for developing acceptable strategies for dietary behavior change, which are usually prevented by barriers. Identifications of barriers and facilitators to healthy eating can guide the implementation of strategies for eating behavior change, because most interventions aim to reduce or remove barriers and build up facilitation skills. Colón-Ramos et al. [21] conducted a Photovoice project to identify barriers and facilitators among Hispanic immigrant mothers living in a food swamp that was defined as a low-income neighborhood with high concentrations of convenience stores and fast-food outlets, saturated with unhealthy foods. They found that the divide between children's food preferences and parents' rules and preferences of eating was one of the common barriers. The high price for some healthy foods was another common

barrier, although parents could manage their budget and find less expensive alternatives for their family. Costs and personal taste preferences were two other barriers to healthy eating [22]. In a cross-cultural study, Musaiger et al. [23] explored perceived barriers to healthy eating (PBHE) and physical activity among adolescents and found that information, motivation, and enough time for preparation were main barriers to healthy eating. However, Most PBHE studies did not use a scale to measure perceived barriers of individuals [22-25]. Few studies have measured barriers to healthy eating by using a scale [26-28]. Janicke et al. [26] developed the Pediatric Barriers to a Healthy Diet Scale to assess healthy dietary barriers among overweight or obese children and adolescents. A "total barriers" score and subscale scores were provided to demonstrate how high the barriers were, which focused on the procedures of developing the questionnaire to assess barriers. Wang et al. [27] used the Barriers to Healthy Eating Scale to examine the perceptions of barriers to healthy eating on dietary intake for weight loss. They observed that by following a healthy eating plan, both barrier scores related to the emotions' group and daily mechanics' group could decrease from baseline to 6 months, but from 6 to 24 months the scores would increase slightly. They found that the decreased barrier scores could lead to energy and fat intake change, as well as to weight loss.

Parents' attitudes and knowledge of nutrition can effectively impact the eating behaviors of children, since children's healthy eating usually starts with parent role models, and children always watch and imitate adult behaviors. They can learn their parents' attitudes and healthy behaviors toward food. In the meantime, parents' unhealthy behaviors also impact children, so to avoid adverse influences on children, parents' unhealthy behaviors should be changed urgently. However, behavior change is difficult

due to many barriers existing in life that prevent individuals from behaving in accordance with their intentions. In order to change unhealthy behaviors, the discovery of perceived barriers to healthy eating among parents is very necessary.

Although there is some understanding of the role of perceived barriers on people's ability to adopt health-promoting dietary behaviors, most studies have focused on qualitative methods, among non-Hispanic population, or among different age groups [21, 23, 29, 30]. Limited studies have explored how socioeconomic factors are related to perceived barriers to healthy eating. In addition, there is a paucity of information regarding the barriers to healthy eating perceived by Hispanic parents of school-age children, and how such perceived barriers may be related to actual dietary intake. Therefore, the primary purpose of this study is to identify the barriers to healthy eating among parents of elementary-school aged children, assessed with a modified version of the Barriers to Healthy Eating scale, assess how socioeconomic factors are related to perceived barriers, and evaluate the relationships between PBHE and fruit, vegetable, and added sugar intakes.

**Research Aims**

The main objectives of the study were to identify the perceived barriers to healthy eating among parents of elementary school aged children by a newly modified scale, characterize their fruit, vegetable, and added sugar consumption, explore the relationships between perceived barriers and fruit, vegetable, and added sugar intake, and explore the relationship between sociodemographic characteristics and perceived barriers to healthy eating.

## Hypotheses and Specific Aims

### Specific Aim 1:

To explore the relationship between socioeconomic factors and the perceived barriers to healthy eating among parents of school-aged children.

### Research Question 1:

Are socioeconomic characteristics negatively associated with PBHE among parents of school-aged children?

**Hypothesis 1**: Household monthly income will be negatively associated with PBHE scores among parents of school-aged children.

**Hypothesis 2**: Education will be negatively associated with PBHE scores among parents of school-aged children.

**Hypothesis 3**: Employment status will be negatively associated with PBHE scores among parents of school-aged children.

### Study Aim 2:

To assess the relationship between the perceived barriers and healthy dietary intake among the parents of elementary-school aged children.

### Research Question 2:

Are high perceived barriers to healthy eating (PBHEs) negatively associated with healthy dietary intake among the parents of elementary-school aged children?

**Hypothesis 1**: PBHE scores will be negatively associated with fruit consumption among the parents of elementary-school aged children.

**Hypothesis 2**: PBHE scores will be negatively associated with vegetable consumption among the parents of elementary-school aged children.

**Hypothesis 3**: PBHE scores will be positively associated with sugar-sweetened beverage intake among the parents of elementary-school aged children.

**Hypothesis 4**: PBHE scores will be positively associated with sweetened foods intake (not including sugar-sweetened beverages) among the parents of elementary-school aged children.

**Hypothesis 5**: PBHE scores will be positively associated with added sugar intake among the parents of elementary-school aged children.

## Definition of Terms

Health disparities: Preventable differences in the incidence, prevalence, mortality and burden of disease and health issues occur in socially disadvantaged populations [31]. The populations are related to different factors such as ethnicity, gender, education, income and so on. The potential reasons for disparities are related to unequal distribution of medical, health, social, economic and political resources.

Chronic diseases: Chronic diseases are defined as the diseases that last or progress for a long time, which include obesity, type 2 diabetes, cardiovascular disease, cancer, and chronic obstructive pulmonary disease (COPD).

Perceived Barriers to Healthy Eating (PBHE): The concept of perceived barriers originally comes from the Health Belief Model in the 1950s [32]. The PBHEs are barriers that people perceive they have when trying to eat healthy, which is related to people's believed challenges to their ability to achieve healthy eating. PBHEs include individual, social, environmental, political and economic obstacles to healthy eating. PBHE is usually used to understand the factors that impact individuals' behaviors to adopt health measures.

Socioeconomic factors: The socioeconomic factors are also known as the dimensions of socioeconomic status (SES), which are related to individual's or family's social status and economic position, including education, income and occupation [33].

Healthy eating: According to the Dietary Guidelines for Americans 2015 -2020, healthy eating emphasizes consuming enough fruits, vegetables, whole grains, and low-fat milk products, and reducing added sugars, saturated fats, trans fats, cholesterol and sodium [34]. The healthy eating in this study includes enough fruit and vegetable intake and decreased added sugar consumption.

Added sugar: As defined by the FDA, added sugars are sugars that are put in foods during the preparing or processing of foods, which come from sugars in syrups and honey, and sugars in concentrated fruit and vegetable juices that are

not 100% fruit and vegetable juices. Added sugar in the diet mainly comes from sugar-sweetened beverages and sweetened foods [35].

Sugar-sweetened beverages: Sugar-sweetened beverages are defined as any liquids with added sugars, including sweetened soft drinks, sweetened fruit drinks, sweetened tea, sweetened coffee, sweetened coffee substitutes, sweetened water, nondairy-based sweetened meal replacements/supplements, sweetened flavored milk beverages, and sweetened yogurts.

Sweetened foods: Any foods, but not including any drinks, containing added sugar. Sweetened foods include sugar syrup, honey, jam, jelly, and preserves, sauces, sweets, candy, frosting or glaze, sweetened flavored milk beverage powder, ready-to-eat cereal (presweetened), flavored popcorn, frozen desserts, pudding and other miscellaneous desserts.

Secondary data analysis: Secondary data analysis involves the utilization of existing data for analyses with new methods or for analyses with other research hypotheses, but the person conducting the analyses can be either a research member who participated in the collection of data or a person who did not participate in collecting the data.

BMI: BMI is the abbreviation of body mass index, which is calculated by a person's weight in kilograms divided by the square of height in meters, or weight

in pounds divided by the square of height in inches with multiplication by the conversion factor of 703. BMI is an indicator of body fat that applies to adult men and women. Higher BMI indicates higher body fat.

Parent-child dyad: A parent-child dyad consists of one parent and one child as a dyad, which can achieve greater stability and strengthen emotional ties between parent and child.

**Limitations**

Even though this study aimed to explore the associations between perceived barriers and healthy diet intake among adults, this analysis was conducted in a cross-sectional fashion with baseline data from an intervention study, so it cannot identify causality or the temporal relationship between perceived barriers and dietary intake. The dietary recall bias was another limitation, since the accuracy of the information depended on the subjects' memory and the skill of an interviewer. There were some diet data and survey data that had potential outliers and were non-normally distributed. In addition, this study was limited to the population living in South Phoenix, and the majority of the participants were Hispanics, so the results of this study were mainly focusing on the Hispanic population.

To minimize the limitation of recall bias, participants were encouraged to record their daily diet and the interviewers were well trained. In addition, to increase the accuracy of the diet recall, the gold-standard method (24 h dietary recall) was used for diet assessment. The outliers were excluded from the study data, and data transformation

was used for non-normally distributed variables. Future research can expand to other groups of people in the US.

# CHAPTER 2

# REVIEW OF LITERATURE

## Sociodemographic data of Hispanics

### *Sociodemographic data of Hispanics in the United States*

According to the 2017 Census Data, Hispanics were the largest ethnic or racial minority group in the United States (US), and are a subgroup of the population that is growing very fast. In 2015 the Hispanic population reached 56.6 million [4] constituting about 17.6% of the total US population, and reached 57.5 million (about 17.8% of the total US population) as of July 2016 [5]. It is estimated that Hispanics will constitute 28.6% of the total US population by 2060 [5].

Hispanics live under disadvantaged socioeconomic conditions compared with their White counterparts. Among people ages 25 years and older, in 2016 there were 20% of Hispanics having a bachelor's degree or higher, compared with 39% of Whites. Nearly 26% of Hispanics in the labor force did not have a high school diploma, compared with 8% of White people [36]. The employment-population ratio and the unemployment rate were 62.0% and 5.8% for Hispanics in 2016, which were similar to that of Whites (60.2%, 4.3%) [36, 37]. However, 57.3% of Hispanics worked on unskilled and high-risk jobs, such as services, production, transportation, material moving, construction, and maintenance occupations, compared to 37.9% of Whites [36]. The median weekly income of full-time jobs for Hispanics in 2016 was $663, which was relatively lower than that of Whites ($862/week) [36].

### *Sociodemographic characteristics of South Phoenix, Arizona*

The South Phoenix area is encompassed by the area located west of 48th Street, east of 27th Avenue, south of Salt River, and north of South Mountain. South Phoenix is an underrepresented area with a predominant percentage of Hispanic residents. Nearly 30% of Arizona's population is Hispanic, following New Mexico (46.3%), California (37.6%) and Texas (37.6%) [17, 38]. Hispanics constitute about 40% of the total population in Phoenix, Arizona [39], but Hispanics make up about 60.3% of the total population in South Phoenix [40].

Compared to the entire population in Arizona, people in the South Phoenix area live under low socioeconomic conditions. For example, in 2015 the median yearly household income in the South Phoenix area ($42,100) was lower than that in Arizona ($49,800). Furthermore, people in the South Phoenix area were less likely to be employed (52.3% vs. 54.0% in Arizona) and to have a high school diploma or higher degree (68.5% vs. 85.7%) [41].

In summary, residents of the South Phoenix area, particularly those of Hispanic descent, live under disadvantaged socioeconomic conditions likely to negatively impact health and health outcomes as outlined below.

## Health Disparities in the Hispanic Population

### *Unhealthy lifestyle behaviors regarding diet, physical activity, and other lifestyle behaviors among Hispanics*

Hispanic individuals are disproportionately affected by the most common unhealthy lifestyle behaviors, including poor nutrition, lack of regular physical activity, tobacco use, and excessive alcohol. It has been documented that Hispanics in the US

consume less healthy diets than other ethnic groups. According to the data from the National Health and Nutrition Examination Survey (NHANES), Kirkpatrick, et al. [10], found that fewer Hispanic adults in the US met the recommendations for dark green (1.1%) or starchy vegetables (25.3%) compared with White (6.4%, 39.7%) and Black (6.8%, 39.4%) people. O'Neil et al. [11] reported that beverages (57.2%) contributed a greater percentage of added sugar for Hispanics than for Whites (41.7%). Hispanics also consumed more energy (9,587 kJ) than Whites (9,310 kJ) and Blacks (8,991 kJ) [11].

Regarding physical activity, fewer Hispanic adults (33.4%) meet the 2008 Physical Activity Guidelines for Americans of at least 150 min/week moderate-intensity activity or equivalent for substantial health benefits, or at least 150 min/week vigorous-intensity activity or equivalent for extensive health benefits, compared with White adults (47.6%) [42]. Moreover, fewer Hispanic than White adults participate in regular moderate physical activity (23% versus 35%) [43]. Moreover, immigrant Hispanic children had a higher level of physical inactivity and sedentary behaviors, compared to native children [44].

In contrast to other lifestyle behaviors, the incidence of tobacco use among Hispanic adults in the US was 20.9%, compared to 28.5% of the other ethnic groups [17]. In addition, Hispanics were less likely than Whites to drink excessive alcohol [17]. However, Hispanic people who choose to drink were more likely to intake more alcohol than White people were. For example, 42.4% of past-year drinkers drank 4+/5+ drinks on an occasion among Hispanics, compared to 31.6% of that among Whites [45].

*Health risks of Hispanics*

Unhealthy lifestyle behaviors may result in higher levels of intermediate risks for chronic diseases including obesity, high blood pressure, high glucose levels and abnormal blood lipids [46]. Overall, the prevalence of obesity among US adults was 36.5% during 2011 to 2014. The middle age adults (40 to 59 years old; 40.2%) had a higher prevalence of obesity than the younger adults (20 to 39 years old; 32.3%), during 2011-2012 [47]. Hispanics in the US are disproportionately affected by obesity. During 2011 to 2012, the prevalence of obesity was higher among Hispanics than Whites (39.0% vs 26.2%, aged 20-39) [48]. Hispanic women aged 20-39 (35.8%) had a higher prevalence of obesity than White women aged 20-39 (27.8%) [49]. Hispanic men aged 20-39 (42.0%) had a higher prevalence of obesity than White men aged 20-39 (24.6%) [49].

According to data from NHANES and the National Health Interview Survey (NHIS), overall, the prevalence of hypertension among US population was 20.5% during 2009-2012. The prevalence of hypertension among Hispanics was 16.8%, with lower rates of awareness (77.7%), treatment (69.6%), and control (40.7%) relative to Whites (81.4%, 7.6%, and 56.3%, respectively) [50].

Base on a CDC report, the age-adjusted prevalence of prediabetes among Hispanic adults aged ≥18 years (31.7%) was comparable to that of White adults (31.5%). However, fewer Hispanic people (7.5%) reported awareness of prediabetes than White people (11.3%) [51]. Moreover, 13.3% of Hispanic people had elevated total cholesterol, compared to 12.7% of White people.

