Does Diet Quality Mediate the Relationship Between Food Insecurity and Obesity Among Preschoolers?

by

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ABSTRACT

Food insecurity and childhood obesity are both major public health concerns in the United States of America. Research has not found a definite relationship between childhood obesity and food insecurity to date, with conflicting results being found due to differences in sample sizes and protocol for measuring key variables. Preschoolers (children aged 2-5 years) are a population of particular interest as there tends to be improved health behaviors and greater adaptability to change at this period of growth and development. This study aims to evaluate if there is a relationship between food insecurity and childhood obesity with diet quality as a mediator among preschoolers in the Phoenix area. A secondary data analysis from participants (n=154) from the SAGE (Sustainability via Active Garden Education) research project was used to evaluate food insecurity status, diet quality components (kcal, saturated fat, added sugars, and servings of juice, fruits, and vegetables), and anthropometrics (waist circumference and BMI percentile). No significant associations between food insecurity status, diet quality components, and anthropometric data were found. There was an increased rate of food insecurity and childhood overweight/obesity in this sample compared to state and national averages. Further research of high quality is necessary to determine whether a relationship exists between childhood obesity and food insecurity exists and in what context. Additionally, practice and policy will need to be implemented to decrease rates of food insecurity and childhood obesity among Phoenix preschoolers.

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CHAPTER 1

INTRODUCTION

Overview

Food insecurity is an important public health concern; in 2016 in the United States, almost 13 million children went hungry ("Hunger & Poverty in Arizona: Map the Meal Gap," n.d.). Food insecurity exists in households that are unable to provide the necessary amount and type of nutrition needed for all family members to have a healthy and active life (Agrawal, Farrell, Wethington, & Devine, 2018; Andress & Fitch, 2016). While older family members may sometimes go hungry to protect younger children from the negative effects, in Arizona in 2016, approximately 21.1% of children were food insecure ("Hunger & Poverty in Arizona: Map the Meal Gap," n.d.; McIntyre et al., 2003). Preschoolers (children ages 2-5) are a population of interest as food insecurity can lead to decreased academic performance and increased risk of chronic health concerns (Skalicky et al., 2006; Vozoris & Tarasuk, 2003; Weinreb et al., 2002).

One program which impacts preschoolers' diet quality and may assist in providing food resources to those who are food insecure is the Child and Adult Care Food Program (CACFP). CACFP is a federal program which reimburses child care centers per student per meal based on the child's family income. In order to receive reimbursement for children participating in CACFP, centers must follow guidelines on the nutritional quality of meals. In 2017, the first major revisions since the establishment of CACFP in 1968 were made in order to better conform with the latest version of the Dietary Guidelines for Americans. There are now specific meal pattern requirements for breakfast, lunch, and snacks which include servings of milk, fruits, vegetables, grains,

and meats/meat alternatives for specific age groups (preschoolers are divided into ages 1-2 and 3-5) ("Nutrition Standards for CACFP Meals and Snacks | Food and Nutrition Service," n.d.).

Childhood obesity is another major public health concern that is impacted by diet quality. In 2016, 18.5% of children in the United States were obese (Ogden, Carroll, et al., 2018). Children who experience childhood obesity may also experience a decrease in overall quality of life due to an increased risk of physical comorbidities and mental health concerns (Crowley, Khoury, Urbina, Ippisch, & Kimball, 2011; Pinhas-Hamiel et al., 1996; Schwimmer, Burwinkle, & Varni, 2003). Preschoolers represent a population of particular interest as they tend to have decreased obesity prevalence (13.9%) and increased fruit and vegetable consumption compared to older age groups (Kim, Moore, Galuska, Wright, & Harris, 2014; Ogden, Carroll, et al., 2018). Therefore, there is potential for early care and education to encourage continuation of health behaviors which support positive health outcomes.

Studies that have examined the relationship between food security status and weight status have found conflicting results (Kaur, Lamb, & Ogden, 2015; Papas, Trabulsi, Dahl, & Dominick, 2016; Speirs & Fiese, 2016). Although it may be assumed that food insecurity will lead to underweight status due to lack of adequate calories, the idea of the hunger-obesity paradox (the concurrent presence of obesity and food insecurity) has been documented as early as 1995 (Dietz, 1995). For low income families, there may be limited access to food resources depending on their environment (Morrissey, Jacknowitz, & Vinopal, 2014; Nackers & Appelhans, 2013). An environment rich in inexpensive, highly accessible, calorie-dense foods and low in nutritious foods

may promote food insecure individuals to have decreased diet quality which subsequently increases their risk of childhood obesity. Due to the complex nature of food insecurity and childhood obesity individually, the presence of a relationship has been found in some studies, but not others, or it has only been found for specific populations. For example, studies have found this relationship to exist among girls or those who experience persistent food insecurity without hunger (Metallinos-Katsaras, Must, & Gorman, 2012; Speirs & Fiese, 2016).

The current study is a secondary data analysis to examine whether a relationship exists between food insecurity and weight status among preschoolers in the Phoenix area. The secondary aim is to evaluate diet quality (i.e., intake of total calories, fruits and vegetables, juice, saturated fats and added sugars) at school as a mediator between food security status and weight status. The goal of these analyses is to contribute to the research on the relationship between food insecurity and weight status by focusing on preschoolers and evaluating a potential mediator. Although previous literature on the relationship between food insecurity and childhood obesity has been mixed, it is expected that for preschoolers, food insecurity will be associated with increased weight status due to a decrease in diet quality. This rationale is supported by the food environment typically experienced by low-income families which allows improved access to calorie-dense foods as well as the fact that preschoolers may be protected from household food insecurity. Based on the results of this study, there may be justification for further evaluation of other shared risk factors between food insecurity and weight status for the preschooler population and creation of interventions to impact future health outcomes for preschoolers.

Research Aim and Hypotheses

Research Question: What is the relationship between food insecurity and weight status for preschoolers?

H1: Food insecurity will be associated with higher BMI percentile among preschoolers in the Phoenix area.

Research Question: Is diet quality a mediator between food insecurity and weight status for preschoolers?

H2: Diet quality will mediate the relationship between food insecurity and weight status.

Definition of Terms

- Food Insecurity: The lack of the necessary type, variety, and/or amount of food for a healthy and active lifestyle at any given point in time. This may be measured at the household, child (all children in the household) or personal level.
- Childhood obesity: Excess body weight for a child's specific gender, age, and sex measured as a BMI in kilograms over meters squared at or above the 95th percentile.
- Diet quality: To what degree an individual conforms to the Dietary Guidelines for Americans in terms of required servings of food groups and sub-groups per day as well as not exceeding recommendations for added sugars, fats, and sodium. In this study, diet quality of preschoolers will be measured via intake of total kcal, juice, fruits and vegetables, added sugars, and saturated fats.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

A child's preschool years from ages 2-5 are marked as a critical stage of growth as well as a period of establishing key health behaviors (Kim et al., 2014; Pietrobellia, Agosti, & the MeNu Group, 2017). Although preschoolers tend to have improved childhood obesity rates compared to older children (Ogden, Carroll, et al., 2018), if health behaviors and their importance is not taught at this age, these behaviors will diminish with age and lead to increased risk of adult obesity and chronic health concerns such as diabetes and cardiovascular diseases (Crowley et al., 2011; Pinhas-Hamiel et al., 1996; Rolland-Cachera, Deheeger, Maillot, & Bellisle, 2006). By determining relationships between risk factors and health behaviors, interventions and policies can be developed to create positive changes for this population. One such relationship that has found conflicting evidence in research to date is between food insecurity and overweight/obesity status. Due to the complex nature of food insecurity and childhood obesity, literature has been mixed on whether a relationship exists for certain populations.

Preschooler Nutrition

Nutrition and Academic Performance

A child's early years represent a significant period of brain growth and development which requires an increased need for various nutrients (Pietrobellia et al., 2017). Whether these nutrients are provided in appropriate amounts to the child determines future health outcomes as well as current academic performance (Crowley et al., 2011; Nyaradi et al., 2016; Pinhas-Hamiel et al., 1996; van Stuijvenberg, Kvalsvig,

Kruger, Kenoyer, & Benadé, 1999; Wesnes, Pincock, & Scholey, 2012). For example, improved diet quality (i.e., increased consumption of fruits, vegetables, whole grains, and non-processed/non-red meat) at age 1 has been associated with higher mathematics, reading, and spelling scores once the child is older (Nyaradi et al., 2016). In addition, diet score at age two and three was associated with differing aspects of academic performance (such as higher diet score at age two associated with higher mathematics, writing, and spelling scores at grade seven) at lesser, but still significant rates.

The relationship between nutrition and academic performance has been found on a micronutrient-basis such as with iron, iodine, and beta-carotene (van Stuijvenberg et al., 1999; Zimmermann et al., 2006). Improvement of micronutrient intake has been found to increase cognition and attention as well as decrease the amount of school days missed. Diet quality and academic performance have also been linked by entire meals such as breakfast. Breakfast consumption, as well as increased diet quality at breakfast (such as oatmeal compared to ready-to-eat cereal), has been found to increase cognitive performance for schoolchildren (Mahoney, Taylor, Kanarek, & Samuel, 2005; Wesnes et al., 2012). Therefore, it is critical that preschoolers meet their nutrient requirements during this critical period of growth and development.

Nutrient Requirements

In order to evaluate the nutrition that preschoolers are receiving, it is important to first look at the standards for child nutrition requirements. The Dietary Guidelines for Americans (DGAs) are a set of nutritional recommendations for the general public that are updated every 5 years by the U.S. Department of Health and Human Services and the U.S. Department of Agriculture (U.S. Department of Health and Human Services & U.S.

Department of Agriculture, 2015). These guidelines are utilized by health professionals to create individualized nutritional recommendations as well as to serve as guidelines for federally funded nutrition programs such as the Child and Adult Care Food Program (CACFP) and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). The DGAs include recommendations per age group for servings of each food group per day as well as overall calorie consumption which may be used to measure diet quality. The most recent revisions (2015-2020) include three chapters which emphasize overall eating patterns, strategies to make shifts in current intake, and the roles that individuals and organizations have on influencing behavior change for themselves and those in their lives.