*Disparities of chronic disease among Hispanics*

The intermediate risk factors mentioned above make people susceptible to many chronic diseases, including cardiovascular disease (CVD), diabetes, cancer, and chronic respiratory diseases.

CVD refers to a cluster of diseases that affecting the heart and circulatory system, including coronary heart disease (CHD) and stroke. According to a report from the American Heart Association [52], the prevalence of CVD among adults (age ≥ 20 years) was 36.6% during 2011-2014. Many of these people were expose to risk factors of behaviors, including unhealthy diet and inadequate physical activity. In 2014, there were 807,775 deaths due to CVD in the US. Overall, the prevalence rate of CVD for Hispanics was 8.3%, compared to Whites (11.1%). However, the prevalence rate of CHD for Hispanic women (5.9%) was higher than White women (4.6%). Among Hispanics rates of awareness of the warning signs of heart disease were 14%, compared to 30% of Whites [53]. The rates for hospitalization for heart attack when they were in elder age among Hispanic males and females (427.4 per 100,000 people, and 606.1 per 100,000 people) were higher than that among White males and females (276.9 per 100,000 people, and 502.6 per 100,000 people) [53].

Among US adults 18 years or older, the age-adjusted incidence of diabetes in Hispanics (8.4 per 1,000 persons) was higher than Whites (5.7 per 1,000 persons) during 2013 to 2015 [8]. The rate of diagnosed diabetes in people aged 20 years or older was 12.8% for Hispanics and 7.6% for Whites [17]. Compared with Whites, Hispanics were 45% more likely to die from diabetes than White peers during 2010 [9]. As CDC reported, cancer and heart disease were the top causes of death among Hispanics [54].

Given the increasing disadvantaged conditions that various underlying health risks lead to high prevalence of chronic diseases of Hispanics, if present health risks and problems keep increasing, the US health care system will have a very large number of Hispanic patients suffering from chronic diseases. Thus, health promotion and community-based intervention need to be done to address these problems.

## The importance of healthy dietary intake on chronic disease

### *Fruit and vegetable intake and chronic disease*

Earlier population-based epidemiological studies have helped to clarify the role of a healthy diet in the prevention of chronic disease. Bazzano et al. [16] explored the relationship between fruit and vegetable intake and the risk of CVD among 25-74 year old adults who were free of CVD at baseline. After an average of 19-year follow-up, researchers found that people consuming fruit and vegetable more than three times per day had 27% lower CVD mortality compared with people consuming fruit and vegetable less than one time per day. Moreover, consuming fruit and vegetable three times per day was associated with 24% lower ischemic heart disease mortality compared with the case of less fruit and vegetable consuming (< 1 time/d) [16]. Thus, this study demonstrated that increasing fruit and vegetable intakes can help people preventing CVD, and reduce the mortality of CVD.

Vegetables are an important source of dietary fiber that can increase satiety and reduce energy intake to prevent obesity. In contrast, fruits were usually considered as one of the sources of sugar, especially glucose, sucrose, and fructose, which were believed to induce obesity. However, there were intervention randomized clinical trials (IRCT) and

prospective observational studies and cross-sectional studies that proved the anti-obesity effects of fruits. Fujioka et al. [15] conducted IRCT in American obese people. They found that after 12 weeks' intervention, the fresh grapefruit group (lost 1.6 kg), the grapefruit juice group (lost 1.5 kg), and the grapefruit capsule group (lost 1.1 kg) lost significantly more weight than the placebo group (lost 0.3 kg). Buijsse et al. [55] reported that high fruit and vegetable intakes were related to the decrease of the risk of weight gain through a prospective observational study. In a cross-sectional study, Moreira and Padrão [56] observed that fruit intake was negatively associated with body weight.

Since most fruits and root vegetables contain many sugars, people with diabetes are often advised to limit consumption of these foods, which led to paradoxical effects of fruits and vegetables on diabetes. A meta-analysis from Carter et. al. [14] concluded that people who had more green leafy vegetables were less likely to develop type 2 diabetes. However, there were no significant relationship between the incidence of type 2 diabetes and the consumption of vegetables only, fruits only, or fruits and vegetables combined. Cooper et. al. [57] found that the hazard ratio for comparing the high fruit and vegetable intake and low fruit and vegetable was 0.90. People with higher fruit intake were less likely to develop to type 2 diabetes (hazard ratio: 0.89). Among the subtypes of fruits and vegetables, root vegetables (hazard ratio: 0.87) and green leafy vegetables (hazard ratio: 0.84) was inversely associated with diabetes.

*Added sugar intake and risk factors of chronic disease*

Added sugars are found primarily in sugar-sweetened beverages, such as soft drinks, sports drinks and other sweetened drinks, as well as in sweetened foods, such as

candy, desserts and other presweetened foods. The World Health Organization recommended that added sugar constitute less than 10% of total calories [58]. The recommendation of added sugars from the American Heart Association was less than 100 calories per day for women and 150 calories per day for men [59]. Over the past three decades, US adults increased more than 30% added sugar consumption. As the United States Food and Drug Administration reported, in 1977, only 228 calories per day of added sugar consumption by American adults, and it increased to 300 calories per day in 2009-2010 period [60]. This increase was mainly attributed to the consumption of sugar-sweetened beverages. As Yang et. al. [3] reported, most of adults consumed added sugar more than 10% of total calories, and 10% of adults consumed added sugar more than 25% of total calories during 2005 to 2010.

Consumption of added sugars directly leads to excessive energy intake and reduce nutrient density, both of which are typically associated with an increased risk of obesity [61]. In an ecological analysis, Siervo et. al. [62] conducted a multivariate regression model for the association between sugar consumption and obesity. The results showed that at a global level sugar consumption was significant related to obesity. Another cross-national study reported that 1% increase of soft drink consumption was associated to a rise of 2.3 obese adults per 100 people, and an increase of 48 overweight adults per 100 people over the world among 75 countries [63]. Bray and Popkin [64] concluded that the consumption of sweetened beverages increased the epidemic of obesity, and avoiding soft drinks could reduce weight gain. Therefore, added sugar intake is a potential risk for the high prevalence of obesity.

Added sugar consumption contributed to the increased CVD mortality risk among US adults [3]. Moreover, Stanhope et. al. reported that there were positive dose-response effects of sugar-sweetened beverage and the risk of cardiovascular mortality [65]. People who consumed higher percentage (17% to 21%) of calories from added sugar were more likely (38% higher) to die from CVD than people who consumed lower percentage (8%) of calories from added sugar. Furthermore, people who consumed more than 21% of calories from added sugar had more than 70% of relative risk of CVD, compared to people who consumed 8% of calories from added sugar [3].

Sugar-sweetened beverages, which were the main source of added sugars in US, were not only related to weight gain and CVDs in adults but also Type 2 Diabetes Mellitus and metabolic syndrome. Malik et. al. [11] did a meta-analysis for sugar-sweetened beverage and type 2 diabetes and metabolic syndrome including 11 studies with total 310,819 participants and 15,043 cases of type 2 diabetes. They found that type 2 diabetes incidence was 26% greater among people who had more than 1-2 servings/day of sugar-sweetened beverages, compared to people who consumed less than 1 serving/month. In another prospective cohort study among more than 50,000 women who were followed for 8 years, consuming more than one sugar-sweetened drink daily increased relative risk of type 2 diabetes by 183%, compared with those who took less than one sugar-sweetened drink monthly [12].

In summary, the healthy dietary consumption, especially fruit, vegetable, and added sugar intake, play an important role in preventing health risks for reducing the prevalence of nutrition-related chronic diseases.

## Dietary Guidance

*2015-2020 Dietary Guidelines for Americans*

The 2015 Dietary Guidelines for Americans [34] were developed by the US Department of Health and Human Services and the US Department of Agriculture to provide science-based advice for health promotion and reduce the risk of chronic disease through diet and physical activity. The 2015-2020 Dietary Guidelines include five overarching guidelines that encourage individuals to follow a healthy eating pattern, to focus on a variety of nutrient dense foods in recommended amounts, to limit the consumption of added sugars, saturated fats, and sodium, to make shifts in healthier food and beverage choices, and to support healthy eating patterns for all Americans. In addition, there are a number of key recommendations further supporting the five Guidelines. The 2015 Dietary Guidelines for Americans recommends individuals consuming a healthy eating pattern, which includes a variety of vegetables (2.5 cup-equivalents/day for a 2000 calorie diet), fruits (2 cup-equivalents/day for a 2000 calorie diet), grains (6 oz-equivalents/day for a 2000 calorie diet, ≥3 oz-equivalents/day for whole grains), fat-free or low-fat dairy (3 cup-equivalents/day for a 2000 calorie diet), protein foods (5.5 oz-equivalents/day for a 2000 calorie diet), and oils (27 g/day). A healthy eating pattern limits saturated (<10% of calories/day) and trans fats (as low as possible), added sugars (<10% of calories/day), sodium (<2,300 mg/day), and alcohol (≤ one drink/day for women; ≤ two drinks/day for men). In addition, individuals should meet the Physical Activity Guidelines for Americans [66] (≥150 min/week moderate-intensity activity or equivalent for substantial health benefits, or ≥150 min/week vigorous-intensity activity or equivalent for extensive health benefits).

*MyPlate*

MyPlate [67] was published by The US Department of Agriculture to guide people creating a healthy meal, by using a plate icon to picture what food groups to put on your plate and the relative portion size. MyPlate was designed to be a visual representation of diet when conforming to the Dietary Guidelines. Myplate constitutes of five food groups, including grains (about 30% of the plate), protein (about 20% of the plate), fruits (about 10% of the plate), vegetables (about 40% of the plate), and dairy (a cup of milk or yogurt). Each food group is color coded, including orange for grains, red for fruits, green for vegetables, purple for protein, and blue for dairy, which has different nutrients and provides different health benefits for now and in the future. The grain section mainly provides carbohydrate and dietary fiber, which is about a quarter of your plate. People should make at least half of the grains whole grains, such as whole-wheat flour, oatmeal and brown rice, which have lots of dietary fiber, minerals and B vitamins, and eat less refined grains that are processed to remove dietary fiber, minerals and many B vitamins. Even though most refined grains are enriched with some B vitamins and iron, fiber is not added back after processing. Half of your plate should be fruits and vegetables. It is necessary to choose a variety of vegetables from different subgroups, including dark-green vegetables (like broccoli, kale, and spinach), red and orange vegetables (like carrots, tomatoes, and sweet potato), beans and peas (like soy beans and black-eyed peas), starchy vegetables (like corn and white potatoes), and other vegetables (like celery, onions and cucumbers). The fruit section of MyPlate is slightly smaller than vegetable section, but the combination of fruits and vegetables should fill half of your plate, and

focusing on whole fruit is the best choice. The protein foods should be about a quarter of your plate. It is important to select protein foods from different sources, such as seafood, low-fat meat and poultry, beans and peas, and nuts. Dairy products are rich in calcium, including fluid milk products, food made from milk (like cheese and yogurt), and soymilk. In addition, MyPlate recommends individuals to focus on the variety, amount, and nutrition of foods, to limit consumption of saturated fat, sodium, and added sugars, to make small changes of healthier food choices, and to support healthy eating for all.

*American Heart Association's diet and lifestyle recommendations*

The American Heart Association (AHA) have published guidelines in 2006 [68] for reducing the risks of cardiovascular disease (CVD) by improving diet and lifestyle for general public. The specific diet and lifestyle goals for preventing CVD are to consume a variety of healthy diet from all the food groups, to keep a healthy body weight, to achieve a desirable lipid profile, blood pressure and blood glucose level, to be physically active, and to avoid tobacco exposure and use. For reducing the risk of CVD, AHA recommends that all adults should achieve or maintain an appropriate body weight by balancing calorie intake and physical activity; consume a variety of fruits and vegetables, foods rich in whole-grain and high-fiber, fish (≥ 2 times/week); limit saturated fat (<7% of calories/day), trans fat (<1% of calories/day), and cholesterol (<300mg/day) by selecting lean meats, vegetables, fat-free or low fat dairy, and avoiding partially hydrogenated fats; minimize added sugars, salt and alcohol; follow the AHA recommendations when you eat out.

*American Diabetes Association's dietary recommendations*

As American Diabetes Association (ADA) [69] recommended, lifestyle management is the foundation of diabetes care, and nutrition therapy plays an important role in the treatment plan to determine what healthy eating pattern for individuals with diabetes. For diabetic patients, the macronutrient distribution should be individualized and there is not an ideal one but people should keep energy balance and metabolic goals in mind. For all the individuals with diabetes, the consumption of refined carbohydrates and added sugars should be replaced with foods higher in fiber and lower in glycemic load, such as whole grains, legumes, fruits and vegetables. Diabetic patients are strongly discouraged to consume sugar-sweetened beverages and processed foods with high amounts of refined grains and added sugars. Overweight or obese patients are recommended to reduce energy intake. All the patients should take medical nutrition therapy; follow carbohydrate recommendations by focusing on foods with higher fiber and lower in glycemic load; take fruits, vegetables, whole grains and dairy products to replace refined and processed carbohydrates; take a variety of eating patterns, like Mediterranean diet, Dietary Approaches to Stop Hypertension (DASH), and plant-based diets; avoid added sugar intake; limit sodium intake (2300 mg/d).

*Dietary Reference Intakes*

The Dietary Reference Intakes (DRIs) [70] are a set of nutrient reference values used to guide nutrient intakes of healthy people, which mainly include Estimated Average Requirement (EAR), Recommended Dietary Allowance (RDA), Adequate Intake (AI), Tolerable Upper Intake Level (UL), and Acceptable Macronutrient

Distribution Range (AMDR). The value of EAR is estimated to meet the nutrient needs of 50% healthy people. The value of RDA meet the nutrient needs of 97%-98% healthy people. The AI is a recommended average daily nutrient intake level, which is determined by observation or experiments based on the nutrient intake levels of healthy people. When RDA is not available, the AI will be used. For example, the RDA for Vitamin C is 90 mg/d and 75 mg/d for men and women 19 through 50 years of age, respectively. The AI for total fiber is 38 g/d and 25 g/d for men and women 19 through 50 years of age, respectively. The UL is the maximum daily nutrient intake level that is unlikely to cause adverse health effects. The AMDR is the range of macronutrients intakes expressed as a percentage of total energy intake, which is developed to help reduce risks of chronic disease and provide adequate essential nutrients. The AMDR was set for carbohydrate at 45-65% of daily calories, for fat at 20-35% of daily calories, and for protein at 10-35% of daily calories, which means 45-65%, 20-35%, and 10-35% of energy intake should come from carbohydrates, fat and protein, respectively.

In conclusion, adoption of these recommendations together can contribute to achieve healthy eating and reduce chronic diseases.

## Factors influencing healthy eating behaviors

### *Influence of socioeconomic factors on healthy eating*

Socioeconomic status (SES) has an important influence on healthy eating among Hispanics living in the US. Dubowitz et. al. [71] reported that neighborhood SES was positively associated with fruit and vegetable intake. Using data from the Third National

Health and Nutrition Examination Survey they found that higher education, higher family income were associated with higher fruit and vegetable intake. For Mexican-Americans, a one standard deviation increase in the neighborhood SES, the consumption of fruit and vegetables increased about 2 additional servings per week [71]. Estaquio et al. [72] found that French middle-aged adults with higher education level had more variety of vegetable consumption than those adults with lower education level. Similar results found in Australia, people with higher education level consumed more fruit and vegetable, compared with people with lower education level [73].

Moore et al. [74] reported that the low-income neighborhoods had more grocery stores and less supermarkets than high-income neighborhoods. The low-income areas had fewer healthy foods stores than the richer areas. Socioeconomic factors could influence diet intake through the quantity and quality of food stores and restaurants in the area, which could, in turn, determine access to healthy foods, the availability of fresh products, the affordability of nutritious foods, the variety of healthy food options and the ease of transportation to grocery stores. The employment usually impacts on people's time management of diet. People with high employment status are usually full-time employed in managerial or professional occupations, and they are busy with their work, so they are more likely to spend less time on healthy diet. Mishra et al. [73] reported that among Australian male adults, people with high employment status had less consumption of fruit and vegetables than unemployed, or part-time employed people, or people in manual occupations. In the meantime, the employment status of women was associated with vegetable consumption. Thus, based on the above review, no matter neighborhood SES or personal SES were closely related to healthy eating.

*Influence of acculturation on healthy eating among Hispanics*

It has been well recognized that Hispanics change their diet as a result of migration. Higher acculturation has been associated with lower dietary quality [75]. According to NHANES data, adults who were born in Mexico were more likely to consume a healthy diet than adults who were born in the US, which included a higher consumption of fruit and vegetables, and a lower consumption of desserts than adults born in the US [75]. With greater acculturation, there is an ongoing transition from traditional diet to adoption of US dietary patterns that were characterized by high in fat and low in fruits and vegetables. Dixon et al. [76], based on the NHANES data, reported that more Mexican-American who born in Mexico met the dietary guidelines of nutrients intake than those who born in the US. Neuhouser et al. [77] examined the associations of diet with acculturation among Hispanics. They reported that dietary patterns varied by acculturation status. Highly acculturated Hispanics consumed fewer fruit and vegetable per day, compared with those who were not highly acculturated, which meant Hispanics were changing their dietary practices as they acculturate. The Hispanics with higher acculturation were more likely to consume sugar sweetened beverage than Hispanics less acculturated. Belinda et al. [78] reported that among first-generation Hispanic immigrants, bilingual people were less likely to eat healthy than people who preferred to speak Spanish. For example, they were more likely to consume fruit, vegetable, wholegrain breads, beans, and steamed chicken or fish. Among second-generation Hispanic immigrants, people who preferred to speak English were more likely to have an unhealthy eating pattern which included Fried foods, frozen desserts, candy, processed

meats, and sweetened drinks, compared to people who preferred to speak Spanish. Overall, Hispanics who are more adapted to US culture or who have resided in the US for a longer time are more likely to have their eating patterns more similar to the US residents.

**Perceived barriers to healthy eating (PBHE)**

In order to achieve the healthy diet and prevent chronic disease, health-promoting dietary behavior change is essential. However, dietary behaviors are difficult to change due to many barriers existing in life that prevent individuals from behaving in accordance with their intentions. Thus, identifications of barriers and facilitators to healthy eating could guide eating behavior change, because most interventions aim to remove or overcome barriers and build up facilitation skills. The concept of perceived barriers was associated with the Health Belief Model (HBM) that was first developed by Godfrey Hochbaum [32] for explaining and predicting preventive health behavior in 1950s. The perceived barriers were defined as one's opinion of the tangible and psychological costs of the desired action, which were related to inconvenient, expensive, unpleasant, painful or upsetting. The most common barriers to lifestyle behaviors, such as healthy eating, physical activity and smoking cessation, were related to personal, environmental and social components.

*Personal component of perceived barriers*

First of all, socioeconomic status was one of the personal components related to barriers to healthy eating. Musaiger et. al. [23] suggested that the variation in barriers to

healthy eating might be caused by the differences in socioeconomic factors, culture, and the prevalence of the disease. However, this hypothesis had not been proved in that study. López-Azpiazu et. al. [79] reported that income levels were associated with perceived barriers related to irregular work hours, unappealing food, busy lifestyle, price of healthy foods and give up foods. For example, the percentage of respondents who selected "unappealing food", "price of healthy foods", and "give up foods" as their PBHE decreased as the income levels increased. By contrast, the percentage of respondents who selected "irregular work hours" and "busy lifestyle" as their barriers to healthy eating increased as the income levels increased. In addition, educational levels were related with perceived barriers for irregular work hours, unappealing food, busy lifestyle, and no difficulty. More people with higher educational levels selected "irregular work hours" and "busy lifestyle" as their perceived barriers. In contrast, more subjects with lower educational levels mentioned "unappealing food", and "no difficulty" as the perceived barriers. The employment status for work, unemployed, student and retired were associated with PBHE. The working people were significantly related to the perceived barrier of "irregular work hours". The students were significantly associated with perceived barriers of "busy lifestyle". The "no difficulty" was the perceived barrier for retired people. The "unappealing food" was selected as the perceived barriers among unemployed subjects. Colón-Ramos et. al. [21] conducted a Photovoice project to identify barriers and facilitators among Hispanic immigrant mothers living in a food swamp. They found that the divide between children's food preferences and parent's rules of eating was one of the common barriers. In a cross-cultural study, Musaiger et al. [23] explored PBHE and physical activity among adolescents, and found that lack of

information, lack of motivation, and lack of enough time for preparation of healthy meals were main barriers to healthy eating.

*Environment component of perceived barriers*

Environment components of PBHE are usually related to the availability of and price of healthy foods. Mackenbach et al. [80] explored the interactions of perceived barriers and neighborhood environment in Europe. They found that low presence of supermarkets, high presence of fast food restaurants were associated with unhealthy eating, such as low vegetable and fish consumption, as well as high sweets, sugar sweetened beverage and fast food consumption, among the people who had more barriers [80]. In a community survey, Sari et al. [81] also found that the lack of access to healthy foods, and high price for health foods were important PBHE. In addition to the neighborhood environment, poor home food environment was an important barrier, especially among children and adolescents. Nicole et al. [82] had reported that among the adolescent participants, the household availability of fruit and vegetable was positively associated intake of those foods. The household availability of soft drinks was negatively associated with dairy intake.

*Social support component of perceived barriers*

Social support barriers usually encompass lack of support from family, friends or peers. Family member's eating habits can influence people's diet consumption. Nicole et al. [82] found that parental modeling and support was positively related to children's fruit, vegetable and dairy intake. The eating behaviors of children and adolescents also can be

influenced by peers and friends [83]. Sari et al. [30] reported that lack of peers' support, children's support and friends' were perceived as barriers to healthy eating by 18-32 years young women. In addition, social media also impact unhealthy diet intake among children [84]. Television experience in childhood was associated to unhealthy diet in early adulthood.

Most PBHE studies did not use a scale and not yield a total score and subscores to measure the barriers of individuals [22-25]. Few studies measured barriers to healthy eating for improving health by a scale [26-28]. Janicke et al. [26] developed the Pediatric Barriers to a Health Diet Scale to assess healthy dietary barriers among overweight or obese children and adolescents. A total barriers score and subscale scores were provided to demonstrate how high the barriers were, which focused on the procedures of developing the questionnaire to assess barriers. Wang et al. [27] used Barriers to Healthy Eating Scale to examine the perceptions of barriers to healthy eating on dietary intake for weight loss. They observed that by following a healthy eating plan, both barrier scores related to emotions' group and daily mechanics' group could decrease from baseline to 6 months, but from 6 to 24 months the scores would increase slightly. They found that the decreased barrier scores could lead to energy and fat intake change, as well as weight loss. However, Wang et al. did not report which barriers are related to healthy eating on diet.

People commonly face many barriers including intrapersonal, interpersonal, and environmental barriers that prevent people from eating healthy. It is very important to identify why people failed to adopt a healthy diet, and take relevant strategies to address them to achieve the healthy eating goal.

## Conclusion

Disparities in chronic disease are very common in the US. Studies have consistently reported that Hispanics are more likely to be affected by risk factors for chronic disease [48, 51]. Healthy eating can prevent people from chronic disease. However, many US people failed to follow a healthy eating diet. Specifically, Hispanic people are disproportionately affected by unhealthy eating behaviors. It has been documented that Hispanics in the US consume less healthy diets than other ethnic groups [10]. Improving healthy eating is an important target for health implementation and health promotion. However, dietary behaviors are difficult to be changed due to many barriers existing in life that prevent individuals from behaving in accordance with their intentions. Identifications of barriers to healthy eating can benefit to dietary change. However, most of the previous studies qualitatively identified the barriers or among different population [22-25]. Few studies have explored how socioeconomic factors are related to perceived barriers. Limited studies have linked the value of perceived barriers to dietary intake to explore the relationships between perceived barriers and healthy eating. Therefore, the purpose of this study is to identify the PBHE among Hispanic parents of children by a newly modified scale, how socioeconomic factors are related to perceived barriers, and the relationships between PBHE and fruit, vegetable, and added sugar.

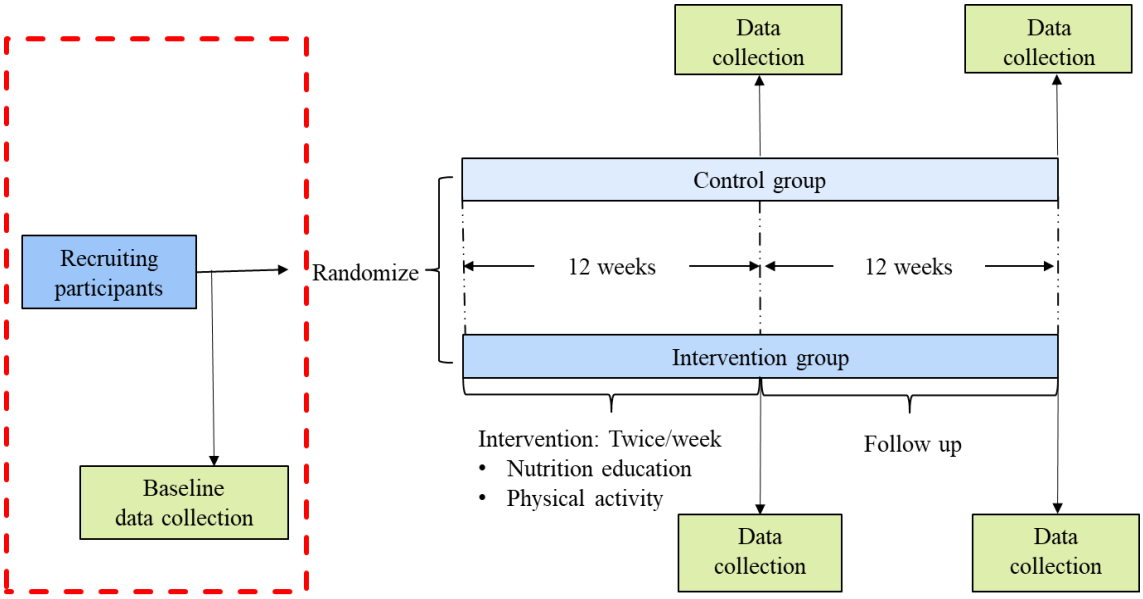
# CHAPTER 3

# MATERIALS AND METHODS

## Study design

This study was a secondary data analysis using baseline data from the Athletes for Life (AFL) project, please see Figure 1 below. AFL is an ongoing randomized controlled trial conducted in South Phoenix, Arizona. The purpose of this trial is to evaluate the effects of a 12-week community-based and theory-driven nutrition and physical activity intervention on cardiovascular fitness, physical activity behavior, fruit and vegetable intake, and daily sugar intake among elementary school aged children and their parents. For purposes of this analysis only the baseline data from adult participants was used, and the subsequent description of methods only includes procedures conducted during the baseline data collection (prior to randomization) related to the adult variables used for this analysis. The study was approved by the Institutional Review Board at Arizona State University (Appendix A).

Figure 1: The Framework of Athletes for Life (AFL) Project




This study only focused on the part that was marked by dash line.

**Participants**

Participants included parent-child dyads based on the following criteria: age 6-11 y for children and >18 y for parents, and speaking English or Spanish, living in the South Phoenix area. Exclusion criteria were: participant, either child or parent, has a mental or physical condition that is contraindicated to participation in sports, and eligible adults who are currently pregnant. Per request of our community partners, ethnicity was not an inclusion/exclusion criterion. However, a majority of the participants (85%) were of Hispanic descent. All participants were given a thorough description of the project, were given an opportunity to have questions related to the study clarified, and provided written consent prior to enrollment in the study (Appendix B).

Out of 175 individuals who consented for AFL, complete survey data were available for 149 participants, and diet data were available for 136 participants.

**Recruitment and consenting**

Participant recruitment occurred mainly in the South Phoenix area, Arizona, through distributing and posting flyers to schools, churches, South Mountain Community Center and other gathering places, and through word of mouth via prior study participants. Trained researchers gave potential participants a screening call or talked with them in person to determine their eligibility. After the eligibility of subjects was confirmed, a consenting meeting was scheduled at the participants' home, during which the study purposes and procedures were explained in detail. Participants were encouraged to ask questions related to the study and the consent form. Children were informed that they had the right to refuse to participate in the program. After written consent was obtained, a copy of the consent form was given to all adult participants. Data collection started immediately after consenting took place (see below). This document only described data collection relevant to the analyses related to the research questions proposed for this thesis.

**Data collection**

Survey data were collected through in-person interviews completed by trained bilingual research staff in English or Spanish based on the preference of participants. Baseline data collection included a survey, and at least two 24 h diet recalls collected via telephone on one weekday and one weekend day within the same week. The first two

cohorts, including 53 participants, had the recalls on two weekdays and one weekend day within the same week. We randomly selected one weekday out of the two weekdays, and used in diet analysis.

**Survey**

The baseline survey included questions related to sociodemographic information, and barriers to healthy eating as follows. Demographic variables included age, gender, marital status, number of children and adults in the household, and ethnicity. Socioeconomic variables included employment status, household's monthly income, and education.