The first chapter of the 2015-2020 DGAs includes guidance on overall eating patterns across the lifespan (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2015). This chapter includes recommendations for each food group (fruits, vegetables, grains, dairy, and protein foods) with sections on healthy intake, key nutrient contributions, and considerations. It also provides information on added sugars, sodium, caffeine, alcohol, the difference between dietary fats, and the composition of common fats and oils. The second chapter offers suggestions on how to shift current dietary intake to conform to the recommendations made in the previous chapter. There is also information on how current typical intake compares to recommendations with 1-3 and 4-8 year olds being the only age groups to meet fruit cup-equivalent recommendations for boys and girls. These age groups also meet total grains and protein foods recommendations with 1-3 year olds also meeting dairy recommendations. However, as age increases, rates of meeting recommendations for food

groups significantly decrease. The chapter then describes recommendations for each food group to support shifts in dietary intake such as consuming more whole grains and less refined grains. Finally, the third chapter focuses on the levels of influence that are exerted on the dietary choices an individual makes, framed within the social-ecological model. Although there are certainly personal factors which determine the decisions an individual makes, choices are also influenced by his/her cultural norms, access to food, and food security status as well as influences in the home, school or worksite, community, and food retail levels.

In terms of specific nutrient requirements for preschoolers, the recommendations are more dependent on overall calorie needs based on the gender, age, and physical activity level of the child with most preschoolers needing 1,000-1,600 calories per day (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2015). Based on the overall calorie needs of the child, there are also recommendations of servings per day for each food group which support the information MyPlate provides to the general public. Each food groups' recommendations are reported in either cup (c) equivalents or ounce (oz) equivalents as each food has its own portion recommendations. For example, 1 slice of bread or 1/2 c portion of cooked brown rice are both equal to 1 oz equivalent of grains. Typically, preschoolers will need 1-2 c equivalents of vegetables, 1-1.5 c equivalents of fruits, 3-5 oz equivalents of whole grains, 2-3 c equivalents of dairy products, and 2-5 oz equivalents of protein foods per day. These 5 food groups can then be further divided into more specific subgroups such as whole grain and refined grains for the grain group and dark-green, red/orange, legumes, starchy, and other vegetables for subgroups of vegetables. This grouping and sub-grouping is designed to promote overall

variety throughout the diet which ensures intake of specific nutrients that may be otherwise missed. Last, there are also recommendations for maximum intake of certain nutrients that have been linked to a decrease in health quality. For all age groups, less than 10% of calories per day is recommended to come from added sugars, less than 10% of calories should come from saturated fats, and less than 2,300 milligrams of sodium should be consumed per day.

The current dietary intake of children is drastically different from the recommendations. In 2013, it was found that only 8.5% of high school students from 33 states across the United States met fruit recommendations and only 2.1% met vegetable recommendations (Moore, Thompson, & Demissie, 2017). Similar to the findings in the DGAs (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2015) consumption of fruits and vegetables appears to be improved in preschoolers compared to older youth. One study found that preschoolers consumed significantly more cup-equivalent per 1,000 calories of fruit than children aged 12-18 and was the only group to meet the Healthy People 2020 goal for fruit intake (but not vegetable intake)(Kim et al., 2014).

The Child and Adult Food Care Program

Children receive a substantial amount of their food throughout the day from schools and child care centers. The Child and Adult Care Food Program (CACFP) is a federal program which reimburses participating centers for meals and snacks given to children in their care according to the child's family income. Centers are reimbursed per child per meal depending on the family's income with children in Head Start programs

automatically eligible for full reimbursement ("Nutrition Standards for CACFP Meals and Snacks | Food and Nutrition Service," n.d.).

In 2012, before CACFP included nutrient-based standards, it was found via surveys that CACFP sites already tended to serve healthier foods and beverages such as less sweetened beverages and juices than non-CACFP sites (Ritchie, n.d.). Another study found that for low income four-year-olds, those participating in CACFP were no more likely to be overweight and tended to have higher consumption of milk and vegetables than non-participating children (Korenman, Abner, Kaestner, & Gordon, 2013).

In October 2017, the first major revisions since CACFPs establishment in 1968 were made to conform to the most recent version of the Dietary Guidelines for Americans. The new standards include offering fruits and vegetables as individual components rather than a combined fruit/vegetable group, ensuring at least one serving of grains must be whole-grain rich per day, placing maximum added sugar requirements for yogurt and breakfast cereals, and adding specifications to milk requirements. There are now guidelines for breakfasts, lunches, and snacks with specific details on which components participating centers can include per meal with serving sizes dependent on age (preschoolers are divided into ages 1-2 and 3-5) ("Nutrition Standards for CACFP Meals and Snacks | Food and Nutrition Service," n.d.).

Before the new rule came into effect, surveys from centers across the nation indicated the majority of early care and education centers felt very prepared to make changes with a majority also reporting to have begun implementing the standards. However, there were also reports of needing more time, money, and/or staff for successful implementation of the new CACFP guidelines. Centers appeared to meet

standards/best practices for beverages, maximum added sugar of breakfast cereals, and serving 100% whole grains more readily. A majority also reported serving a fruit or vegetable as part of a snack at least once per day and serving processed meats less than once per week. However, only 33% reported serving only plain/unflavored yogurt or no yogurt (Chriqui, Leider, & Schermbeck, 2018). After the change was implemented, a study which evaluated compliance found that when taking into account acceptable substitutions, foods served matched menu items for breakfast, lunch, and snacks with a 94-100% match. The most notable deviance found was the absence of fruit at lunch on 4 out of 69 observed meals and 2 out of 66 observed snacks (Dave & Cullen, 2018).

Besides the actual foods that are being provided to preschoolers in CACFP programs, the way in which they are provided can shape a child's dietary habits. Similar to the influences caregivers have in the home on children, workers at CACFP programs are presented opportunities in terms of the food environment and messages directed toward children around food. For example, Head Start programs (which all participate in CACFP) include healthful eating/nutrition performance standards and require providers sit with children during meal times. As a result, Head Start programs have been found more likely to teach children about nutrition and model healthy eating compared to other programs (CACFP and non-CACFP participating). However, experience of preschoolers is shaped by individual caregivers per site and some may still attempt to restrict intake of children perceived to be overweight/obese or be pressured to try new foods (Dev, Mcbride, Speirs, Donovan, & Cho, 2014)

Nutrition in the Home

A preschooler's diet quality is also influenced by food given in the home. Due to their young age, preschoolers are limited in their independence around mealtime; their main decisions evolve around which foods offered they decide to eat and how much. However, a majority of factors surrounding diet quality for preschoolers are either predetermined or heavily influenced by their caregiver(s). For example, caregivers primarily decide what foods are offered to the child, including any exposure to new foods. Caregivers also act as role models for dietary habits and behaviors with preschoolers' overall diets being moderately associated with the diet of the parent who reported the child's diet (Vepsäläinen et al., 2018).

The way in which food is presented to children has been widely researched with key findings creating recommendations for parenting practices (e.g., promoting responsive parenting). Responsive parenting includes aspects such as ensuring the child is comfortably seated with few distractions, the food is appropriate for the child and given at an appropriate time of day, and the caregiver will respond to the child's signals throughout mealtime. This allows the child to develop at a pace that is individual-specific and learn to respect their hunger and satiety cues (Black & Aboud, 2011). Conversely, when parents pressure children to eat, the children have increased rates of neophobia (fear of new foods) and decreased intake of fruits and vegetables (Kaar, Shapiro, Fell, & Johnson, 2016).

The home food environment also influences preschooler's eating habits. The home food environment consists of factors such as rate of family meals, whether television or other electronic devices are permitted during meal times, and overall mealtime routine. One study of preschoolers found higher odds of limited variety and

food refusals when television was watched during meals (Cole, Musaad, Lee, Donovan, & The STRONG Kids Team, 2018). Among low-income families who may struggle to find time for family meals, research has found that mothers tend to value family meals as time to bond with their children and education on family meals has received positive feedback (Lohse, Rifkin, Arnold, & Least, 2012; Malhotra et al., 2013)

Childhood Obesity

Definition

The term 'childhood obesity' has been used to describe various definitions in the past. In general terms, obesity refers to excess body fat which is indirectly measured in terms of excess body weight for standards. Body weight for standards is determined by evaluating weight in comparison to height (weight in kilograms divided by height in meters squared), also known as BMI (body mass index), to standards for that child's age and sex. In 2007, the recommendations for percentiles to identify those overweight, obese, and/or at risk of overweight remained the same, but there was a shift in terminology. The current recommendations are those children identified to have a BMI for their sex and age between the 85th and 95th percentile to be classified as overweight (previously classified as "at risk of overweight") and those at or above the 95th percentile to be classified as obese (previously classified as overweight)(Ogden & Flegal, n.d.).

It is important to note that these definitions do not account for actual body fatness and therefore are an indirect measure of obesity. There are additional concerns with using BMI as an indicator of obesity such as inherent errors which accompany measuring height and weight. Regardless, BMI is still regarded as the most practical tool to screen for obesity, especially when protocol is adhered to in order to reduce error in

measurements (Dietz & Bellizzi, 1999; Himes, 2009). In addition, BMI may be evaluated using a z-score to determine severity in the case of obesity. A z-score is a more precise measure of how a child's BMI compares to other children their age across a normal distribution with 0 being the average score for that specific age. A z-score other than 0 indicates how many standard deviations the child's BMI is away from the norm, with positive numbers indicating a BMI for age higher than the norm and negative numbers indicating a BMI for age lower than the norm.

Rates and Comorbidities

In 2015-2016, the prevalence of childhood obesity (youth aged 2-19 years) was 18.5% overall which exceeds the Healthy People 2020 goal of 14.5%. However, preschoolers was the only age group with the lower prevalence at 13.9% overall (with no significant difference in prevalence between boys and girls)(Hales, Carroll, Fryar, & Ogden, 2015). This decreased incidence among preschoolers has been supported by other literature as well (Ogden, Fryar, et al., 2018).