**Perceived barriers to healthy eating (PBHE)**

The PBHE were measured using a modified version of the PBHE Scale (Appendix C). The original version of the scale focused on barriers to healthy eating for weight loss [27]. Given that for the current study the focus was on healthful eating instead of weight loss, the scale was modified to focus on perceived barriers to following a healthful diet. For example, the previous description of "lose weight" was replaced by the new statements of "improve diet" or "eat healthy". One question specifically related to fruit and vegetable consumption was also added to the scale: "changing my diet to increase fruits and vegetables seems too complicated". Answers were scored on a 1- to 5-point scale based on the participant's perception of the extent to which each factor made it difficult for the respondent to follow healthy eating habits. For example, QUESTION 1: Appropriate foods are not available in my home. One point indicated that the factor was

not at all a problem for healthy eating, whereas five points indicated that the given factor was a very important problem or barrier for the respondent. The modified PBHE scale consisted of 23 questions, with answers based on a 1- to 5-point scale, and a total possible score ranging from 23 to 115. The questionnaire had 3 subscales, including emotions (12 items; possible 12-60 points), daily mechanics of following a healthy eating plan (8 items; possible 8-40 points), and social support (3 items; possible 3-15 points). A higher score indicated greater PBHE for participants.

**Diet assessment**

Dietary intake was assessed by two telephone-administered 24 h dietary recalls reflective of one weekend day and one weekday, which were entered and analyzed using the Nutrition Data System for Research (NDSR) software developed by the University of Minnesota [85]. Trained bilingual staff collected recalls by phone from each participant adult. The two-dimensional Food Portion Visual was used to assist the illustrations of portion sizes. The consumption of added sugar and energy from all sources was reported in the Food File by the NDSR Output File 4. The NDSR calculates added sugars in two different way, added sugars (by available carbohydrate), and added sugars (by total sugars). The added sugars (by available carbohydrate) include all the carbohydrates added into food as a caloric sweetener, which include monosaccharides, disaccharides and polysaccharides. Added sugars (by total sugars) include all the sugars added in to food as caloric sweeteners, which only include monosaccharides and disaccharides. Since this study did not involve any nutrients, the added sugars (by total sugars) was used. The serving count of food groups (fruit, vegetable, sugar sweetened beverages, and sweetened

foods) were reported by the Serving Count Food File (NDSR Output File 9). The consumption of sugar-sweetened beverages was obtained from the Serving Count Food File by NDSR Output File 9 (see Table 1). The sweetened foods were summed by the items listed in Table 1. The consumption of all sources of fresh fruit included 100% citrus juice, 100% fruit juice excluding citrus juice, citrus fruit and fruit excluding citrus fruit and avocado and similar. Consumption of all sources of fresh vegetable was determined by summing subgroup category serving counts of dark-green vegetables, deep-yellow vegetables, tomato, white potatoes, other starchy vegetables, legumes, other vegetables and 100% vegetable juice.

Table 1. Food groups and subgroups for diet assessment

| **Food Group** | **Subgroup ID** | **Subgroup Name** |
|---|---|---|
| Sugar-Sweetened Beverage | | |
| | BVS0400 | Sweetened soft drinks, |
| | BVS0300 | Sweetened fruit drinks, |
| | BVS0500 | Sweetened tea, |
| | BVS0100 | Sweetened coffee, |
| | BVS0200 | Sweetened coffee substitutes, |
| | BVS0600 | Sweetened water, |
| | BVS0700 | Nondairy-based sweetened meal replacement/supplement, |
| | DML0300 | Sweetened Flavored Milk Beverage Powder with Non-fat Dry Milk |
| Sweetened Foods | | |
| | SWT0400 | Sugar |
| | SWT0500 | Syrup, honey, jam, jelly, and preserves |
| | SWT0700 | Sauces, Sweet - Regular |
| | SWT0800 | Sauces, Sweet - Reduced Fat/Reduced Calorie/Fat Free |
| | SWT0100 | Chocolate Candy |
| | SWT0200 | Non-chocolate Candy |
| | SWT0300 | Frosting or Glaze |
| | SWT0600 | Sweetened Flavored Milk Beverage Powder without Non-fat Dry Milk |
| | GRW0700 | Ready-to-eat Cereal (presweetened) – Whole Grain |
| | GRS0700 | Ready-to-eat Cereal (presweetened) – Some Whole Grain |
| | GRR0700 | Ready-to-eat Cereal (presweetened) -Refined Grain |
| | GRW1200 | Flavored Popcorn |
| | DOT0100 | Frozen Dairy Dessert |
| | DOT0200 | Frozen Nondairy Dessert |
| | DOT0300 | Pudding and Other Dairy Dessert |
| | MSC0600 | Miscellaneous Dessert |
| | DYF0100 | Yogurt - Sweetened Whole Milk |
| | DYR0100 | Yogurt - Sweetened Low Fat |
| | DYL0100 | Yogurt - Sweetened Fat Free |

**Statistical analyses**

The socioeconomic factors and other demographic data, diet data (fruit, vegetable, sugar-sweetened beverage, sweetened foods and energy intake), and PBHE data among baseline adult participants were used in the secondary data analysis. The statistical analyses were conducted by SPSS version 23 software (IBM SPSS Statistics, Chicago: IBM Inc., USA). The significant level was $p<0.05$ for 2-sided hypothesis testing. Socioeconomic data and other demographic data were reported as the mean values ± standard deviation (mean ± SD) or the proportion of respondents within each answer option. Diet data was reported as mean ± SD (grams/day or servings/day). The total score and each sub-scale score of PBHE were reported as mean ± SD.

To adjust the total scale of barriers and the sub-scales of barriers for direct comparisons between scales and sub-scales, total score or sub-scale scores were divided by number of items available for each respondent. The score of each question of PBHE was reported as the mean ± SD.

Before the correlation tests, the diet data that were more than 3SD and less than -3SD were excluded. For the total sugars, added sugars, and sugar sweetened beverages, three participants were excluded. For the energy, sweetened foods, fruit, and vegetable, two participants were excluded. Since all the diet and barrier data that were used in the correlation were non-normally distributed, non-parametric tests were used for analyses. The household monthly income and all the barrier variables were continuous data, so the Spearman's correlation was used for the associations. The original employment status in the survey was categorized as employed (including employed full-time, employed part-time, and employed in seasonal labor) and unemployed status (including out of work for

more than 1 year, out of work for less than 1 year, and homemaker). Since the employment was a binary variable (employed vs. unemployed), the association between employment and barrier variables was analyzed by Mann-Whitney Test. The original education levels in the survey were simplified as four categories. No school or kindergarden, and 1st grade-8th grade were defined as less than high school. The 9th grade-12th grade/GED were defined as high school or equivalent. Trade/vocational school certificate, and some college were defined as vocational school or some college. The original category of college graduate category was kept in the analysis. Since the education was a multiple categorical variable, the associations between education and barriers were analyzed by Kruskal Wallis Test.

A linear regression model was developed and used to assess the associations between total PBHE and the diet variables (fruit, vegetable, and added sugar). The lg10(X+1) was used to transform diet data, and square root was used to transform barrier data, before the regression analysis. The socioeconomic factors, age and gender were adjusted in the regression model. Untransformed data are displayed in tables for ease of interpretation.

# CHAPTER 4

# RESULTS

## Characteristics of participants

The characteristics of participants are summarized in Table 2. A total of 149 subjects completed the survey data collection at baseline. There were 136 participants completing the 24h diet recall, but 2 outliers were excluded from the total sugars, added sugars and sugar sweetened beverages data, and 3 outliers were excluded from the other dietary data. The mean age of participants was 38.47 years. Only 7.4% of participants were male. The majority of participants were born in Mexico (84.6%), 12.1% of participants were born in United States, and the remaining participants (3.4%) were born in another country. For marital status, 100 participants (67.1%) were married, living with spouse, 27 participants (18.1%) were living together, not legally married, and 12 participants (8.1%) were single. The remaining participants reported to be married, not living with spouse (4%, n=6), separated (2%, n=3) and divorced (0.75%, n=1). The mean household size was 2.79 ±1.30 children and 2.44 ±0.88 adults.

More than half of participants were homemakers (54.3%, n=82), with 20.5% of participants (n=31) having a part-time employment, and 18.5% of participants (n=28) having full-time employment. The remaining responses were classified as out of work for more than 1 year (4.0%, n=6), employed in seasonal labor (1.3%, n=2) and out of work for less than 1 year (1.3%, n=2). There were 109 out of 149 participants reporting their household monthly income; mean reported income was $2,533±$2,092. The majority of participants had household monthly income of $1,000-$1,999 (33.94%, n=37) and $2,000-$2,999 (30.28%, n=33), whereas 14.68% of participants (n=16) had household

monthly income of $3,000-$3,999, 11.01% of participants had household monthly income of more than $4,000, and the remaining participants (10.09%, n=11) had household monthly income of less than $1,000. Among the participants whose households had 4 members (household size = 4), 46.67% of them reported a yearly household income level below the 2016 federal poverty line. There were 62.86% of the participants whose households had 5 members (household size = 5) having a yearly income below the 2016 federal poverty line. Regarding education, 79 participants (53.02%) reported that they had completed high school or equivalent, 21 participants (14.09%) did not complete high school, 35 participants (23.49%) completed vocational school or some college, and the remaining participants (n=14, 9.40%) were college graduates.

Table 2 Characteristics of participants

| Characteristics | n | % | Mean (SD) |
|---|---|---|---|
| Age (years) | 149 | | 38.47 (7.08) |
| Gender | 149 | | |
| Female | 138 | 92.6% | |
| BMI (kg/m$^2$) | 138 | | 30.79 (6.16) |
| In what country were you born? | 149 | | |
| United States | 18 | 12.1% | |
| Mexico | 126 | 84.6% | |
| Another country | 5 | 3.4% | |
| Marital Status | 149 | | |
| Single | 12 | 8.1% | |
| Married, Living with Spouse | 100 | 67.1% | |
| Married, Not Living with Spouse | 6 | 4% | |
| Living Together, Not Legally Married | 27 | 18.1% | |
| Separated | 3 | 2.0% | |
| Divorced | 1 | 0.7% | |
| Household Size (number) | 149 | | |
| Children | | | 2.79 (1.30) |
| Adults | | | 2.44 (0.88) |
| Employment Status [a] | 149 | | |
| Employed full-time, ≥35 h per week | 28 | 18.5% | |
| Employed part-time, < 35 h per week | 31 | 20.5% | |
| Employed in seasonal labor | 2 | 1.3% | |
| Out of work for more than 1 year | 6 | 4.0% | |
| Out of work for less than 1 year | 2 | 1.3% | |
| Homemaker | 82 | 54.3% | |
| Employment Status (dichotomized) | | | |
| Employed | 61 | 40.9% | |
| Household monthly income ($) | 109 | | 2532.99 (2092.41) |
| <$1000 | 11 | 10.09% | |
| $1000-$1999 | 37 | 33.94% | |
| $2000-$2999 | 33 | 30.28% | |
| $3000-$3999 | 16 | 14.68% | |
| >=$4000 | 12 | 11.01% | |
| Household size=4 | 30 | | |
| Yearly income< 2016 Federal Poverty line[b] | 14 | 46.67% | |
| Household size=5 | 35 | | |
| Yearly income< 2016 Federal Poverty line[c] | 22 | 62.86% | |
| Education | 149 | | |
| Less than high school | 21 | 14.09% | |
| High school or equivalent | 79 | 53.02% | |
| Vocational school or some college | 35 | 23.49% | |

| | | | |
|---|---|---|---|
| College graduate | 14 | 9.40% | |

SD: Standard Deviation
[a] The employment status is a multiple choice question.
[b] The 2016 Federal Poverty line for 4 household size was $24,300
[c] The 2016 Federal Poverty line for 5 household size was $28,440

**Description of perceived barriers to healthy eating (PBHE)**

The adjusted scores of total PBHE, social support, emotions and daily mechanics were divided by their question numbers (total PBHE: 23 questions; social support: 3 questions; emotions: 11 questions; daily mechanics: 9 questions). The mean value of the adjusted total PBHE, social support, emotions and daily mechanics are listed in Table 3. Scores for each of the individual barriers are listed in Table 4. There were four items having scores higher than three points: "I have trouble estimating portion sizes" (3.32±1.690); "When I am hungry I have trouble controlling what I eat" (3.21±1.810); "Eating well is rewarding but I have trouble staying motivated to keep preparing healthy meals" (3.05±1.708); and "When I am busy or feeling overwhelmed, I find it difficult to remember all of the rule about what foods are appropriate" (3.10±1.773).

Table 3 Description of total PBHE and subgroups

| | [a]Mean (SD) |
|---|---|
| Total PBHE[b] | 2.63 (0.91) |
| Social support[c] | 2.52 (1.16) |
| Emotions[d] | 2.71 (1.06) |
| Daily mechanics [e] | 2.58 (0.95) |

[a]The mean value had a range of 1-5. SD: Standard Deviation.
[b]Total PBHE was adjusted by its question number of 23.
[c]The Social support subscale represents that the healthy eating barriers are due to lack of social support.
[d]The emotions subscale represents that the healthy eating barriers are caused by emotion change.
[e]The daily mechanics subscale represents that the healthy eating barriers are caused by the fact that people or environment are not ready for following a healthy eating diet.

Table 4 Description of each PBHE

| | Mean[a] | SD | Subscales[b] |
|---|---|---|---|
| 1. Appropriate foods are not available in my home. | 1.95 | 1.379 | DM |
| 2. I have trouble estimating portion sizes | **3.32** | 1.690 | DM |
| 3. It is difficult to find time to plan appropriate meals for my family. | 2.54 | 1.712 | DM |
| 4. It is difficult to shop for one person in the grocery store. | 2.29 | 1.764 | DM |
| 5. I don't know what foods I should eat to improve my diet | 2.66 | 1.700 | DM |
| 6. Changing my diet to reduce sugar seems too complicated. | 2.77 | 1.753 | DM |
| 7. Changing my diet to increase fruits and vegetables seems too complicated. | 2.05 | 1.513 | DM |
| 8. I find it difficult to select appropriate foods when shopping. | 2.66 | 1.657 | DM |
| 9. The foods that are more healthful for me cost more than I can afford. | 2.91 | 1.728 | DM |
| 10. It is difficult to motivate myself to eat appropriately. | 2.91 | 1.692 | EM |
| 11. I use food as a reward or treat for myself. | 1.89 | 1.445 | EM |
| 12. I don't see any benefits from my efforts to improving my diet | 2.22 | 1.631 | EM |
| 13. I have difficulty controlling my eating when I am with friends. | 2.40 | 1.688 | EM |
| 14. When I am hungry I have trouble controlling what I eat. | **3.21** | 1.810 | EM |
| 15. Eating well is rewarding but I have trouble staying motivated to keep preparing healthy meals. | **3.05** | 1.708 | EM |
| 16. I feel deprived when I have to restrict so many foods. | 2.78 | 1.733 | EM |
| 17. I never feel that my appetite is satisfied when I am trying to eat more healthfully. | 2.66 | 1.705 | EM |
| 18. The taste of healthful foods is different. | 2.52 | 1.646 | EM |
| 19. Resisting tempting unhealthful foods in my work setting is difficult. | 2.81 | 1.767 | EM |
| 20. When I am busy or feeling overwhelmed, I find it difficult to remember all of the rule about what foods are appropriate. | **3.10** | 1.773 | EM |
| 21. When I am with my family I find it difficult to watch what I eat. | 2.99 | 1.730 | SS |
| 22. My friends do not support me when I try to change my eating. | 2.33 | 1.674 | SS |
| 23. My family does not support my efforts to change my diet. | 2.25 | 1.572 | SS |

[a]The mean values have a range of 1-5. SD: Standard Deviation; bold numbers indicate mean scores greater than 3-points.

[b]For each subscale, DM = daily mechanics; EM = emotions; SS = social support

## Dietary intake

Diet data were available for 136 participants. Mean energy intake was 1615.46±392.74 kcal. Total sugars were 85.72±31.46 g. Added sugars were 49.93±31.17 g. Sugar-sweetened beverage and sweetened foods were reported as 1.19±1.30 servings, and 2.02±2.12 servings respectively. The means of fruit and vegetable intake were 1.66±1.56 servings and 2.45±1.43 servings respectively.

Table 5. Diet intake among study participants.

| | N | Mean (SD)[a] |
|---|---|---|
| Energy (kcal) | 134 | 1616.95 (394.08) |
| Total sugars (g) | 133 | 84.96 (29.68) |
| Added sugars[b] (g) | 133 | 47.45 (26.65) |
| Sugar-sweetened beverages[c] (servings) | 133 | 1.08 (1.07) |
| Sweetened foods[d] (servings) | 134 | 1.86 (1.66) |
| Fruit (servings) | 134 | 1.54 (1.18) |
| Vegetable (servings) | 134 | 2.34 (1.25) |

[a] SD: Standard Deviation
[b] The added sugars were from the total sugars.
[c] Sugar-sweetened beverages include all the liquids that have added sugars.
[d] Sweetened foods include all the solid foods that have added sugars.

## Correlation and regression analysis

*PBHE and Socioeconomic Factors*

Since the all the variables were non-normally distributed, non-parametric tests were used for correlation analyses. The employment (categorized as employed and unemployed) and PBHE were analyzed in the Mann-Whitney's test. Table 6 showed that employment status was significantly and negatively associated with total PBHE (Z = -

2.280, p=0.023), and support PBHE (Z = -2.623, p=0.009), which meant employed participants perceived having lower total barriers to healthy eating, and lower barriers to healthy eating related to social support than unemployed participants. Education was significantly related with total PBHE (Chi-Square = 7.987, p=0.046), and daily PBHE (Chi-Square = 11.735, p=0.008), which indicated that people with higher education perceived having lower total barriers to healthy eating, and lower barriers to healthy eating related to daily mechanics than people with lower education. Household monthly income levels were significantly correlated to daily PBHE (r = -0.265, p=0.005), which indicated that people with higher household monthly income perceived having lower barriers to healthy eating related to daily mechanics than people with lower household monthly income. Table 7 listed the barriers that had a significant association with socioeconomic factors, the complete data is listed in Appendix D. People with higher education level were more likely to perceive "*Appropriate foods are not available in my home*", "*I never feel that my appetite is satisfied when I am trying to eat more healthfully*", "*The foods that are more healthful for me cost more than I can afford*", and "*The taste of healthful foods is different*" as their barriers to healthy eating. People with lower household monthly income were more likely to select "*It is difficult to shop for one person in the grocery store*", "*I don't know what foods I should eat to improve my diet*", and "*The foods that are more healthful for me cost more than I can afford*" as their barriers to healthy eating. The employed people were less likely to perceive "*Appropriate foods are not available in my home*", "*My family does not support my efforts to change my diet*", "*I have trouble estimating portion sizes*", "*I never feel that my appetite is satisfied when I am trying to eat more healthfully*", "*The foods that are more healthful for*

*me cost more than I can afford*", and "*The taste of healthful foods is different*" as their barriers.

Table 6 Associations between PBHE and Socioeconomic Factors

| | | Total PBHE | Support PBHE | Emotion PBHE | Daily PBHE |
|---|---|---|---|---|---|
| Employed[a] | Z | -2.280* | -2.623** | -1.955 | -1.840 |
| | p-value | **.023** | **.009** | .051 | .066 |
| | N | 149 | 149 | 149 | 149 |
| Education[b] | Chi-Square | 7.987* | 2.332 | 4.867 | 11.735** |
| | p-value | **.046** | .506 | .182 | **.008** |
| | N | 149 | 149 | 149 | 149 |
| Household monthly income[c] | Correlation Coefficient | -.177 | -.127 | -.091 | -.265** |
| | p-value | .066 | .189 | .347 | **.005** |
| | N | 109 | 109 | 109 | 109 |

Since the all the variables were non-normally distributed, non-parametric tests were used for analyses.

[a]The employment was binary variable (employed vs. unemployed), which was analyzed by Mann-Whitney Test, and the Z value was reported as the coefficient.

[b]The education was multiple categorical variable (the categories including less than high school, high school or equivalent, vocational school or some college, and college graduate), which was analyzed by Kruskal Wallis Test, and the Chi-Square was reported as the coefficient

[c]Income was continuous data, which was analyzed by Spearman's correlation test, and the Correlation Coefficient was reported.

The bolded numbers are p-value<0.05; **. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed).

Table 7. Significant correlations between each PBHE and Socioeconomic Factors

| | | Education levels[a] | Household monthly income[b] | Employed[c] |
|---|---|---|---|---|
| Appropriate foods are not available in my home. | Coefficient | 9.727* | -.091 | -.164* |
| | p-value | **.021** | .349 | **.045** |
| | N | 149 | 109 | 149 |
| My family does not support my efforts to change my diet. | Coefficient | 6.340 | -.099 | -.184* |
| | p-value | .096 | .307 | **.025** |
| | N | 149 | 109 | 149 |
| I have trouble estimating portion sizes | Coefficient | 3.068 | -.150 | -.177* |
| | p-value | .381 | .120 | **.031** |
| | N | 149 | 109 | 149 |
| It is difficult to shop for one person in the grocery store. | Coefficient | 4.837 | -.256** | -.060 |
| | p-value | .184 | **.007** | .465 |
| | N | 149 | 109 | 149 |
| I don't know what foods I should eat to improve my diet | Coefficient | 6.223 | -.254** | -.055 |
| | p-value | .101 | **.008** | .507 |
| | N | 149 | 109 | 149 |
| I never feel that my appetite is satisfied when I am trying to eat more healthfully. | Coefficient | 7.869* | -.139 | -.178* |
| | p-value | **.049** | .151 | **.031** |
| | N | 148 | 108 | 148 |
| The foods that are more healthful for me cost more than I can afford. | Coefficient | 9.353* | -.193* | -.185* |
| | p-value | **.025** | **.045** | **.024** |
| | N | 149 | 109 | 149 |
| The taste of healthful foods is different. | Coefficient | 13.353** | -.140 | -.177* |
| | p-value | **.004** | .146 | **.031** |
| | N | 149 | 109 | 149 |

All the variables were non-normally distributed, so non-parametric analyses were used.

[a]The education was multiple categorical variable (the categories including less than high school, high school or equivalent, vocational school or some college, and college graduate), which was analyzed by Kruskal Wallis Test, and the Chi-Square was reported as the coefficient.

[b]Income was continuous data, which was analyzed by Spearman's correlation test, and the Correlation Coefficient was reported.

[c]The employment was binary variable (employed vs. unemployed), which was analyzed by Mann-Whitney Test, and the Z value was reported as the coefficient.

The bolded numbers are p-value<0.05; **. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed).

*Diet and PBHE*

The diet data that were more than 3SD and less than -3SD were excluded before the correlation tests. Since all the variables were not normally distributed, Spearman's correlation analysis was used for analysis (See Table 8). Added sugar was significantly correlated to total PBHE (r=0.202, p=0.020), emotion PBHE (r=0.239, p=0.006) and daily PBHE (r=0.179, p=0.04), suggesting that as participants perceived greater total and emotions barriers to healthy eating, they consumed more added sugars. The sugar sweetened beverage intake was significantly correlated to emotion PBHE (r=0.183, p=0.035), which meant as participants perceived greater emotional barriers to healthy eating, they consumed more sugar sweetened beverages. Table 9 shows the significant correlations between each PBHE and diet intake. Added sugar and sugar sweetened beverages had more significant correlations with barriers than the other diet components assessed. Interestingly, participants with a greater perception for lack of time to plan meals reported lower consumption of sweetened foods (r= -0.241, p=0.005). As participants perceived greater barriers to healthy eating related to lack of support from friends, they consumed less fruit (r= -0.186, p=0.032). There was not any barrier that was significantly related to vegetable intake.

Added sugar, fruits and vegetables were used as dependent variables in the regression model. The total PBHE was the independent variable in the regression. All the barrier and diet variables used in the regression were approximately normally distributed. Socioeconomic factors, age, gender, and birth country were entered into the model as covariates. Fruit intake was significantly associated with income (p=0.36) and gender (p=0.12), which meant that each additional dollar of monthly income was associated with

a decrease of -1.870E-5 fruit servings, and that male participants had 0.187 fewer servings of fruit than female participants. However, there was not any significant association between diet and PBHE found in Table 10.

Table 8. Correlations between diet and PBHE

| | | Total PBHE | Support PBHE | Emotion PBHE | Daily PBHE |
|---|---|---|---|---|---|
| Added sugar | Coefficient | .202* | .060 | .239** | .179* |
| | p-value | **.020** | .491 | **.006** | **.040** |
| | N | 133 | 133 | 133 | 133 |
| Sugar sweetened beverage | Coefficient | .143 | .097 | .183* | .080 |
| | p-value | .101 | .269 | **.035** | .359 |
| | N | 133 | 133 | 133 | 133 |
| Sweetened foods | Coefficient | -.022 | .024 | -.040 | -.025 |
| | p-value | .804 | .781 | .650 | .771 |
| | N | 134 | 134 | 134 | 134 |
| Fruit | Coefficient | -.025 | -.028 | -.021 | -.027 |
| | p-value | .776 | .748 | .809 | .761 |
| | N | 134 | 134 | 134 | 134 |
| Vegetable | Coefficient | .085 | .064 | .070 | .071 |
| | p-value | .327 | .464 | .424 | .416 |
| | N | 134 | 134 | 134 | 134 |

Since the variables were non-normally distributed, Spearman's test was used. The diet data that were more than 3SD and less than -3SD were excluded before the correlation tests.

** Coefficient is significant at the 0.01 level (2-tailed). * Coefficient is significant at the 0.05 level (2-tailed). The bolded numbers are p-value<0.05.

Table 9. Significant correlations between each PBHE and diet intake

| | | Added sugar | Sweetened beverage | Sweetened foods | Fruit | Vegetable |
|---|---|---|---|---|---|---|
| It is difficult to find time to plan appropriate meals for my family. | Coefficient | .082 | .125 | -.241** | -.020 | .044 |
| | p-value | .352 | .153 | **.005** | .818 | .614 |
| | N | 132 | 132 | 133 | 133 | 133 |
| When I am hungry I have trouble controlling what I eat. | Coefficient | .173* | .196* | -.118 | -.051 | .003 |
| | p-value | **.046** | **.024** | .176 | .559 | .974 |
| | N | 133 | 133 | 134 | 134 | 134 |
| Eating well is rewarding but I have trouble staying motivated to keep preparing healthy meals. | Coefficient | .195* | .202* | .070 | -.031 | -.020 |
| | p-value | **.024** | **.020** | .423 | .725 | .816 |
| | N | 133 | 133 | 134 | 134 | 134 |
| Changing my diet to reduce sugar seems too complicated. | Coefficient | .213* | .172* | .024 | -.056 | .094 |
| | p-value | **.014** | **.048** | .784 | .519 | .281 |
| | N | 133 | 133 | 134 | 134 | 134 |
| Changing my diet to increase fruits and vegetables seems too complicated. | Coefficient | .205* | .179* | -.001 | -.143 | .010 |
| | p-value | **.018** | **.040** | .988 | .100 | .907 |
| | N | 132 | 132 | 133 | 133 | 133 |
| The taste of healthful foods is different. | Coefficient | .286** | .159 | .019 | -.107 | .027 |
| | p-value | **.001** | .067 | .831 | .219 | .756 |
| | N | 133 | 133 | 134 | 134 | 134 |
| When I am busy or feeling overwhelmed, I find it difficult to remember all of the rule about what foods are appropriate. | Coefficient | .180* | .103 | .062 | .144 | .011 |
| | p-value | **.038** | .239 | .479 | .096 | .904 |
| | N | 133 | 133 | 134 | 134 | 134 |
| My friends do not support me when I try to change my eating. | Coefficient | .150 | .188* | .061 | -.186* | .102 |
| | p-value | .085 | **.031** | .485 | **.032** | .242 |
| | N | 133 | 133 | 134 | 134 | 134 |

Since the variables were non-normally distributed, Spearman's test was used.
** Coefficient is significant at the 0.01 level (2-tailed). * Coefficient is significant at the 0.05 level (2-tailed). The bolded numbers are p-value<0.05.

Table 10. Linear regression of PBHE and added sugar

| | | B | Beta | p-value |
|---|---|---|---|---|
| Added sugar[a] | Constant | 1.315 | | .000 |
| | Total PBHE [b] | .154 | .157 | .097 |
| | Income | 7.064E-6 | .053 | .556 |
| | Employed | -.016 | -.028 | .775 |
| | Education | .052 | .154 | .098 |
| | Birth Country | .000 | -.066 | .457 |
| | Age | -.007 | -.173 | .065 |
| | Gender | .178 | .146 | .115 |
| Fruit | Constant | .754 | | .000 |
| | Total PBHE | -.066 | -.089 | .337 |
| | Income | -1.870E-5 | -.191 | **.036** |
| | Employed | .001 | .003 | .972 |
| | Education | -.018 | -.071 | .439 |
| | Birth Country | .000 | -.039 | .659 |
| | Age | -.001 | -.018 | .849 |
| | Gender | -.187 | -.230 | **.012** |
| Vegetable | Constant | .547 | | .001 |
| | Total PBHE | .005 | .009 | .922 |
| | Income | -2.454E-6 | -.032 | .731 |
| | Employed | -.048 | -.144 | .148 |
| | Education | -.018 | -.090 | .348 |
| | Birth Country | .000 | -.077 | .404 |
| | Age | -.001 | -.031 | .749 |
| | Gender | .030 | .047 | .615 |

The bolded numbers are p-value<0.05.

[a] The diet data were transformed by lg10(x+1)

[b] Total PBHE were transformed by square root.

Socioeconomic factors, age, gender, and birth country were put into the model as covariates.