The presence of childhood obesity, as well as the age in which a child becomes obese are both fundamental to how that child's health will be affected in the future (Crowley et al., 2011; Pinhas-Hamiel et al., 1996). The earlier that a child experiences obesity, the more negative impacts it can have on the child as an adult (Rolland-Cachera et al., 2006; Williams & Goulding, 2009). For example, typically around the age of 6, a child's BMI for age reaches a minimum along the growth curve and then begins a steep upward incline known as the adiposity rebound (AR). An AR earlier than 6 has been associated with an increase in BMI as an adult. In fact, one study found that even though

the group of ‘early’ AR subjects had the lowest BMI at age 3, they had the highest BMI at age 5 years which continued into adulthood.

Beyond the increased risk for obesity as an adult, the relationships between childhood obesity and other severe health concerns such as diabetes and cardiovascular disease have been well established (Crowley et al., 2011; Pinhas-Hamiel et al., 1996). Along with the rise in childhood obesity prevalence, there has been a similar rise in prevalence of these comorbidities among adolescents which only amplifies the burden to the child, their family, as well as the healthcare system.

Overall, the effects of childhood obesity and subsequent comorbidities lead to a significant decrease in health-related quality of life which includes physical, psychosocial, emotional social, and school functioning aspects. One study reported that obese children were found to be 5.5 times more likely to have impaired health-related quality of life compared to a healthy child (Schwimmer et al., 2003). In fact, the quality of life for obese children was found to be comparable to children with cancer and rates of impaired health-related quality of life occurred at a similar rate.

The link between obesity and these comorbidities, as well as the evidence that earlier obesity magnifies the negative impacts as an adult are all justification for childhood obesity to be recognized as a major public health issue. The screening and subsequent treatment of obesity is fundamental in the prevention of further health disparities for the child, increased healthcare costs, and decrease of emotional burden (Crowley et al., 2011; Pinhas-Hamiel et al., 1996; Schwimmer et al., 2003). These negative consequences of childhood obesity are preventable by first identifying key risk factors for children.

Risk Factors for Obesity

Research on risk factors for childhood obesity have been well established with several associations heavily supported by research such as race/ethnicity and socioeconomic status (Conlon et al., n.d.; Gibbs & Forste, 2014). These major risk factors are made up of several individual risk factors which create a complex network of overall influence. For example, socioeconomic status has been found to be associated with decreased breastfeeding rates and both lower socioeconomic status and decreased prevalence of breastfeeding have been found to be associated with childhood obesity (Gibbs & Forste, 2014).

Another major risk factor is race/ethnicity; the inequity of health has placed undue burden on several minorities which has led to increased risk of health disparities. Both Hispanic youth (2-19 years of age) and non-Hispanic black youth have been found to have higher prevalence of childhood obesity than non-Hispanic white and non-Hispanic Asian youth (Ogden, Fryar, et al., 2018). Additionally, Hispanic boys have been found to have higher prevalence of childhood obesity at 28.0% than non-Hispanic black boys at 19.0% (Hales et al., 2015). This association has been further found in studies which aim to identify why this disparity exists. One possible explanation is that there is decreased neighborhood socioeconomic status among minority populations which creates an obesogenic environment (R. E. Lee, McAlexander, & Banda, 2011; Sharifi et al., 2016).

A risk factor of particular interest to healthcare providers due to its preventable nature is diet quality. One study of preschoolers found that after consuming a high- or low-energy preload drink and then having access to a standard lunch (chicken, cheese, white bread roll, crackers, chocolate biscuits, white grapes and cherry tomatoes or carrot

sticks), overweight/obese children showed the least compensation compared to children over and under the 50th percentile for BMI (Carnell, Benson, Gibson, Mais, & Warkentin, 2017). The lack of compensation implies that overweight/obese children may have difficulties regulating their intake depending on hunger and satiety cues.

A final common risk factor that is highly related to those previously mentioned is education level of the caregiver. Overall education level of the household head has been linked to childhood obesity with increased prevalence among those with a high school diploma or less (22.3%) compared to some college education (18.1%) or college graduate (11.6%) (Ogden, Fryar, et al., 2018). Additionally, health behavior knowledge of the caregiver is an area of interest for interventions targeting childhood obesity. These health behaviors may include knowledge on topics such as breastfeeding, physical activity, and general eating habits (such as the DGAs).

Beyond the few major risk factors already listed, there is also a multitude of research to support a wide variety of other risk factors which may contribute to childhood obesity. These include, but are not limited to, genetics (Bouchard, 1997), more than 3 courses of antibiotics before the age of 2 (Scott et al., 2016), primarily nighttime feeding as an infant (Cheng et al., 2016), and introduction to solid foods before the age of 6 months (Gibbs & Forste, 2014). It is also important to note that some of these factors are inherited rather than decisions the individual has made and there are multiple levels of influence on other factors such as from family members, the community, schools/workplaces, and the food industry. This creates an elaborate network of factors which may either protect against childhood obesity or promote it depending on how each factor interacts to influence each individual. The complexity of risk factors may also

contribute to some of the discrepancies in research involving childhood obesity and other factors such as food insecurity.

Food Insecurity

Definition

Like childhood obesity, the definition of food insecurity has a few variations with subtle distinctions. Typically, food insecurity refers to the inability to consume food needed for a healthy and active life. Food insecurity may exist in relation to the amount, type, and/or variety of food that is consumed. A household may also cycle between food security and food insecurity throughout each month or the year (Agrawal et al., 2018; Andress & Fitch, 2016). However, it is important to note that definitions vary among the literature which may account for discrepancies in findings.

Also similar to childhood obesity, there are a multitude of risk factors for food insecurity such as lack of access to food, lack of funds to buy foods, or inability to store food safely (Andress & Fitch, 2016; Trapp et al., 2015). Each of these factors may also have multiple causes such as homelessness, reliance on government support, time of month that income is received and expenses are due, conflict in being able to pay for all expenses, and amount and type of stores that are in the neighborhood. Numerous variables need to be considered when attempting to determine why a family might be food insecure and what assistance will be most beneficial.

Measures of food insecurity vary in the type and strength of the possible factors listed above per research study. This may include whether food security is measured at the household or personal level. For example, even though the household may be affected by food insecurity, certain family members may not personally be food insecure due to

other family members going hungry to protect them (McIntyre et al., 2003). While older children may be more aware and therefore attempt to manage food resources, preschoolers may be too young to understand why there may be less food or less desirable food being presented to them (Fram et al., 2011). This may also account for some of the conflict that exists among research on food insecurity that will be presented momentarily.

Physical Consequences of Food Insecurity

In terms of physical health, a lack of proper nutrition can lead to malnourishment, nutrient deficiencies, and stunting of growth in severe cases. In adults and the elderly, the relationship between nutrient status and food insecurity has been well established. Not only do food insecure adults have lower intakes of key nutrients during times of food insecurity, they have also been found to have lower serum concentrations of nutrients which indicates that long-term nutrient intake is inadequate (Dixon, Winkleby, & Radimer, 2001; J. S. Lee & Frongillo, 2001). Similarly, in low-income children, rates of nutrient deficiency such as iron deficiency anemia are significantly increased among those who are food insecure (Skalicky et al., 2006).

Along with nutrient deficiencies, there are also increased rates of certain medical conditions in those who are food insecure. While some studies have reported generally poorer health status (J. S. Lee & Frongillo, 2001; Stuff et al., 2004), other research has targeted specific medical conditions for specific populations. For example, one study using National Health and Nutrition Examination Survey (NHANES) data found that household food insecurity was significantly associated with clinical diabetes and among those with diabetes, the rate of adequate control was decreased for food insecure

individuals (self-reported HbA1C of 7.4% compared to 8.1%)(Seligman, Laraia, & Kushel, 2010). The same study also found that food insecurity was significantly associated with clinical hypertension, but not hyperlipidemia.

There has also been evidence of significant economic impact that results from food insecurity and the subsequent health consequences. A study of adults in Canada found that health care costs increased alongside the severity of household food insecurity in terms of inpatient care, emergency department visits, physician services, same-day surgery, home care, and Ontario Drug Benefit claims (Tarsuk et al., 2015). In fact, those in moderately and severely food insecure households had 1.33 and 1.71 times the odds of using health care services respectively compared to food secure households (marginally food insecure households were not significantly different). These costs amount to approximately an additional $235 in health care costs per year for marginally food insecure households, an additional $455 for moderately food insecure households, and an additional $1,092 for severely food insecure households. It can be noted that there is lack of publicly funded programs such as WIC to assist food insecure households in Canada, although there is universal healthcare, which decreases generalizability to the United States.

Behavioral/Cognitive Consequences of Food Insecurity

Beyond the health consequences of food insecurity, there is also evidence for negative impacts on behavior and academic performance. A study of California university students found that 51% of food secure individuals had a cumulative A average GPA while only 30% of food insecure individuals had an A average (Martinez, Frongillo, Leung, & Ritchie, 2018). Conversely, only 9% of food secure individuals had a

C average compared to 19% of food insecure individuals. In addition, those experiencing food insecurity were found to experience a significantly higher proportion of poor mental health indicators such as feeling hopeless, very lonely or sad, overwhelming anxiety or anger, and tremendous stress.

The impact of hunger on children can have severe consequences, especially when paired with other forms of hardship. For example, in a study of 9 year olds, food insecurity and energy hardship (such as inability to pay the electric or gas utility bill) at the same time was associated with almost a threefold greater odds of withdrawn/depressed behavior and somatic complaints in the borderline/clinical range (Fernandez, Yomogida, Aratani, & Hernandez, 2018). Additionally, there was almost a fourfold greater odds of rule-breaking behavior compared to children with no hardship.

In terms of preschoolers, research has found increased prevalence of developmental risk and behavior problems (such as aggression, anxiety/depression, or inattention/hyperactivity) among food insecure populations (Vozoris & Tarasuk, 2003). Additionally, those with severe hunger in the past year experienced more traumatic life events such as homelessness and had more health conditions (Weinreb et al., 2002).

Rates of Food Insecurity among Preschoolers

In 2016, overall food insecurity prevalence in the United States was 12.9% with approximately 41,204,000 people affected ("Hunger & Poverty in Arizona: Map the Meal Gap," n.d.). In Arizona, the rate was slightly higher at 14.9% with approximately 1,033,590 food insecure people. Further, in Maricopa County, the rate was 14.3% overall and 21.1% for children. Similar to childhood obesity, there is increased prevalence of food insecurity among ethnic minority households such as Latino compared to White

households (Metallinos-Katsaras et al., 2012). Additionally, food insecurity has been associated with low educational attainment, low household income, lack of health insurance, and tobacco use (Seligman et al., 2010).

The negative impacts associated with food insecurity affect a child's health, behavior, and ability to perform in academic settings (Fernandez et al., 2018; Skalicky et al., 2006; Vozoris & Tarasuk, 2003; Weinreb et al., 2002). There is an increased rate of food insecurity among families with children in CACFP; about 20% compared to 4% of food insecurity among nonparticipant households (Korenman et al., 2013). This disparity may be due to the increased need for food sources outside of the home among food insecure populations. The increased need among CACFP participating preschoolers also presents an opportunity for continued research on shared risk factors that may be targeted by interventions utilizing CACFP.

Relationship of Food Insecurity to Obesity

In terms of the relationship between food insecurity and obesity, there is a logical explanation for either a positive (also known as the hunger-obesity paradox) or inverse relationship to exist. For low income families, dietary choices are limited by what foods are accessible and affordable (Andress & Fitch, 2016). Typically for these families, there is a food environment rich in cheap calorie-dense foods and limited in affordable nutritious foods (Morrissey et al., 2014; Nackers & Appelhans, 2013). This can be exemplified by the fact that the term 'food desert' (a geographical area scant in food resources accessible to residents) is now being used less in favor of the term 'food swamp' (a geographical area saturated in food resources that are calorie-dense, but low in key nutrients) (Cooksey-Stowers, Schwartz, & Brownell, n.d.). These areas of poor

access to nutritious foods disproportionately affect low-income and minority families and recently it has been found that food swamps may predict obesity better than food deserts. It may be assumed that for low-income families this environment promotes those who are food insecure to become overweight due to the only source of calories to be from energy-dense foods that are more affordable/accessible to the family. However, the evidence of the relationship between food insecurity and weight status is currently mixed.

The conflicting evidence may be explained by the fact that the definition and measurement of food insecurity varies per study. For example, a study that finds household food insecurity exists, does not necessarily mean that each individual child in that household is food insecure or not. Further, whether a study records participation on government assistance programs (i.e. WIC, CACFP, etc.) may impact results. If a household is food insecure, they may participate in these programs, which may help to mitigate their food security status. Therefore, it is important that with each piece of literature reviewed, the methods are evaluated to account for discrepancies between studies.

The current gold standard for measuring food security is the U.S. Household Food Security Survey Module (HFSSM). These questions consist of screening questions to limit the total questions asked while still being reliable, with most households only having to answer 3 questions, or 5 if there are children in the household. These questions address food insecurity by asking about topics such as the presence of the amount and the kinds of food desired, the worry of having money to buy food, and if meals had to be adjusted or completely skipped at all. They also allow for a household food insecurity

score as well as a food insecurity score among children (but not individual children) (USDA Economic Research Service, 2012b).

Literature on the Relationship between Food Insecurity and Childhood Obesity

While there has been an increasing interest in research on the potential relationship between food insecurity and childhood obesity, there exists a case report from 1995 on an obese, food insecure 7-year-old girl. The author notes that during times of greater food security, typically higher calorie foods such as chicken wings and hot dogs are consumed which may contribute to obesity. However, he also hypothesizes that due to cycling between periods of hunger and periods of binge eating, the child's body adapted to lose weight slower and regain weight more quickly than a normal child (Dietz, 1995). In more recent years, research has expanded to look at larger samples to evaluate if children such as the one described in this case report are typical or are the exception to the rule. Key findings are summarized below.

In a study using data from 1997, it was found among 5-12 year olds that the risk of overweight was higher for those in food secure households (40.7%) compared to food insecure (34.2%). Additionally, participation in food assistance programs such as SNAP and any school meal program decreased risk of both overweight and underweight for food insecure households. However, it is important to note that in this study, weight was self-reported while height was measured by staff which may create some error (Jones, Jahns, Laraia, & Haughton, 2003). A similar study using 2007-2008 NHANES data found an increase in BMI for food secure, low-income children who utilized food assistance programs. However, BMI score for low-income food insecure (measured at the child-level with the HFSSM) children did not change with participation (Kohn, Bell,

Grow, & Chan, 2014). These studies imply that food assistance programs have varying influences on body weight depending on if the family is food insecure or not and further research is required to determine how this relationship exists among specific populations.

Another study which looked at food insecurity while on WIC further evaluated the relationship between food insecurity and prevalence of obesity by gathering data over time and differentiating between food insecurity with and without hunger. At the first visit, BMI-for-age z-scores were significantly higher for infants in households reporting food insecurity without hunger than food insecurity with hunger. Over time, if food insecurity without hunger persisted, there was a 22% greater odds that the infant would be obese as a child compared to children who were persistently food secure (Metallinos-Katsaras et al., 2012). This study further adds nuance to the narrative of families who are food insecure: while a household may be food insecure, the presence of hunger for individual family members and the role of food assistance programs can both influence whether childhood obesity occurs or not.

In terms of preschoolers, the relationship between food insecurity and childhood obesity has still received mixed results. In one study of 2-8 year old Hispanic children and their mothers, after adjusting for several factors, food insecurity was significantly associated with childhood overweight/obesity in families where the mother was overweight or obese. Additionally, the odds of overweight/obesity was increase 10-fold for those with low food security status compared to 30-fold for those with very low food security status (Papas et al., 2016).

There have also been several studies with less-conclusive results. One study of preschoolers found only a significant association between food insecurity and higher

BMI z-score for girls. Authors note that for those who were child food insecure, 25% were also overweight/obese, as well as 27% of those in household that were food insecure and the sample size of 438 may have affected the ability to detect statistical significance (Speirs & Fiese, 2016). A larger study of 9,701 which looked at both food insecurity per person and for all children for 2-11 year olds also only found food insecurity for a specific subgroup. There were no significant relationships between food insecurity at the overall child level for either age group, but there was a statistically significant association between personal food insecurity and childhood obesity for 6-11 year olds (Kaur et al., 2015). Finally, a study of preschoolers which also examined diet quality found that neither dietary patterns nor child overweight/obesity status differed based on food security status (Trapp et al., 2015). While results between each of the studies listed do vary, the protocol for measuring obesity and food insecurity differ between studies which may lead to the inconsistencies in findings.

A summary of the key methods and results for other studies that have investigated the relationship between food insecurity and obesity among youth are listed below (Table 1). While the quality of individual studies varied (depending on sample size and characteristics, measures used, confounding variables controlled for, etc.), there are several inconsistencies in protocol which may contribute to the varying results. For example, sample size varied from 74 participants to 28,353, with an average of 5,840 participants. While most studies used a sample of preschoolers, some studies include a larger age range which may introduced additional variance. In terms of measurements, while most studies use the 18-item HFSSM, some studies use a different or additional measure (e.g., four item subscale of HFSSM or Spanish version). Additionally, methods

of classifying childhood obesity ranged from parent-reported to utilizing BMI z-score and waist circumference percentile as measured by trained researchers. Finally, some studies accounted additional variables and demographics (e.g., use of other food assistance, some look at only Hispanic populations, examined depression), resulting in inconsistent studies designs and outcomes.

Table 1: A summary of key findings from studies which evaluated the relationship between food insecurity and childhood obesity among preschoolers and/or similar populations.

Author	n	Age Range	Key Demographics	Food Insecurity Measure	Weight Measure	Additional variable (if applicable)	Findings
(Jones et al., 2003)	772	5-12 year olds	Below 185% income-poverty ratio	HFSSM 18-item scale	Parent-reported weight, measure height. BMI: dichotomized to below/above the 85th percentile	Participation in Food Stamp Program, school lunch, or school lunch and breakfast	Food assistance decreased risk of both overweight and underweight for food insecure households
(Kohn et al., 2014)	1321	4-17 year olds	At or below 200% of the federal poverty line	HFSSM 18-item scale	BMI z-score (normal weight, overweight, obese) Waist circumference percentile (high or normal)	Food assistance (SNAP, WIC, school meals)	Increase in BMI for low-income food secure children with food assistance
(Metallinos-Katsaras et al., 2012)	28,353	2-5 year olds	WIC participants	4-item subscale of HFSSM	BMI for age z-score (obesity = at or above the 95th percentile)	Longitudinal: measurements completed as infant and child	Greater odds of obesity with persistent food insecurity without hunger

(Papas et al., 2016)	74	2-8 year olds	Hispanic	Spanish HFSSM (19 questions)	BMI underweight, healthy weight, overweight, or obese	Maternal overweight/obesity	Significant association between food insecurity and child overweight/obese with mothers overweight/obese
(Speirs & Fiese, 2016)	438	2-5 year olds	STRONG participants	HFSSM 18-item scale	BMI z-scores dichotomized into underweight, healthy weight, overweight/ obese	N/A	Only significant positive relationship between household food insecurity and BMI z-scores for girls
(Kaur et al., 2015)	9,701	2-11 year olds	NHANES participants	Child and personal level using 18-item HFSSM and 5 personal food security question	BMI for age z-score (obesity = at or above the 95^{th} percentile)	N/A	Only significant for personal-level food insecurity for 6-11 year olds
(Trapp et al., 2015)	222	2-4 year olds	Hispanic or African American, WIC participants	HFSSM 18-item scale	BMI health weight, overweight, or obese	Children's Dietary Questionnaire and maternal depression	No significant associations

Summary

Food insecurity and childhood obesity are both major public health concerns each with a complex network of risk factors. The interaction between these factors has thus far made it inconclusive to determine whether a definitive relationship exists. The use of standard protocols for evaluating food security status and weight status as well as focusing on a specific population may clarify why previous discrepancies in the literature exist. Preschoolers are a population of particular interest due to the fact that they may be protected from food insecurity either by food assistance programs or older household members. There is also a greater opportunity for interventions which promote health behaviors with the goal to prevent future childhood obesity. This highlights the need for additional research with consistent protocols to provide evidence on the relationship between food insecurity and childhood obesity for preschoolers and how diet quality may play a role in that relationship.