# CHAPTER 5

# DISCUSSION

In this study, we used a five-point scale to measure the value of the total perceived barriers to healthy eating among parents of elementary-school aged children. These values showed that participants' mean barriers scores were approximately in the middle of the barriers scale. The emotions subscale score was relatively higher than the other barriers, which meant people were more likely to pay attention to their emotions to follow a healthy diet or not.

The 2015-2020 Dietary Guidelines for Americans [34] recommends adult women with sedentary or moderately active lifestyle need 1800-2200 calories per day, and adult men with sedentary or moderately active lifestyle need 2200-2800 calories per day. In this study, the energy intake was 1615.46±392.74 calories per day, which is lower than the recommendations. Interestingly, the mean value of BMI among all the participants was 30.79±6.16 $kg/m^2$, which can be considered obese. This may due to under-reporting of energy intake, because without any weight management, obese people should have consumed more energy than non-obese people. Several studies have reported that obese people tend to under-report their energy intake due to their food restriction, and increased concerns about their weight [86-88]. Moreover, underreporting of energy intake is more prevalent in women [89], and 92.6% of the subjects in this study were women. In general, people tend to underreport foods they know they should not be consuming (like soda and sweets) but over-report healthier food consumption (like fruits and vegetables) because of social desirability [90], which may result in reporting errors and bias. However, obese people is not always consume more fruit, vegetable, and added sugars than non-obese

people, and low energy intake is not always associated to low fruit, vegetable and added sugars intake [91]. Although we can conclude that people underreported the energy intake based on their high BMI, however, in this study we cannot determine whether people underreported or over-reported their consumption of fruit, vegetable and added sugars or not, just from the high value of BMI and low value of energy intake.

Participants in the current study consumed 49.93±31.17 g of added sugars each day, which was higher than the recommendations. The Dietary Guidelines recommends American people limit added sugar to less than 10% of their daily calorie consumption, which is about 48 grams of added sugar for a 2000 calorie diet. Furthermore, recommendations from the Dietary Guidelines suggest Americans consume 2 cup-equivalents of fruits and 2.5 cup-equivalents of vegetables per day for a 2000 calorie diet, which are about 2 servings of fruits or 1 servings of fruit juice, and 2.5 servings of raw vegetables or 1.25 servings of cooked vegetables for a 2000 calorie diet. In this study, participants had 1.66±1.56 servings of fruits and 2.45±1.43 servings of vegetables per day, which are very close to the recommendations.

In correlation analysis, added sugar consumption was the most commonly reported to be related to perceived barriers. People who had higher total PBHE score, emotions subscore, and daily mechanics subscore consumed more added sugar, compared to people who had lower scores. Sugar sweetened beverage intake was significantly related to emotion PBHE. However, when all the confounders (including age, gender, birth country, and socioeconomic factors), diet (including added sugar, fruit, and vegetables), and total barriers scores were put into regression analysis, there was no significant association between PBHE and diet observed in the regression analysis.

**Socioeconomic factors impact PBHE**

This study explored the relationship between socioeconomic factors and PBHE among parents of elementary-school aged children. Employment status, education and household monthly income were significantly and negatively associated with perceived barriers. Employed people had lower total PBHE score, while unemployed people had higher total PBHE score, which meant that the employed people perceived having lower total barriers to healthy eating than unemployed people. Employed people had lower PBHE related to social support than unemployed people, which indicated that employed people perceived having lower barriers to healthy eating related to social support than unemployed people. People with higher education levels had lower total PBHE score, compared with people with lower education levels. People who had higher education or more household monthly income had lower barriers related to daily mechanics PBHE than people who had lower education or lower household monthly income. It could be explained that people with higher education levels or higher household monthly income perceived having lower barriers to healthy eating related to daily mechanics than people with lower education or monthly income, which may be due to personal or environment conditions.

In this study, socioeconomic characteristics, including education, employment, and income, were highlighted as potential risk factors for perceived barriers of accepting a healthy diet. We found that socioeconomic factors were negatively associated with total PBHE, support PBHE and daily PBHE. This might reflect that people in higher socioeconomic levels perceived themselves having less obstacles to follow a healthy

eating plan, compared with people in lower socioeconomic levels. In contrast, people living under lower socioeconomic conditions may have found it more difficult to eat healthy, which may be explained by poor social support and lack of daily mechanics support to follow a healthy eating plan. The impact of socioeconomic factors on perceived barriers may be explained by the fact that people with low socioeconomic status often live in areas where there is limited access to healthy foods, and unhealthy foods are easily accessible, so these people had fewer healthy food choices, and greater access to fast-food [92]. Although a previous study from Sari Andajani-Sutjahjo et. al. [81] reported lack of social support and time as important perceived barriers to healthy eating, they did not find that perceived barriers varied by different socioeconomic status. This may due to the fact that their sample was young women aged 18-32 years, and many of them were students whose socioeconomic status were not yet established.

Other previous studies only focused on identifying what difficulties were perceived as barriers to healthy eating classified by different levels of socioeconomic factors, rather than directly comparing the relationship between socioeconomic factors and perceived barriers. López-Azpiazu et. al. [79] found that education level, income level and employment status were related to some perceived barriers, such as irregular work hours, unappealing food, busy lifestyle, and price of healthy foods. In the present study, education, employment, and income, were negatively associated with PBHE. This result is important to future health intervention, because it will not be known whether interventions to reduce perceived barriers and promote healthy eating are equally effective among populations with socioeconomic inequalities. If the target population

suffers socioeconomic disparities, their PBHEs are likely to vary, and PBHE may affect healthy behaviors.

In general, the subgroup analyses showed that socioeconomic factors mainly impacted on the daily mechanics PBHE and social support PBHE. López-Azpiazu et. al. [79] reported the irregular work hours and busy lifestyle were associated with different socioeconomic levels. In this study, the two items were included in the daily mechanics of PBHE to follow a healthy diet plan which was significantly associated with socioeconomic factors. This result was consistent with the previous findings. However, in this study, socioeconomic factors were not found to have any significant impact on PBHE related to emotions. This may be explained by the fact that people in different socioeconomic levels had similar psychological stress (no matter high or low) to follow a healthy diet.

**Associations between PBHE and healthy eating**

The main contribution of this study is quantifying the effects of perceived barriers to healthy eating on accurate mean intakes of fruits, vegetables, added sugar by total sugar, sugar sweetened beverage, and sweetened food among parents of elementary-school aged children. Even though we had explored the socioeconomic factors that were related to PBHE, the ultimate goal to explore perceived barriers was to overcome barriers and improve people's healthy dietary intakes. This study found that perceived barriers are significantly associated with added sugar consumption; in particular, perceived barriers related to emotions were significantly related to sugar sweetened beverage consumption. Unexpectedly, other perceived barriers were not significantly related to sugar sweetened

beverages and sweetened foods. In contrast, the previous study from Pinho et. al. [93] had reported that healthy eating barriers were related to the consumption of sugar-sweetened beverages and sweets. Although the added sugar always came from sugar-sweetened beverages and sweets, most studies did not report the associations between barriers and added sugars. This may be explained by the fact that added sugars are usually reported in 24 h diet recalls, however most previous studies used food frequency questionnaires to estimate dietary intake, in which added sugars were not reported. In addition, food frequency questionnaires only access the frequency of consumption of foods rather than collecting the appropriate unit of foods. In contrast, we used at least two days of 24 h diet recalls for collection of individual dietary data, which is believed to be more accurate and superior to estimate dietary intakes.

In this study, perceived barriers were not significantly related to fruit and vegetable consumption. However, in a previous study, perceived barriers were commonly reported to be associated with fruit and vegetable intake [93]. The reasons for the difference between our study and the previous study are unknown. It may due to the fact that in this study, the fruit and vegetable intakes were calculated by servings which was less accurate than grams. Another reason may be that our study had a smaller sample size than the previous study (N=5900) [93], so any future studies may try to increase the sample size to increase the accuracy and stability of the study. Even though we put all the confounders, including age, gender, socioeconomic factors, as well as diet and PBHE into the regression model, results showed only income and gender were significantly associated with fruit intake. However, according to the unstandardized beta of income in Table 10, with each additional 100 dollars, participants ate 0.00187 fewer servings of

fruit. The association between income and fruit intake was very tiny, even though it was significant. In addition, for the significant relationship between gender and fruit intake found in this study, there are similar result reported by previous studies. For example, Morrow et al. [94] had reported that more women (25.05%) met the WHO recommendation of a minimum intake of 400 g fruit and vegetable per day than men (21.89%). According to the Behavioral Risk Factor Surveillance System data, Seung et al. also reported that a higher proportion of women met both fruit and vegetable recommendations than men did [2]. However, there is a large disparity in gender ratios in this study (92.6% of the participants in this study were women), which may affect the gender related results.

**What this study adds on PBHE**

There is scant information from previous studies reporting perceived barriers to healthy eating among Hispanic individuals. The emotions as perceived barriers was relatively higher the other two subgroups, which may be that people perceived emotions were more difficult to overcome to achieve the goal of eating healthy. In this study, the question related to knowledge, "I have trouble estimating portion sizes", was 3.32±1.69. "When I am hungry I have trouble controlling what I eat" related to self-control was 3.21±1.81. "Eating well is rewarding but I have trouble staying motivated to keep preparing healthy meals" related to motivation was 3.05±1.708. Lack of time was 3.10±1.77 ("When I am busy or feeling overwhelmed, I find it difficult to remember all of the rules about what foods are appropriate"). The barriers related to knowledge of healthy eating, self-control motivation and time to eat healthy were higher than 3-score,

which meant these issues were outstanding barriers that should be considered in future health interventions or health promotions. Even though some other studies reported the value of perceived barriers, most of them focused on different topics or among different populations. Wang et. al. [27] reported total perceived barriers related to healthy eating was 61.3±14.0 (the potential range was from 22 to 110) among people with BMI between 27 and 43 kg/m$^2$. The perceived barrier subgroups for emotions, daily mechanics and social support were 34.5±8.1 (potential range: 11-55), 20.4±6.3 (potential range: 8-40), and 6.5±2.5 (potential range: 3-15) respectively among overweight or obese people. Welsh et. al. [25] reported the value of perceived barriers among obese adults by a five-point scale. The perceived barrier for lack of knowledge, lack of self-control, and lack of time were 2.9±0.1, 3.5±0.1, and 2.9±0.1, respectively. Similarly, we found that the scores of knowledge, self-control and lack of time were higher than 3-score.

**Strengths of this study**

This study's strengths include using a perceived barriers to healthy eating scale to estimate the value of barriers, which contributes to higher accuracy and quantitates the value of personal barriers to following a healthy diet. In addition, using 24-hour diet recalls as a dietary assessment tool can improve the accuracy and standardized dietary data. Another strength of this study is that we linked socioeconomic factors to perceived barriers to accessing the impacts of socioeconomic factors on the barriers of eating healthy. Furthermore, we linked perceived barriers to the consumption of healthy diets for accessing the effects of the perceived barriers listed in the study on different healthy

dietary intakes. This study may contribute to a more integrated understanding of how subjective factors qualitatively and quantitatively influence adults' healthy eating.

**Limitations of this study**

This cross sectional study explored the effects of PBHE on fruit, vegetable, added sugar by total sugar, sugar sweetened beverage, and sweetened food among parents of elementary-school aged children, but it cannot identify causality or the temporal relationship between socioeconomic factors and perceived barriers, as well as between perceived barriers and dietary intake. Even though the non-normal distributed data were transformed by logarithm or square root, most of the data were still non-normally distributed, so the non-parametric tests were conducted for data analysis. The accuracy of the data of the food recall depends on the subjects' memory and the skill of the interviewers. Respondents may underreport unhealthy foods (such as sweets and soda) or over-report healthier foods (such as fruits and vegetables), if they view this as social desirability. Therefore recall bias and social desirability bias may occur. We used at least two days of recall data to estimate an approximate individual's usual intake to minimize the recall bias. Although using the PBHE scale to quantitatively and qualitatively evaluate people's barriers was a strength in this study, some of the barrier questions were difficult to understand. For example, "the taste of healthful foods is different", this description of a barrier was vague. Of course salad would taste different than a cheeseburger, and even low fat milk might taste different than high fat milk, but implying that "different" is a negative connotation, might make people confused, and wonder why different taste is a barrier to healthy eating. In addition, this study was limited to the

population living in the South Phoenix area, and the majority of the recruited participants were Hispanics. Thus, the results of this study may mainly benefit the Hispanic population.

# CHAPTER 6

# CONCLUSION

In conclusion, this study shows socioeconomic status is significantly associated with perceived barriers, but total PBHE score is not associated with diet intake. The findings suggest that focusing on socioeconomic status is critically important in overcoming barriers to healthy eating. The shared barriers that were found in this study can provide context for the needs in communities, and may help community researchers to know what strategies will be the most effective to address barriers to healthy eating. Given that most participant were Hispanics living in South Phoenix, the finding from this study may mainly contribute to these populations, but the research methods and theory will benefit a broader area. Furthermore, it will also be important to further quantify the value of the relationship between PBHE and diet intake, as well as the causality and temporal relationship between them. Beyond the barriers to healthy eating, to improve the effectiveness of health implementation in communities, the facilitators to healthy eating also need to be studied in the future.