CHAPTER 3

METHODS

Study Design

The current study is a cross-sectional secondary data analysis on baseline data from two cohorts of the SAGE project (R. E. Lee et al., 2019). The SAGE (Sustainability via Active Garden Education) project is a research project with garden-based programming which provides education on gardening, physical activity, and nutrition to preschoolers in the Phoenix area. The primary outcome is to evaluate if there is a change in certain health behaviors (such as physical activity, sedentary time, and fruit and vegetable consumption) after the project. This study and all related materials were approved by the Arizona State University Institutional Review Board (STUDY00003761); written consent was provided by all parents. A copy of the consent form can be found in Appendix A.

ECEC recruitment

Early care and education centers (ECECs) of preschoolers were recruited for the SAGE project based on inclusion criteria of over 30% Hispanic/Latino population based on census tracts and at least 3,000 residents per tract. In order to detect statistically significant differences in physical activity and fruit and vegetable consumption, a sample size of 336 children across 3 cohorts provided power > .85. It was proposed that approximately 12 children from 8-12 ECECs from each cohort (28 ECECs total) would be recruited to meet this goal. In cohort 1, the first 10 out of 20 ECECs within 5 miles of Arizona State University (ASU) Downtown campus were contacted by sending a postcard to the director and then making a phone call to further evaluate potential

participation. In cohort 2, all ECECs within 10 miles of ASU Downtown campus were contacted via phone call and email which included the postcard as an attachment due to cohort 1 directors reporting they did not have time to read the mailed version. Centers were then evaluated to ensure Child and Adult Care Food Program (CACFP) participation, less than a 60 minute drop-off or pick-up window, and at least 4 or 5 school days per week; in cohort 1, centers were also required to have received at least a 3 or more Quality First rating (a program of First Things First which evaluates quality of early care and education programs) (First Things First, 2019). Research staff and directors then met at the center and completed a memorandum of understanding; in cohort 2, the teacher also met with staff and completed a memorandum of agreement for the school board or principal to approve. Once the ECEC was approved, participant recruitment at that center began.

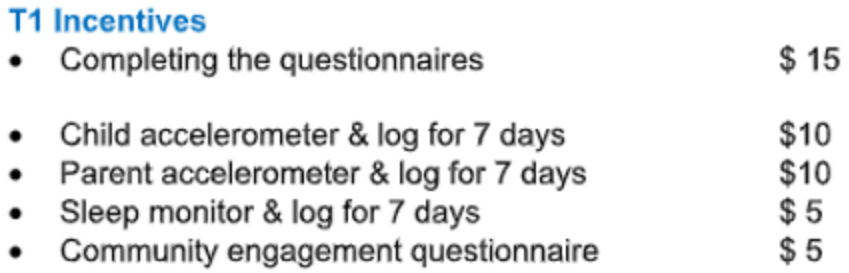
Participant recruitment

Participants were recruited from ECECs during drop-off time in the morning, pick up time in the afternoon, and at parent-teacher events. All parents of preschoolers in the enrolled classroom were approached for potential participation; if more than one child of a parent was enrolled in the same classroom, only one child was eligible for SAGE. Participants were informed that SAGE is a gardening, physical activity, and nutrition program that would be implemented at their preschooler's center if enough parent participation (75%) was reached by consenting to complete surveys, measurements, and allow staff to complete observations at the school. If interested, staff would then review the consent form (see Appendix A) in English or Spanish and discuss any questions from the parent. If the parent allowed their voluntary consent, they would complete the consent

form and be issued a participant identification number. They would also then complete a staff-instructed demographic survey, fruit and vegetable screener, and physical measurements of the parent. The enrollment process took approximately 30 minutes; if parents were unable to complete all measures, an appointment was set during the next recruitment session at their child's school.

The parent would be given parent and child accelerometers as well as a survey packet which included a Home Food Inventory, Parent and Child Demographic Survey, and Community Engagement Survey with instructions on how to complete them. While not all data was used for this study, a full description of all SAGE design and methodology is published elsewhere (R. E. Lee et al., 2019). Once recruitment was completed, staff began completing data pick up sessions during drop-off and pick up times for the preschoolers. Participants received incentives based on materials returned according to the following chart.

Figure 1: Incentives provided to participants based on measures completed and returned to staff.



Measures

Food Insecurity

Food insecurity was measured via questions taken from the previously validated Six-item Short Form Food Security Survey Module in the Parent and Child Demographic

Survey (See Appendix B)(USDA Economic Research Service, 2012a). Questions involve recall of the food eaten in the household in the last 12 months. The first two questions were asked as statements with participants instructed to identify whether in the past 12 months, the statement was often true, sometimes true, or never true:

- "The food that (I/we) bought just didn't last and (I/we) didn't have money to get more"
- "(I/we) couldn't afford to eat balanced meals".

The following 3 questions required yes or no responses with a follow up question required if 'yes' was answered:

- "In the last 12 months, since last (name of current month), did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?"
    - "How often did this happen- almost every month, some months but not every month, or in only 1 or 2 months?"
- "In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?"
- "In the last 12 months, were you ever hungry but didn't eat because there wasn't enough money for food?"

Food security status was evaluated based on raw score determined by the sum of affirmative responses. Two or more affirmative responses indicated food insecurity.

Anthropometric Measures

Anthropometric measures for children were completed during a school day once parent recruitment was completed. Measures were completed by trained staff who

ensured the participant did not have any bulky clothing or hair ornaments that would interfere with measurements. Height was measured twice in feet and inches to the nearest .25 inch using a stadiometer. If the two measurements differed by more than .25 inch, a third measurement was taken. Weight was measured in pounds using a TANITA TBF-310-white scale twice to the nearest tenth of a pound. Waist circumference was measured at the belly button using the Baseline Gulick Measurement tape centimeters to the nearest tenth of a centimeter with a third measurement taken if the first two differed by more than 1.0 cm.

Diet Quality

During school assessments, classroom meal observations were also measured by staff for measures of dietary intake. Staff were instructed to fill out a log (see Appendix C) which included basic information such as date/time of meal, name of meal, and food items present for the meal. For each participant, staff would then record how much of a food item was given to the child, whether the child served themselves or the teacher did, how much (if any) additional servings were given to the child, the amount left on the child's plate (recorded in percent or fraction) and any notes such as if the child dropped or shared a food item. Staff were instructed to record as much detail as possible such as the brand name on packaged items and exact amount of foods that were prepackaged such as milk, taking pictures of food items as needed. Staff were also instructed to discuss with each other and come to a consensus on how to report certain food items.

The meal observation records were then entered by trained staff into the National Data System for Research (NDSR) database. Meal observation records included name/time of meal and amount of food item consumed with as much detail as possible,

and any notes that may be pertinent. An excel sheet was also created to record any changes made by the person who verified the initial record as well as to record justification for using a certain food item in substitute for an item not found in the database as approved by the principal investigator. Diet quality was measured via evaluation of intake of total calories, fruits and vegetables, juice, and saturated fats and sugars from the NDSR. These components will be assessed individually as these dietary quality components have been associated with excess weight gain in children (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2015).

Sociodemographic Variables

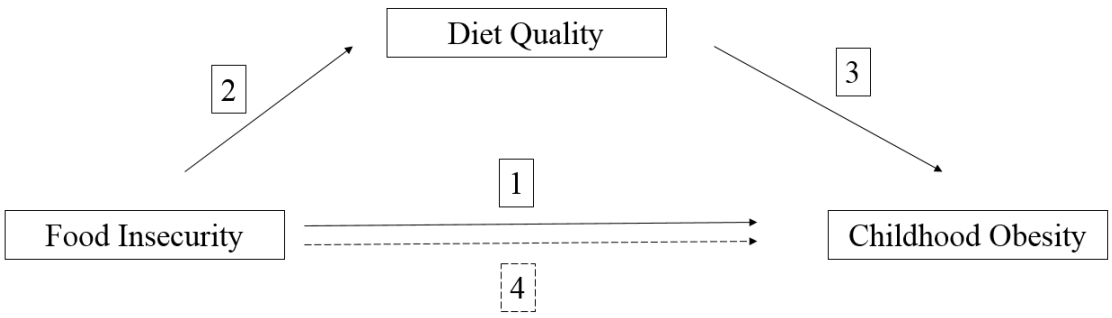
Sociodemographic characteristics were recorded via questions on the Parent and Child Demographic Survey as well as the staff-instructed demographic survey completed after voluntary consent was received. Measures household size, parental acculturation, and child demographics (race, ethnicity, age, and sex). Acculturation was evaluated using the previously validated General Acculturation Index on a scale of 1-5 with 1 being low acculturation (Balcazar, Castro, & Krull, 1995).

Statistical Analyses

Statistical analyses were completed with SPSS Version 25. The alpha level (statistical significance) for all tests was set at .05. Descriptive statistics were reported as means plus/minus standard deviations for child age in months, household size, acculturation, BMI, BMI percentile, and waist circumference. Categorical data, child sex and race/ethnicity, food security status, and weight status, was reported as valid percent (percent of the sample for whom data is available). Chi square tests were used to evaluate differences between categorical data; child race, sex, food security status, and weight

status. Independent t-tests were used to test significant differences between independent groups (divided by child race, child sex, and food security status) on key outcome variables (BMI percentile and waist circumference) with equivalent non-parametric tests used for data that are not normally distributed. A mixed multivariate regression analysis using the Baron-Kenny approach (Baron & Kenny, 1986) was used for the mediation analysis between food insecurity, diet quality, and BMI percentile or waist circumference. This involves first determining that a relationship exists between food insecurity and the anthropometric measures (1). Then, correlations between food insecurity and diet quality (2) as well as diet quality and anthropometric data (3) will be evaluated to determine if a relationship exists. If significant relationships have been identified in all of the previous steps, the final step is to determine if a relationship between food insecurity and anthropometric data exists while controlling for diet quality (4). This final step should be non-significant as diet quality will be contributing to the relationship between food insecurity and BMI percentile or waist circumference.

Figure 2: Mediation analysis assessing the relationship of food insecurity to childhood obesity (measured as BMI percentile or waist circumference) with diet quality as the mediator.



CHAPTER 4

RESULTS

Participant Characteristics

The sample of participants (*n*=154) was nearly equal female and male children with a majority reported as Hispanic (78.6%; Table 2). Child age ranged from 3-5 years (mean 4.4 ± .4). No significant differences in sociodemographic characteristics between cohorts were observed. Diet quality components are listed in Table 3. Additionally, 28 participants (19.3%) did not consume a fruit and 59 participants (40.7%) did not consume a vegetable during the school day.

Table 2. Sociodemographic characteristics of SAGE preschool participants from cohorts 1 and 2 (*n*=154)

Characteristic (n)	*Mean ± SD*
Child Age in months (150)	53.13 ± 4.49
BMI (145)	16.86 ± 2.57
BMI Percentile (141)	67.67 ± 28.59
Waist Circumference in cm (144)	55.17 ± 6.78
Household size (119)	4.95 ± 1.62
Acculturation (121)	3.04 ± 1.31
Characteristic (n)	*% (valid)*
Child Sex (154)	
Male (81)	52.6%
Female (73)	47.4%
Ethnicity (145)	
Hispanic (114)	78.6%
Non-Hispanic (31)	21.4%
Race (146)	
Hispanic White (56)	38.4%
Hispanic Black (4)	2.7%
Non-Hispanic White (14)	9.6%
Non-Hispanic Black (14)	9.6%
Hispanic Race Unknown (54)	37.0%
Don’t know (1)	.7%

American Indian/Alaskan Native (3)	2.1%
Food Security Status (122)	
Food Secure (71)	58.2%
Food Insecure (51)	41.8%
Overweight/Obesity status (144)	
Not overweight/obese (88)	62.4%
Overweight/Obese (53)	37.6%

Table 3. Diet quality components of SAGE preschool participants (*n*=154). Data was taken from all meals observed during one school day

	Minimum	*Maximum*	*Mean ± SD*
Juice	0	2.75	.17 ± .39
Fruit (not including juice)	0	3.30	.85 ± .77
Vegetables (not including fried potatoes)	0	1.82	.23 ± .35
Vegetables (including fried potatoes)	0	1.82	.26 ± .36
Energy (kcal)	27.20	1001.37	491.46 ± 211.79
Saturated Fat (g)	0.32	20.04	5.88 ± 3.52
Added Sugars (g)	0	44.43	10.19 ± 9.95

Chi-square Analyses

Chi-square analyses revealed no significant difference between child sex, age, or race for food security status or weight status. Likewise, there was no significant difference between children grouped by weight status and food security status.

Table 4. Chi-Square Tests examining the bivariate association between sociodemographic and weight status or food security status

	Weight Status			Food Security Status		
	Not overweight/ obese	Overweight/ obese		Food Secure	Food Insecure	
	n (%)		*p-value*	*n (%)*		*p-value*
Ethnicity: Hispanic	65 (75.6%)	41 (83.7%)	*p*=.271	54 (77.1%)	42 (84.0%)	*p*=.355

Ethnicity: Non-Hispanic	21 (24.4%)	8 (16.3%)		16 (22.9%)	8 (16.0%)	
Sex: Male	48 (54.5%)	26 (49.1%)	*p*=.527	37 (52.1%)	23 (45.1%)	*p*=.445
Sex: Female	40 (45.5%)	27 (50.9%)		34 (47.9%)	28 (54.9%)	
Food Security Status: Secure	46 (69.7%)	32 (66.7%)	*p*=.800		-	
Food Security Status: Insecure	20 (30.3%)	16 (33.3%)				

Mann-Whitney U Analyses

Mann-Whitney U tests revealed no significant difference between mean waist circumference or BMI percentile of children grouped by sex, ethnicity, or food security status (table 5).

Table 5. Mann-Whitney U tests examining bivariate association between sociodemographic variables and BMI percentile or waist circumference

	BMI Percentile		Waist Circumference	
	Mean ± SD (n)	*p-value*	*Mean ± SD (n)*	*p-value*
Ethnicity: Hispanic	68.48 ± 28.82 (106)	*p*=.294	55.48 ± 7.13 (106)	*p*=.483
Ethnicity: Non-Hispanic	633.93 ± 27.08 (29)		53.72 ± 4.06 (29)	
Sex: Male	67.19 ± 29.15 (74)	*p*=.933	55.48 ± 7.10 (74)	*p*=.405
Sex: Female	68.19 ± 28.15 (67)		54.85 ± 6.47 (70)	
Food Security Status: Secure	63.53 ± 29.39 (66)	*p*=.477	53.71 ± 4.35 (66)	*p*=.659
Food Security Status: Insecure	67.13 ± 27.88 (48)		55.13 ± 7.84 (48)	

Mediation Analyses

For step one of the mediation analyses (Table 6), food security status showed no association between waist circumference nor BMI percentile when controlling for acculturation, household size, and child demographics (age, sex, and ethnicity). While a true mediation analysis would stop after no significant relationship is found in this initial analysis, all 3 following steps were run for the purpose of this thesis. In step two (Table 7), no associations were found between food security and any individual diet quality component (note that this step was only run once the association between food insecurity and diet quality components is independent of BMI percentile or waist circumference). In step three (Table 8), no associations were found between individual diet quality components and waist circumference nor BMI percentile. Finally, there were no significant findings in the final step of the mediation analysis (Table 9). It is important to note than in a majority of these analyses, the standard error of beta was greater than beta itself. This indicates that the variance is too large to signify consistent results between participants.

Table 6. Step 1 of the mediation analysis examining the relationship between sociodemographic variables and physical measures (BMI percentile and waist circumference) (*n*=154)

	→BMI Percentile			→Waist Circumference		
	Beta	*SE of beta*	*p-value*	*Beta*	*SE of beta*	*p-value*
Food Insecurity	2.424	5.995	.687	1.886	1.277	.143
Acculturation	.497	3.365	.883	.288	.720	.690
Age	-.493	.665	.460	.282	.143	.052
Sex	-2.708	5.865	.645	.142	1.244	.909
Hispanic	-5.764	9.948	.564	-1.311	2.132	.540

Table 7. Step 2 of the mediation analysis examining the relationship between food insecurity and diet quality components (*n*=154)

Food insecurity →	*p-value*	*Beta*	*SE of beta*
Fruit	0.516	.093	.144
Vegetables	0.751	-0.24	.076
Juice	0.338	-0.085	0.088
Total kcal	0.389	-37.634	43.475
Saturated Fat (g)	0.542	-0.457	.745
Added sugars (g)	0.127	-3.309	2.152

Table 8. Step 3 of the mediation analysis examining the relationship between diet quality components and physical measures (BMI percentile and waist circumference) (*n*=154)

	BMI Percentile			Waist Circumference		
	Beta	*SE of beta*	*p-value*	*Beta*	*SE of beta*	*p-value*
Fruit	-0.002	0.002	0.315	-.002	.013	.890
Vegetables	0.002	0.001	0.220	.004	.007	.575
Juice	0.001	0.002	0.577	.005	.008	.556
Total kcal	0.796	0.747	0.289	1.362	3.801	.721
Saturated Fat (g)	0.023	0.013	0.069	.057	.064	.375
Added sugars (g)	0.048	0.037	0.200	.043	.189	.819

Table 9. Step 4 of the mediation analysis examining the relationship between food insecurity and physical measures (BMI percentile and waist circumference) while controlling for diet quality components (*n*=154)

	BMI Percentile			Waist Circumference		
	Beta	*SE of beta*	*p-value*	*Beta*	*SE of beta*	*p-value*
Fruit	1.530	6.249	0.807	-.122	.885	.462
Vegetables	1.355	6.219	0.828	.935	1.661	.575
Juice	1.422	6.219	0.822	.836	1.416	.556
Total kcal	1.785	6.264	0.776	.001	.003	.721
Saturated Fat (g)	1.974	6.172	0.750	.153	.172	.375
Added sugars (g)	2.420	6.293	0.701	.013	.059	.819

CHAPTER 5

DISCUSSION

Overview

The purpose of this secondary data analysis was to examine the relationship between food insecurity and BMI percentile with diet quality as a mediator among preschoolers in the Phoenix area. Contrary to the hypotheses, there were no statistically significant findings across all analyses. In previous literature, there have been mixed results on whether a relationship between food insecurity and weight status exists (Jones et al., 2003; Kaur et al., 2015; Kohn et al., 2014; Metallinos-Katsaras et al., 2012; Papas et al., 2016; Speirs & Fiese, 2016; Trapp et al., 2015). Beyond the limitations of this study, this may be due to the fact that there are numerous risk factors for both food insecurity and weight status that cannot all be controlled. Future research of high quality is needed to confirm or deny if a relationship between food insecurity and weight exists for preschoolers and if so, in what context.

While no bivariate analyses provided significant findings, there are a few characteristics of the sample that are notable. For example, the food insecurity rate for preschoolers in the Phoenix area was 41.8% which is higher than the child food insecurity rate in Arizona in 2016 at 22.7% ("Hunger & Poverty in Arizona: Map the Meal Gap," n.d.). Food insecurity is a major public health issue due to the health and cognitive implications, particularly for preschoolers as they are undergoing brain development and growth at this age (Hamelin, Habicht, & Beaudry, 1999; Robson, Lozano, Papas, & Patterson, 2017; Seligman, Bindman, Vittinghoff, Kanaya, & Kushel, 2007; Seligman et al., 2010; Weinreb et al., 2002). Additionally, there are concerns for

the quality of nutrition that these children are receiving during times of food security. Previous research has found that the diet quality of individuals who are food insecure may suffer.

We found average servings of fruits and vegetables were lower than recommendations with some children not eating a single fruit or vegetable during the school day. It is important to note that the diet components used in these analyses are only during the school day and are therefore not indicative of 24-hour diet quality. While vegetable servings with and without fried potatoes only varied by .03 servings, vegetables without fried potatoes were used for analyses as fried potatoes are not recognized as having the same diet quality as other vegetables. Finally, it is important to note that even though the minimum for juice, fruit, and vegetable servings were all 0 (with 19.3% of children not consuming a fruit and 40.7% not consuming a vegetable during the school day), all children in the sample consumed saturated fat during the school day. The average grams of saturated fat and added sugars consumed was 5.9 and 10.2 respectively which translates to over 40 kilocalories each with students who consumed the maximum saturated fat or added sugar grams reported consuming 180 kilocalories from these sources. While this study evaluated diet quality components individually, rather than an index, this information indicates that there are children in the sample with poor diet quality. Despite CACFP requirements to offer certain foods, children in this sample may not be meeting fruit and vegetable recommendations and/or exceeding saturated fat and added sugar recommendations. Since children at this age are establishing key health behaviors, future policies and practices should take this information into account.