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# APPENDIX A

## APPROVAL FORM FROM THE IRB AT ASU

ASU Knowledge Enterprise Development

APPROVAL FULL BOARD

Noe Crespo
SNHP - Exercise and Wellness
602/827-2279
Noe.Crespo@asu.edu

Dear Noe Crespo:

On 8/1/2014 the ASU IRB reviewed the following protocol:

| | |
|---|---|
| Type of Review: | Initial Study |
| Title: | Athletes for Life Phase 3: A family nutrition and physical activity intervention to improve fitness and prevent cardiovascular disease among elementary aged children and their parents. |
| Investigator: | Noe Crespo |
| IRB ID: | STUDY00001286 |
| Funding: | Name: American Heart Association, National Center; Funding Source ID: 14SDG20490382, |
| Documents Reviewed: | • Appendix 12_Child Assent Form_English_072414_AC.pdf, Category: Consent Form;<br>• Appendix 11_Parental Consent Form_English_073114_CLEANED.pdf, Category: Consent Form;<br>• AHA_Bioscience application_FINAL_73114_AC.docx, Category: IRB Protocol;<br>• Appendix 15- Child survey english+spanish.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Appendix 10-PAR-Q.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Appendix 14- Parent survey english+spanish.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Appendix 16- |

| | |
|---|---|
| | FINAL_AFL_MODIFIEDHomeFoodInventory1_22_14.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Appendix 13- Anthropometric Measurements Protocol (ALBERTO FLOREZ's conflicted copy 2014-07-06).pdf, Category: Other (to reflect anything not captured above);<br>• Appendix 5- Adult Physical Activity Curriculum outline.pdf, Category: Other (to reflect anything not captured above);<br>• Appendix 6- Adult nutrition program outline.pdf, Category: Other (to reflect anything not captured above);<br>• Appendix 1-Valentina_MPHC_Letter of Support_.pdf, Category: Other (to reflect anything not captured above);<br>• Appendix 2-Frank_SMCC_Letter of Support_.pdf, Category: Other (to reflect anything not captured above);<br>• Appendix 3-Child Nutrition Curriculum Outline_.docx, Category: Other (to reflect anything not captured above);<br>• Appendix 4-Child Physical activity Curriculum Outline_.pdf, Category: Other (to reflect anything not captured above);<br>• Appendix 7-AFL2_RECRUITMENT FLYER_.pdf, Category: Recruitment Materials;<br>• Appendix 8-AFL2_INTEREST PARENT CONTACT INFO SHEET_.pdf, Category: Recruitment Materials;<br>• Appendix 7-AFL2_RECRUITMENT FLYER_.pdf, Category: Recruitment materials/advertisements /verbal scripts/phone scripts;<br>• Appendix 9- Athletes for life_Recruitment Script_070313.pdf, Category: Recruitment materials/advertisements /verbal scripts/phone scripts;<br>• Appendix 8-AFL2_INTEREST PARENT CONTACT INFO SHEET_.pdf, Category: Recruitment materials/advertisements /verbal scripts/phone scripts;<br>• Crespo_AHA_RMT30521120_award_letter.pdf, Category: Sponsor Attachment;<br>• AHA Grant_Research Strategy_1-13-13.pdf, Category: Sponsor Attachment;<br>• Appendix 18- Home Visit Protocol.pdf, Category: Technical materials/diagrams;<br>• Appendix 17-backtranslation-form.pdf, Category: Translations; |

The IRB approved the protocol from 7/23/2014 to 7/22/2015 inclusive. Before 7/22/2015, you are to submit a completed "FORM: Continuing Review (HRP-212)" and required attachments to request continuing approval or closure.

If continuing review approval is not granted before the expiration date of 7/22/2015 approval of this protocol expires on that date. When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Monica Gutierrez
Rachel Ganger
Erika Hernandez
Gabriel Shaibi
Michael Todd
Kendra Swanson
Peggy Gomez
Leopoldo Hartmann Manrique
Alayna Terrell
Sonia Vega-Lopez
Noe Crespo
Mia Teran
Sarah MULLANE
Rachel Cassinat
Argemiro A Florez Pregonero
Monica Gutierrez
Adrian Chavez
Jennifer Huberty
Matthew Hulse
Jeremy Webb
Carla Dellaserra

# APPENDIX B

# ATHLETES FOR LIFE IRB APPROVAL FORM

**Arizona State University**
**Athletes for Life 3**
**Adult Consent Form**

**INTRODUCTION:**
The purpose of this form is to provide you with important information that may affect your decision regarding you and your child's participation and to record the consent of those who agree to participate and give permission for their child to participate in this study.

**RESEARCHERS**:
Drs. Sonia Vega-López, Noe Crespo, and Gabriel Shaibi are professors in the School of Nutrition and Health Promotion at Arizona State University, in collaboration with the City of Phoenix Parks and Recreation Department's South Mountain Community Center

**DESCRIPTION OF THE RESEARCH STUDY**:
We are inviting parent-child pairs to participate in a research study to test the effectiveness of a family fitness and nutrition program. If you and your child decide to participate, you will be randomly assigned (by chance) to be in one of two groups, either the "immediate program treatment" group or the "wait-list" group.

Both groups will participate in a 12-week fitness and nutrition program. The "immediate program" group will begin the 12-week fitness and nutrition program after completing the first set of measurements(described below). The "wait-list" group will wait to begin the 12-week fitness and nutrition program until all measurements have been completed, approximately 24 weeks after the completion of the first set of measurements.

Data from all participants (both immediate program group and wait-list group)will be collected in four phases: before the immediate program group starts the program (week 0) and at 6, 12, and 24 weeks, thereafter.The measurements will take place in three separate visits and will be collected before the immediate program group starts the program and at week 12.

**Fitness and Nutrition Program:**
Child Participation: Each session will consist of an 80-minute physical activity and a 10-minute interactive nutrition lesson. The sessions include group activities, games, and exercises designed to improve your child's fitness, sports skills, and wellbeing. These games and activities will provide information about the importance of eating nutritious foods. Your child may be given information from some of the sessions to share with the family.

Parent Participation. The parent portion consists of 45 minutes of interactive nutrition lessons with cooking demonstrations and taste tests. The other 45 minutes will be spent doing physical activities to help improve your health and fitness level.

At the end of the program your family will be invited to participate in a youth Olympics event to showcase you and your child's athletic skills developed over the course of the program.

We expect to have about 160 families enrolled in this study over four years. If assigned to the immediate program group, you and your child's participation will take approximately 28 weeks. If assigned to the wait-list group participation will take approximately 40 weeks (28 weeks of wait period plus 12 weeks of the program).

In order to evaluate this program we will ask each group to complete the following measurements.

**InitialProceduresBefore the start of the Program (Week 0)**

Visit 1(approximately 1 hour total)

*Location: Your Home*

- You and your child will receive a full explanation of the study and if both of you agree to participate; you and your child will sign a written informed consent.
- You (parent) will fill out a questionnaire about you, including your place of birth and child's place of birth, and your child's diet and physical activity habits
- (Optional) Home food inventory (approximately 45 minutes)–With your permission,a research assistant will go to your home to conduct a brief inventory of the food items that are available in your kitchen

Visit 2 (approximately 1 hour total)

*Location: ASUNutrition &Health Promotion Laboratory (downtown Phoenix)*

- You and your child will be asked to fast (not consume foods or drinks) for at least 8 hours before the visit and you will be offered a light snack during the visit
- (Child) We will apply numbing cream at the spot of the blood draw
- Post-pubertal females will be asked to provide a urine sample to conduct a pregnancy test
- (Adult and child) We will ask you to sit down for 5 minutes after which we will measure blood pressure
- (Adult and child) Full body DEXA (x-ray) scan to measure total and abdominal body fat
- (Adult and child)We will measure height, weight, and waist circumference
- (Adult and child) We will draw blood(approximately 2 tablespoons from adults and 1 tablespoon from children)
- (Adult and child) Fitness assessment - stepping up and down from a 12 inch step while we measure your heart rate

Visit 3 (approximately 45 minutes)

*Location: South Mountain Community Center*

- Activity warm-up for exercise
- (Adult and child) Fitness assessment – same as the fitness assessment from the last visit
- (Adult and child) Run/walk 1 mile while being timed
- (Adult and child) Activity trackers (Accelerometers) - You and your child will be given an accelerometer that we will ask you to wear for one week to measure physical activity
- We will also ask you to fill out a 3-day food record in which you will write down all the foods and drinks you consume for the week before the start of the program.

**Week 6 Procedures (takes place during intervention session)**

*Location: South Mountain Community Center*

- (Adult and child) Repeat height, weight, and waist circumference measurements
- (Adult and child) Repeat a run/walk 1 mile while being timed

**Week 12 Procedures**

Visit 1 (approximately 1 hour and 30 minutes)

*Location: South Mountain Community Center*

- (Adult and child) Activity warm-up
- (Adult and child) Fitness assessment (step test)– same as the fitness assessment from the initial visit
- (Adult and child) Run/walk 1 mile while being timed
- You (parent) will fill out a questionnaire about you and your child's diet and physical activity habits

- (Adult only) We will also ask you to fill out a 3-day food record for the week following the last program session
- (Adult and child) Activity trackers (Accelerometers) - You will be given an accelerometer that we will ask you and your child to wear for one week to measure physical activity
- Immediate program group only – Parent Interview. We will interview to ask your opinions about your experience with the program.

Visit 2 (approximately 30 minutes total)
*Location: ASUNutrition & Health Promotion Laboratory (downtown Phoenix)*

- You and your child will be asked to fast (not consume foods or drinks) for at least 8 hours before the visit and you will be offered a light snack during the visit
- Post-pubertal females will be asked to provide a urine sample to conduct a pregnancy test
- (Adult and child) We will ask you to sit down for 5 minutes after which we will measure blood pressure
- (Adult and child) Full body DEXA scan to measure total and abdominal body fat
- (Adult and child)We will measure height, weight, and waist circumference
  (Adult and child) We will draw blood (approximately 2 tablespoons from adults and 1 tablespoon from children)

Visit 3 (approximately 1 hour total)

- (Optional) Home food inventory – With your permission,a research assistant will conduct a brief home food inventory of the food items that are available in your kitchen

**Week 24 Procedures (approximately 45 minutes)**
*Location: South Mountain Community Center*

- (Adult and child) Repeat blood pressure, height, weight, and waist circumference measurements
- (Adult and child) Fitness assessment (step test)– same as the fitness assessment from baseline and 12 weeks visit
- (Adult and child) Run/walk 1 mile while being timed.
- (Adult only) complete a survey about your and your child's eating and physical activity habits
- (Adult and child) Activity trackers (Accelerometers) - You will be given an accelerometer that we will ask you and your child to wear for one week in order to measure physical activity

**INCLUSIONARY and EXCLUSIONARY CRITERIA**:
In order for you and your child to participate in this study, your child must be 6 to 11 years old. You both must be free of any mental or physical condition that limits your ability to move or restricts participation in sports and are not currently pregnant.

**RISKS**:
There is risk of being injured, experiencing fatigue and shortness of breath or experiencing a cardiac problem during the exercise testing and exercise sessions. The research team will reduce these risks by first asking you some questions about your general health and your ability to safely do the exercise testing before starting the exercise tests. In addition, the study team will be utilizing recommended exercise training procedures including having warm-up and cool-down activities, using appropriate facilities and equipment for the exercise sessions, increasing exercise intensity slowly throughout the program, and request that everyone wear appropriate clothing and shoes. Participants will be screened prior to enrollment in this study to determine if it is safe for them to participate in exercise. In some situations where exercise may not be safe, a physician's approval is required.

It is possible that participants may feel uncomfortable answering survey or interview questions, during body measurements or during fitness assessments. You are able to stop during any procedures you are not comfortable with and can skip any survey or interview questions you do not wish to answer. Privacy screens will be used during body measurements to protect your privacy.

There is a risk of slight discomfort, bruising, swelling, dizziness, or you may faint as a result of the blood draw. Only trained research personnel will draw you and your child's blood and you both will be offered a snack after the blood draw. We will also apply numbing cream at the site of the draw for children. If at any time you or your child feels unable to complete the blood draw, you may ask to skip this measure.

There is a slight risk of discomfort when wearing the blood pressure cuff as it inflates. There is also a slight risk of discomfort to you or your child from doing the step-test.

There is a small risk associated with radiation exposure during the body composition measure (DEXA). However, the amount of radiation you and your child will be exposed to is approximately 1/10$^{th}$ of the amount that you would be exposed to during an x-ray and less than you would experience on a flight across the Atlantic Ocean. All female participants who are menstruating will receive a pregnancy test before completing the DEXA to avoid any possible risks of radiation exposure to the fetus.

**BENEFITS**:
The possible benefits of your family's participation in the research include improving your and your child's fitness and improving dietary habits.

**NEW INFORMATION**:
You will be contacted if new information is discovered that would reasonably change your decision about you and your child's participation in this study.

**CONFIDENTIALITY**:
The results of the research study may be published but you and your child's name or identity will not be revealed. In order to maintain confidentiality, participants will be assigned a study identification number that will be used on all study records in place of participants' names. Study records with information about you will be kept locked in filing cabinets or on computers protected with passwords. Only those who work with this study will be allowed access to your information.

**WITHDRAWAL PRIVILEGE**:
There will be no penalty if you choose not to participate in this study. It will not affect you or your child's medical treatment, or future participation in the South Mountain Community Center's activities. Likewise, you and your child are free to drop from the study at any time for any reason and there will be no penalty.

**COSTS AND PAYMENTS**:
There is no cost to participants to join this study.
As compensation for your time and participation in this program, you or your child will receive:

- Lab visit: Your family will receive an incentive worth approximately $20 for participating in the laboratory visit (before the program and after the program at 12 weeks).
- Accelerometer: Your child will receive a toy worth approximately $5 for each time that they wear the accelerometer (before the program, 12, and 24 weeks).

- Following last visit before the program begins: A one-year City of Phoenix Park and Recreation Department Recreation Pass/membership card for you and your child. If you already have one, we will give you a voucher to renew your membership when yours expires.
- Home visits: You will receive an incentive worth approximately $10 for each home visit you participate in (before the program begins and after the program at week 12).
- Twelve week follow up: You will receive an incentive worth approximately $10 participating in the 24 week follow-up measurements

**COMPENSATION FOR ILLNESS AND INJURY**:
Agreeing to you and your child's participation does not waive any of your legal rights. However, no funds have been set aside to compensate you in the event of injury. In the event that you or your child suffers harm as a result of participation in this research project, you may contact Dr. Sonia Vega-López at (602) 827-2268 or you may contact the Chair of the Human Subjects Institutional Review Board through the Research Compliance Office at (480) 965-6788.

If, during the interviews, there is evidence that you or your child has extreme depression, other signs of mental illness, or even suicide; project staff would work with you to see that you or your child gets help. This might require that we inform other professionals if necessary to protect your safety.

Project staff will also report to appropriate professionals if there is evidence that any member of your family is in danger of being harmed by any other family member or of causing harm to themselves, another family member, or others. This includes evidence of possible suicide and abuse of minor children.

**VOLUNTARY CONSENT**
By signing this form, you are saying 1) that you have read this form or have had it read to you, and 2) that you are satisfied and you understand this form, the research study, and its risks and benefits. The researchers will be happy to answer any questions you have about the research. If you have any questions, please feel free to contact Dr. Sonia Vega-López at (602) 827-2268.

If at any time you feel pressured to participate, or if you have any questions about your rights or this form, please call the Chair of the Human Subjects Institutional Review Board through the ASU Office of Research Integrity and Assurance at (480) 965-6788.

Note: By signing below, you are telling the researchers YES, that you agree to participate and give permission for your child to participate in this study. Please keep one copy of this form for your records.

_____
Your child's name (please print)

_____ _____ _____
Parent: Your name (please print) Parent Signature Date

Your initials here indicate whether you consent to completing the **home visit**.

I ☐*DO* consent to completing the home visit.

I ☐*DO NOT* consent to completing the home visit.

_____
Parent's Initials

Your initials here indicate whether your child would like to wear t**he additional activity monitor** during each of the data collection phases (0, 12, and 24 weeks)

I ☐*DO* consent to have my child wear an additional activity monitor.

I ☐*DO NOT* consent to have my child wear an additional activity monitor.