Finally, the anthropometric data of these participants imply poorer health behaviors compared to national averages. The incidence of childhood overweight/obesity in this sample was increased (37.6%) compared to the 2016 national average of preschoolers at 13.9% (Ogden, Carroll, et al., 2018). Likewise, the nation-wide average waist circumference for 4-year olds are 51.5 cm and 51.1 cm for males and females respectively. However, in this sample, the average waist circumference was 55.2. This information indicates that this sample has physical measures that are increased compared to the national average of preschoolers. Childhood overweight/obesity has already been recognized as a national public health concern due to the negative health consequences, both immediate and long-term (Ekström et al., 2017; Mameli et al., 2018; Rolland-Cachera et al., 2006; Schwimmer et al., 2003). The increased incidence of childhood overweight/obesity in this sample is alarming due to implications that preschoolers may struggle with their weight and health in the future.

Although no significant associations between food insecurity, diet quality components, and anthropometric measures were found, there are implications from the results. This sample appears to have both higher rates of food insecurity and childhood overweight/obesity compared to national averages and children with poor diet quality, despite CACFP participation. Previous studies have found mixed results, with mostly null results or only achieving statistical significance under specific circumstances. Along with the limitations of this study, it is important to note that there are numerous risk factors for both food insecurity and childhood overweight/obesity which cannot all be taken into account.

Strengths and Limitations

There are several study strengths and limitations that need to be considered when interpreting the findings. Strengths of this study include the well-defined population, the methods of obtaining data, and the fact that diet quality was included as a potential mediator. This study examined food insecurity and weight for the well-defined population of 3-5 year olds in the Phoenix area. To date, only 3 previous studies have focused on an equally narrow age range (Metallinos-Katsaras et al., 2012; Speirs & Fiese, 2016; Trapp et al., 2015). While previous studies have used parent-reported anthropometric measures and/or categorized weight status, this study used researcher-observed meal data and anthropometrics and analyzed weight as two continuous variables (BMI percentile and waist circumference). Finally, this study also evaluated diet quality as a mediator which is novel in this research. While no significant associations were found, it allowed further insight into the diet quality of Phoenix preschoolers which would have been overlooked if not included in the analyses.

There are also several limitations of this study which may have contributed to the null results. This study used the 6-item Household Food Security Survey Module which provides household food security status, rather than child or individual levels as compared to the 18-item HFSSM which is the gold standard (USDA Economic Research Service, 2012a, 2012b). Results may have differed if child-level food security status was used in the analyses. Meal data only exists for school meals and cannot account for all 24 hours of diet quality. Particularly for those participants who experience food insecurity, diet quality may have differed if 24-hour meal data was available. Additionally, although meal data was included as a mediator, not all risk factors of food insecurity and weight were included in these analyses. A convenience sample was used as not all children at

each site participated, which may limit the generalizability of the findings. Findings may not be generalizable to other populations outside of the Phoenix metro.

Implications for Policy and Practice

Due to the paucity of research on the relationship between food insecurity and childhood obesity, particularly among preschoolers, additional investigation is warranted. It is vital that this future research by of high quality and utilize consistent protocols (i.e. the 18-item HFSSM, researcher-measured anthropometrics, etc.). Additionally, research will need to be completed on potential mediators to detremine the full context of for whom the relationship between food insecurity and childhood obesity exists, when, and why. For example, previous research has found significant associations between childhood obesity for children with persistent food insecurity without hunger and for 2-5 year old girls (Metallinos-Katsaras et al., 2012; Speirs & Fiese, 2016).

Further, as this context is provided, policy and practice may be designed and/or modified in order to target this relationship to provide interventions which aim to prevent both food insecurity and childhood overweight/obesity at once. This includes not only providing food to those who are food insecure, but ensuring that the food is of high nutritional quality. This may be achieved by improving access to nutritional foods such as with community gardens, making nutritional foods more affordable through policy change, and/or ensuring that families have enough nutritious foods for all members of the family so they do not have to rely on highly-processed foods. This also includes utilizing programs such as the Child and Adult Care Food Program to provide nutritious foods to preschoolers, such as those in this study ("Nutrition Standards for CACFP Meals and Snacks | Food and Nutrition Service," n.d.). While CACFP does have nutrition standards,

there appeared to be children in this study with poor diet quality which implies there is room for improvement within such programs. Finally, nutrition education for preschoolers is paramount to ensure that children are utilizing these resources properly and establishing positive health behaviors early.

Summary

This study was the first to examine food insecurity, diet quality, and anthropometrics in Phoenix preschoolers. While the results do not support the hypotheses, there are implications for future research, practice, and policy based on the findings of this study. The participants of this study experienced both food insecurity and childhood overweight/obesity at a higher rate than the state/national averages and had diet quality component measures which implied there are preschoolers who have poor diet quality despite CACFP participation. Future research is needed to confirm or deny if a relationship between food insecurity and childhood obesity exists, for whom, and in what context. Additionally, future practice and policy needs to address food insecurity in a way which provides nutritious foods to those in need.

CHAPTER 6

CONCLUSION

Food insecurity and childhood obesity are both major public health concerns in the United States of America (Hales et al., 2015; "Hunger & Poverty in Arizona: Map the Meal Gap," n.d.). Both of these concerns are affected by a multitude of risk factors and share numerous negative physical and cognitive repercussions. These negative consequences have even further implications for preschoolers (children ages 2-5) as they are experiencing rapid growth and development of key health behaviors. Preschoolers tend to have improved health behaviors compared to older age groups which suggests there is potential for interventions and policies to target these behaviors and influence future health outcomes (Kim et al., 2014; Ogden, Carroll, et al., 2018; U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2015).

Research on the relationship between food insecurity and childhood obesity has been inconclusive, possibly due to the complex nature of the research and inconsisent quality of research (Jones et al., 2003; Kaur et al., 2015; Kohn et al., 2014; Metallinos-Katsaras et al., 2012; Papas et al., 2016; Speirs & Fiese, 2016; Trapp et al., 2015). The present study aimed to evaluate the relationship between food insecurity and BMI percentile with diet quality as a mediator for preschoolers in the Phoenix area. While no bivariate analyses were statistically significant, there are implications from results such as the increased rate of food insecurity and childhood overweight/obesity among the sample, and the fact that there were children with poor diet quality despite CACFP participation. Future research of high quality is needed to confirm for whom the relationship between food insecurity and childhood obesity exists, and in what context. Additionally, policy

and practice may be developed with the goal to decrease these harmful conditions and create a healthier future for everyone.

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APPENDIX A

SAGE CONSENT FORM

SAGE

Sustainability via Active Garden Education

Consent Form

Title of research study: Partnering to prevent early childhood obesity: Sustainability via Active Garden Education (SAGE)

Principal Investigator: ***Dr. Rebecca E. Lee***

Why am I being invited to take part in a research study?

We invite you to take part in this research study, because your child's early care and education center will be implementing the Sustainability via Active Garden Education (SAGE) program. SAGE teaches children about the importance of physical activity and eating fruits and vegetables in order to grow healthy and strong. Your child will taste new fruits and vegetables and will learn how to plant, water, and harvest in a real garden. In addition, SAGE provides a safety curriculum that teaches children about various safety topics including sun, fire, water, and pedestrian safety.

Why is this research being done?

The purpose of this study is to determine whether a garden-based physical activity and nutrition education program in early care and education centers will increase physical activity and improve dietary habits among 3-5 year-old preschool children to meet national guidelines for good health.

How long will the research last?

This research study will last one year. We expect that children will spend about one year participating in the proposed activities, which will take place at your child's early care and education center. The SAGE Garden and Safety curricula last for 12 weeks. There will be one to two weeks of measurement before the program begins, after that; your child will complete each curriculum over the course of the school year. We may contact you later to measure your child again and ask follow up questions. If we contact you after one year, we will have a new consent form for you to review and sign, if you wish to continue participation. There is more information about this below in this document.

How many people will be studied?

We expect between 15 and 40 children and their parents from each center will participate in SAGE.

What happens if I say yes, I want to be involved with this research?

If you say yes, your child will be asked to participate in the SAGE program, which includes a garden and a safety curriculum. **The garden curriculum** is a physical activity, and nutrition education program. Your child will learn how to plant, water, weed, mulch and harvest the garden, as well as learn simple food preparation activities such as washing, cleaning and sampling garden produce. You will receive newsletters to show key concepts about the garden and what your child is learning will be sent home weekly to keep you informed about the SAGE gardening program at your child's early care and education center. We will also send you text messages to look for the newsletters from your child, to update you on what is happening at school and to remind you about measurements.
The safety curriculum includes topics on sun, fire, water, and pedestrian safety. Both curricula are delivered in your child's early care and education center.

We will ask your child and you to complete surveys and measures to determine whether participation in the program increased your child's physical activity and the amount of fruit and vegetables that she or he eats. We will ask you to complete these measurements four times during the project, at the beginning of the school year, in late July - early August; in November or December; at the end of the school year, in April or May; and at the beginning of the following school year, June or July next year.

Children measurements (at school); 4 times in a year

- At the center, your child will participate in an age-appropriate assessment of their hunger and fullness, as well as age appropriate assessments of fitness and motor skills.
- We will measure your child's and your height, weight, waist circumference.
- We will also observe what your child eats at the center periodically.

Parent measurements (at school); 4 times in a year

- We will measure your height, weight, waist circumference, blood pressure, and body fat with a scale.

At home measures for children and parents

- Physical activity monitor: Your child's and your physical activity will be measured using a small electronic device like a pedometer called an accelerometer. The accelerometer is completely safe for children and adults to wear. Your child and you will wear a physical activity accelerometer on the hip for 7 days, continuously, except during bathing or swimming.

- Sleep monitor: You may be asked to place a sleep monitor on your child's non-dominant ankle for 7 nights. The sleep monitor should be worn from bedtime to the time that your child gets out of bed in the morning. If your child is right-handed then you will place the sleep monitor around your child's left ankle. If your child is left-handed, then you will place the sleep monitor around your child's right ankle. Sleep monitors are completely safe, and are similar to wearing a "Fit Bit" type of device.