_____
Subjects Initials

As a part of this program we would like to take pictures for use on our Facebook page, and presentations or publications describing the project. Your name and other contact information will not be associated with these pictures in any way.

Your initials here indicate whether you consent for the AFL research team to **take pictures of you and your children** while participating in the program.

I ☐*DO* consent to the use of photographs of me and my family.

I ☐*DO NOT* consent to the use of photographs of me and my family.

_____
Parent's Initial's

**INVESTIGATOR'S STATEMENT**:
I certify that this form includes all information concerning the study relevant to the protection of the rights of the participants, including the nature and purpose of this research, benefits and risks, costs, and any experimental procedures.

I have described the rights and protections afforded to human research participants and have done nothing to pressure, coerce, or falsely entice the parent to allowing this child to participate. I am available to answer the parent's questions and have encouraged him/her to ask additional questions at any time during the course of the study.

_____ _____

Investigator's Signature Date

# APPENDIX C

## THE QUESTIONNAIRE OF PERCEIVED BARRIERS TO HEALTHY EATING

Below we have listed some things which participants report can make it difficult to change their eating habits. For each item, please indicate the extent to which this factor has made it difficult for you to follow appropriate eating habits in THE PAST 3 MONTHS.

| | Not at all a problem for me | | | | A very important problem for me |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| a) Appropriate foods are not available in my home. | ○ | ○ | ○ | ○ | ○ |
| b) My family does not support my efforts to change my diet. | ○ | ○ | ○ | ○ | ○ |
| c) I have trouble estimating portion sizes | ○ | ○ | ○ | ○ | ○ |
| d) It is difficult to motivate myself to eat appropriately. | ○ | ○ | ○ | ○ | ○ |
| e) I use food as a reward or treat for myself. | ○ | ○ | ○ | ○ | ○ |
| f) It is difficult to find time to plan appropriate meals for my family. | ○ | ○ | ○ | ○ | ○ |
| g) I don't see any benefits from my efforts to improving my diet | ○ | ○ | ○ | ○ | ○ |
| h) It is difficult to shop for one person in the grocery store. | ○ | ○ | ○ | ○ | ○ |
| i) I don't know what foods I should eat to improve my diet | ○ | ○ | ○ | ○ | ○ |
| j) I have difficulty controlling my eating when I am with friends. | ○ | ○ | ○ | ○ | ○ |
| k) When I am hungry I have trouble controlling what I eat. | ○ | ○ | ○ | ○ | ○ |
| l) Eating well is rewarding but I have trouble staying motivated to keep preparing healthy meals. | ○ | ○ | ○ | ○ | ○ |
| m) Changing my diet to reduce sugar seems too complicated. | ○ | ○ | ○ | ○ | ○ |
| n) Changing my diet to increase fruits and vegetables seems too complicated. | ○ | ○ | ○ | ○ | ○ |
| o) I feel deprived when I have to restrict so many foods. | ○ | ○ | ○ | ○ | ○ |
| p) I find it difficult to select appropriate foods when shopping. | ○ | ○ | ○ | ○ | ○ |

| | Not at all a problem for me | | | | A very important problem for me |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| q) I never feel that my appetite is satisfied when I am trying to eat more healthfully. | ○ | ○ | ○ | ○ | ○ |
| r) The foods that are more healthful for me cost more than I can afford. | ○ | ○ | ○ | ○ | ○ |
| s) The taste of healthful foods is different. | ○ | ○ | ○ | ○ | ○ |
| t) Resisting tempting unhealthful foods in my work setting is difficult. | ○ | ○ | ○ | ○ | ○ |
| u) When I am busy or feeling overwhelmed, I find it difficult to remember all of the rule about what foods are appropriate. | ○ | ○ | ○ | ○ | ○ |
| v) When I am with my family I find it difficult to watch what I eat. | ○ | ○ | ○ | ○ | ○ |
| w) My friends do not support me when I try to change my eating. | ○ | ○ | ○ | ○ | ○ |

# APPENDIX D

## CORRELATIONS BETWEEN SOCIOECONOMICS AND EACH PBHE

| | | Education levels | Household monthly income | Employed |
|---|---|---|---|---|
| Appropriate foods are not available in my home. | Coefficient | 9.727 | -.091 | -.164 |
| | P-value | **.021** | .349 | **.045** |
| | N | 149 | 109 | 149 |
| My family does not support my efforts to change my diet. | Coefficient | 6.340 | -.099 | -.184 |
| | P-value | .096 | .307 | **.025** |
| | N | 149 | 109 | 149 |
| I have trouble estimating portion sizes. | Coefficient | 3.068 | -.150 | -.177 |
| | P-value | .381 | .120 | **.031** |
| | N | 149 | 109 | 149 |
| It is difficult to motivate myself to eat appropriately. | Coefficient | 2.484 | -.137 | -.105 |
| | P-value | .478 | .156 | .201 |
| | N | 149 | 109 | 149 |
| I use food as a reward or treat for myself. | Coefficient | .146 | .115 | .108 |
| | P-value | .986 | .235 | .191 |
| | N | 149 | 109 | 149 |
| It is difficult to find time to plan appropriate meals for my family. | Coefficient | 3.488 | -.148 | .156 |
| | P-value | .322 | .127 | .059 |
| | N | 148 | 108 | 148 |
| I don’t see any benefits from my efforts to improving my diet | Coefficient | 2.021 | -.103 | .008 |
| | P-value | .568 | .286 | .924 |
| | N | 149 | 109 | 149 |
| It is difficult to shop for one person in the grocery store. | Coefficient | 4.837 | -.256 | -.060 |
| | P-value | .184 | **.007** | .465 |
| | N | 149 | 109 | 149 |
| I don’t know what foods I should eat to improve my diet | Coefficient | 6.223 | -.254 | -.055 |
| | P-value | .101 | **.008** | .507 |
| | N | 149 | 109 | 149 |
| I have difficulty controlling my eating when I am with friends. | Coefficient | 5.542 | -.041 | -.094 |
| | P-value | .136 | .675 | .256 |
| | N | 149 | 109 | 149 |
| When I am hungry I have trouble controlling what I eat. | Coefficient | 3.329 | .056 | -.013 |
| | P-value | .344 | .560 | .879 |
| | N | 149 | 109 | 149 |
| Eating well is rewarding but I have trouble staying motivated to keep | Coefficient | 3.890 | -.170 | -.114 |
| | P-value | .274 | .078 | .165 |

| | | | | |
|---|---|---|---|---|
| preparing healthy meals. | N | 149 | 109 | 149 |
| Changing my diet to reduce sugar seems too complicated. | Coefficient | 0.749 | -.127 | -.082 |
| | P-value | .862 | .190 | .318 |
| | N | 149 | 109 | 149 |
| Changing my diet to increase fruits and vegetables seems too complicated. | Coefficient | 4.417 | -.015 | -.074 |
| | P-value | .220 | .875 | .373 |
| | N | 148 | 109 | 148 |
| I feel deprived when I have to restrict so many foods. | Coefficient | .508 | -.003 | -.134 |
| | P-value | .917 | .973 | .104 |
| | N | 148 | 109 | 148 |
| I find it difficult to select appropriate foods when shopping. | Coefficient | 6.265 | -.186 | -.123 |
| | P-value | .099 | .054 | .138 |
| | N | 148 | 108 | 148 |
| I never feel that my appetite is satisfied when I am trying to eat more healthfully. | Coefficient | 7.869 | -.139 | -.178 |
| | P-value | **.049** | .151 | **.031** |
| | N | 148 | 108 | 148 |
| The foods that are more healthful for me cost more than I can afford. | Coefficient | 9.353 | -.193 | -.185 |
| | P-value | **.025** | **.045** | **.024** |
| | N | 149 | 109 | 149 |
| The taste of healthful foods is different. | Coefficient | 13.353 | -.140 | -.177 |
| | P-value | **.004** | .146 | **.031** |
| | N | 149 | 109 | 149 |
| Resisting tempting unhealthful foods in my work setting is difficult. | Coefficient | 5.421 | .052 | -.093 |
| | P-value | .143 | .605 | .274 |
| | N | 140 | 102 | 140 |
| When I am busy or feeling overwhelmed, I find it difficult to remember all of the rule about what foods are appropriate. | Coefficient | .068 | -.143 | -.109 |
| | P-value | .995 | .137 | .186 |
| | N | 149 | 109 | 149 |
| When I am with my family I find it difficult to watch what I eat. | Coefficient | 1.930 | -.057 | -.117 |
| | P-value | .587 | .559 | .154 |
| | N | 149 | 109 | 149 |
| My friends do not support me when I try to change my eating. | Coefficient | .548 | -.108 | -.137 |
| | P-value | .908 | .262 | .096 |
| | N | 149 | 109 | 149 |

# APPENDIX E

## CORRELATIONS BETWEEN EACH PBHE AND DIET INTAKE

| | | Added sugar | Sugar sweetened beverage | Sweetened foods | Fruit | Vegetable |
|---|---|---|---|---|---|---|
| Appropriate foods are not available in my home. | Coefficient | .026 | .030 | .009 | .066 | -.037 |
| | P-value | .764 | .733 | .919 | .451 | .673 |
| | N | 133 | 133 | 134 | 134 | 134 |
| My family does not support my efforts to change my diet. | Coefficient | -.064 | -.017 | -.088 | .035 | -.040 |
| | P-value | .465 | .850 | .312 | .692 | .645 |
| | N | 133 | 133 | 134 | 134 | 134 |
| I have trouble estimating portion sizes. | Coefficient | .110 | .053 | -.114 | -.003 | .074 |
| | P-value | .209 | .544 | .188 | .972 | .397 |
| | N | 133 | 133 | 134 | 134 | 134 |
| It is difficult to motivate myself to eat appropriately. | Coefficient | .055 | .016 | -.019 | .011 | .102 |
| | P-value | .526 | .852 | .828 | .895 | .239 |
| | N | 133 | 133 | 134 | 134 | 134 |
| I use food as a reward or treat for myself. | Coefficient | -.069 | .023 | -.141 | .038 | .145 |
| | P-value | .430 | .792 | .104 | .666 | .094 |
| | N | 133 | 133 | 134 | 134 | 134 |
| It is difficult to find time to plan appropriate meals for my family. | Coefficient | .082 | .125 | -.241 | -.020 | .044 |
| | P-value | .352 | .153 | **.005** | .818 | .614 |
| | N | 132 | 132 | 133 | 133 | 133 |
| I don't see any benefits from my efforts to improving my diet. | Coefficient | .153 | .166 | -.036 | -.042 | -.022 |
| | P-value | .079 | .056 | .677 | .633 | .798 |
| | N | 133 | 133 | 134 | 134 | 134 |
| It is difficult to shop for one person in the grocery store. | Coefficient | .131 | .124 | -.136 | .008 | .040 |
| | P-value | .132 | .157 | .118 | .930 | .643 |
| | N | 133 | 133 | 134 | 134 | 134 |
| I don't know what foods I should eat to improve my diet | Coefficient | .043 | .040 | .012 | -.023 | -.049 |
| | P-value | .621 | .648 | .895 | .789 | .573 |
| | N | 133 | 133 | 134 | 134 | 134 |
| I have difficulty controlling my eating when I am with friends. | Coefficient | .132 | .094 | -.123 | -.041 | .025 |
| | P-value | .131 | .281 | .156 | .640 | .771 |
| | N | 133 | 133 | 134 | 134 | 134 |
| When I am hungry I have trouble controlling what I eat. | Coefficient | .173 | .196 | -.118 | -.051 | .003 |
| | P-value | **.046** | **.024** | .176 | .559 | .974 |
| | N | 133 | 133 | 134 | 134 | 134 |
| Eating well is rewarding but I have trouble staying motivated to keep preparing healthy meals. | Coefficient | .195 | .202 | .070 | -.031 | -.020 |
| | P-value | **.024** | **.020** | .423 | .725 | .816 |
| | N | 133 | 133 | 134 | 134 | 134 |
| Changing my diet to reduce sugar seems too | Coefficient | .213 | .172 | .024 | -.056 | .094 |
| | P-value | **.014** | **.048** | .784 | .519 | .281 |

| | | | | | | |
|---|---|---|---|---|---|---|
| complicated. | N | 133 | 133 | 134 | 134 | 134 |
| Changing my diet to | Coefficient | .205 | .179 | -.001 | -.143 | .010 |
| increase fruits and | P-value | **.018** | **.040** | .988 | .100 | .907 |
| vegetables seems too | N | 132 | 132 | 133 | 133 | 133 |
| complicated. | | | | | | |
| I feel deprived when I | Coefficient | .100 | .049 | -.020 | -.081 | .019 |
| have to restrict so many | P-value | .253 | .577 | .816 | .356 | .826 |
| foods. | N | 132 | 132 | 133 | 133 | 133 |
| I find it difficult to select | Coefficient | .065 | -.044 | -.054 | .071 | -.025 |
| appropriate foods when | P-value | .461 | .619 | .539 | .419 | .777 |
| shopping. | N | 132 | 132 | 133 | 133 | 133 |
| I never feel that my | Coefficient | .133 | .078 | -.056 | -.015 | .116 |
| appetite is satisfied when I | P-value | .129 | .374 | .522 | .866 | .185 |
| am trying to eat more | N | 132 | 132 | 133 | 133 | 133 |
| healthfully. | | | | | | |
| The foods that are more | Coefficient | .021 | -.155 | .141 | -.012 | .124 |
| healthful for me cost more | P-value | .814 | .074 | .103 | .890 | .154 |
| than I can afford. | N | 133 | 133 | 134 | 134 | 134 |
| The taste of healthful | Coefficient | .286 | .159 | .019 | -.107 | .027 |
| foods is different. | P-value | **.001** | .067 | .831 | .219 | .756 |
| | N | 133 | 133 | 134 | 134 | 134 |
| Resisting tempting | Coefficient | .175 | .153 | .001 | -.101 | .082 |
| unhealthful foods in my | P-value | .052 | .091 | .990 | .263 | .363 |
| work setting is difficult. | N | 124 | 124 | 126 | 125 | 125 |
| When I am busy or feeling | Coefficient | .180 | .103 | .062 | .144 | .011 |
| overwhelmed, I find it | P-value | **.038** | .239 | .479 | .096 | .904 |
| difficult to remember all | N | 133 | 133 | 134 | 134 | 134 |
| of the rule about what | | | | | | |
| foods are appropriate. | | | | | | |
| When I am with my | Coefficient | .020 | .029 | .054 | .055 | .072 |
| family I find it difficult to | P-value | .824 | .737 | .532 | .526 | .410 |
| watch what I eat. | N | 133 | 133 | 134 | 134 | 134 |
| My friends do not support | Coefficient | .150 | .188 | .061 | -.186 | .102 |
| me when I try to change | P-value | .085 | **.031** | .485 | **.032** | .242 |
| my eating. | N | 133 | 133 | 134 | 134 | 134 |