- Physical activity and sleep log: We will ask you to complete a 7-day log of the times when the accelerometers were removed for bathing or swimming, and what times your child went to bed and got up for the day, each day.

- Surveys: We will also ask you to complete short surveys that tell us about the amount fruit and vegetables that are available in your home, your physical activity and nutrition parenting practices, and your child's sleep habits. We will also ask you some demographic questions about how you describe both your child and yourself, and a community engagement questionnaire. You may complete these surveys either during parent meetings or at home using an electronic survey on a computer, tablet, phone or a paper survey. These surveys will take approximately 30-60 minutes to complete.

We will ask you to complete these measurements **only four times during the project**:

1. First measurements, in late July - early August
2. Second measurements, in November or December
3. Third measurements, April or May
4. Fourth measurements, June or July

Additional measures for mothers
You may have the opportunity to be part of a small group of mothers who will provide us with additional information. We will invite 100 mothers to give a small blood sample (finger stick) to measure blood fats (cholesterol and triglycerides), sugar and other indicators of how cholesterol and sugar are transported and processed in the body. Mothers who agree to have their blood sample measured will need to be fasting for at least 10 hours. The blood sample process will take about 5 minutes. We will also ask you to complete an active transportation log to track any time you walk or bike to or from a destination during the 7 days when you wear an accelerometer. This will be used to determine if a relationship exists between active transportation and blood fats and sugar. You may experience minor discomfort and/or bruising at the site of the finger stick. You will also be given a copy of the results of your blood test for you to share with your health care provider, and a list of clinics that provide free or reduced-price health care will be given to you in the event you do not have a primary care provider.

What happens if I say yes, but I change my mind later?

Your child and you can leave the research study at any time, and it will not be held against you. You are free to decide whether you wish to participate in this study. Your participation is voluntary and you may refuse to participate or withdraw at any time without penalty or loss of benefits to which you are otherwise entitled. You may also refuse to answer any question or complete any portion of the assessments if you choose.

Is there any way being in this study could be bad for me?

There are minimal risks associated with this study that are associated with physical activity. While participating in SAGE, children will be running and jumping, which pose risks like those that children may experience during recess at school (i.e. falls, scrapes, and exacerbate asthma). There will be constant oversight of the children as they engage in the garden program. We will never use fertilizer or other toxic chemicals, or large, metal garden tools in the presence of the children while in the garden. You may experience boredom or fatigue from completing surveys. Also, you may experience mild discomfort when getting your blood pressure measured, similar to what you experience during a visit to the doctor.

Will being in this study help me in any way?

While you will not directly benefit, your participation may help investigators understand how to improve physical activity and dietary habits in preschoolers to help improve health outcomes and meet federal guidelines.

What happens to the information collected for the research?

We will make every effort to protect your family's and your confidentiality. All identifying information (like your child's and your name or contact information) will be assigned a code number by the principal investigator and project manager. The code number will appear on all written materials. The list pairing identifying information to the assigned code number will be kept separate from all research materials in a locked and safe location and will be available only to the SAGE research team. Confidentiality will be maintained within legal limits. We cannot promise complete secrecy. An organization that may view or copy your information is the University institutional review board that reviews research. This board ensures that researchers are doing their jobs correctly and protecting your information and rights.

Information that you give us will be combined with the information from other research participants like your family and you. Information will be aggregated together so that no single individual can be identified. Findings based on this combined information from this study will be presented at scientific meetings and published in scientific journals, and may be published by the popular media or used on web sites.

What else do I need to know?

This research is being funded by the National Institute on Minority Health and Health Disparities at the National Institutes of Health (NIH).

How much does it cost to participate?

SAGE is free and has no cost to you.

We are grateful for your participation, and we recognize that your participation may pose some inconvenience for you. In order to recognize the time that you will take to participate in the study, you will receive up to a total of $25 for completing the all of the first measurements, $30 for completing all of the second measurements, $35 for completing all of the third measurements, and $40 for completing all of the fourth and last measurements, for completing the questionnaires, and having your child wear the accelerometer for 7 days.

If you participate in the group of parents who will wear an accelerometer for 7 days at T1 and T2, or T1, T2 and T3, you will receive an additional $10.

If you participate in the group of parents who will have their child wear a sleep monitor at night for 7 nights, you will receive an additional $5.

If you participate in the group of mothers who will provide us with a small blood sample to measure blood fats, you will receive an additional $10.

If you participate complete the community engagement questionnaire, you will receive an additional $5.

Who can I talk to?

If you have questions, concerns, or complaints, please call 602-496-2011 to speak to a member of the research team.

This research has been reviewed and approved by the ASU Social Behavioral IRB. You may contact them at (480) 965-6788 or by email at research.integrity@asu.edu for any of these reasons:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research participant.
- You want to get information or provide input about this research.

SAGE

Sustainability via Active Garden Education

Contact Form

Parent full name Child full name

Street address City State Zip code

( ) ( )

Home phone number Cellular phone number Email

Alternate contact information (in case we are not able to contact you)

Alternate contact full name

Street address City State Zip code

( ) ( )

Home phone number Cellular phone number Email

Alternate contact information (in case we are not able to contact you)

Alternate contact full name

Street address City State Zip code

( ) ( )

Home phone number Cellular phone number Email

Additional Permissions & Waivers

Photographs: We would like to know whether we may use photographs of your child during their participation in the SAGE garden program. These photographs will be used for scientific presentations and/or publications, and to show community partners and potential participants what we do in the SAGE program. We may add these photographs to our SAGE website (sageasu.weebly.com), flyers and brochures, and to the weekly newsletters that you will receive during the SAGE program. If you agree, please check "yes" below, giving us permission to use photographs of your child.

_____ Yes, I agree for the SAGE team to take photographs of my child.

_____ ▫ Complete Photo release form.

_____ No, I do not agree for the SAGE team to take photographs of my child.

Phone calls and text messages: We would like to know whether it is okay to call and send you text messages during data collection periods to remind and see if you have any questions or concerns about the assessments, accelerometers, and sleep monitor. We will also send you texts during your child's participation in the SAGE program. This will be about once or twice a week.

_____ Yes, I agree to receive phone calls.

_____ No, I do not want to receive phone calls.

_____ Yes, I agree to receive text messages.
Phone Carrier:_____

_____ No, I do not want to receive text messages.

Participating in future research studies or follow-up interviews: We may want to contact you in the future to ask you follow up questions about your child's or your experience in SAGE. Please indicate below if you agree to be contacted in the future.

_____ Yes, I agree to be contacted in the future.

_____ No, I do not want to be contacted in the future.

Street address and nearest cross streets: We would like to know if it is okay if we obtain the walkability score of the census block group where your street address and/or nearest cross streets are located. This information will be used for statistical analyses for the SAGE program and will be kept confidential.

_____ Yes, I agree that you use my street address and nearest cross streets to obtain walkability scores
Nearest cross streets:_____and_____

_____ No, I do not agree that you use my street address and nearest cross streets to calculate walkability

Signature Block for Parental Permission for Children
Your signature documents your permission for the named child to take part in this research.

Printed name of child

Signature of parent or individual legally authorized to consent to the child's general medical care

Date

Printed name of parent or individual legally authorized to consent to the child's general medical care

❑ Parent
❑ Individual legally authorized to consent to the child's general medical care (See

Note: Investigators are to ensure that individuals who are not parents can demonstrate their legal authority to consent to the child's general medical care. Contact legal counsel if any questions arise.

Signature Block for Capable Adult
Your signature documents your permission to take part in this research.

Signature of participant

Date

Printed name of participant

Signature of person obtaining consent

Date

Printed name of person obtaining consent

My signature below documents that the information in the consent document and any other written information was accurately explained to, and apparently understood by, the participant, and that consent was freely given by the participant.

Signature of witness to consent process

Date

Printed name of person witnessing consent process

ASU ARIZONA STATE UNIVERSITY

Photo/Filming Subject Release

I grant permission to the Arizona Board of Regents, a body corporate, for and on behalf of Arizona State University, and its agents and employees (**ASU**), the absolute right to use, not use, reuse, publish, republish and make derivative works of, all or any part of photographs and/or motion pictures and/or voice recordings and/or written/spoken statements taken of me on the date(s) and at the location(s) listed below (the **Photos/Filming**), in any media now or hereafter known, including the internet, for the purpose set forth below, and for any related ASU purposes, including illustration, promotion, art, editorial, and advertising, without restriction.

I waive any right to inspect or approve the Photos/Filming, or any uses thereof, now or in the future, and I waive any right to royalties or other compensation arising from or related to the use of the Photos/Filming.

I release and discharge ASU of and from any claims, demands, and damages that may arise from or related to the use of the Photos/Filming, including any claims for libel or violation of any right of publicity or privacy, and including any re-use, distortion, blurring, alteration, or use in composite form. It is in the discretion of ASU to decide whether and how to use the Photos/Recordings.

This Release will be binding upon me and my heirs, legal representatives, and assigns.

Unless my parent or guardian signs where indicated on the signature lines below, I certify that I am 18 years of age or older, and I am competent to contract in my own name. I have read this Release and I fully understand the contents, meaning, and impact of this Release.

For subjects of the Photos/Filming who are under 18, this Release must be signed by both the minor subject and his/her parent or guardian. By signing, the parent or guardian attests that he/she is competent to contract in her/his own name, has read this Release, and fully understand the contents, meaning, and impact of this Release.

Date(s) of Photos/Filming: August 2018 - May 2019

Location(s) of Photos/Filming: _____

Purpose of Photos/Filming: We will use photos for SAGE website, newsletters, scientific publications and presentations.

Signature of Subject of Photos/Filming: _____

Print Name of Subject of Photos/Filming: _____

Parent/Guardian Signature and Print Name: _____

(Parent or Guardian must sign only if Subject of Photos/Recordings is under 18)

Date Signed: _____

Mailing Addresses of all signatories: _____

Emails of all signatories: _____

Name of ASU Photographer/Filmer: _____

Revised 10/12/15 OGC

APPENDIX B

SAGE SURVEYS

SAGE
Sustainability via Active Garden Education

Parent ID #_____ Parent and Child Demographic Survey Child ID #_____

Instructions: Thank you for completing our parent survey!
These first few questions are ABOUT YOU, and we will ask you more about your child later.

1. During the past **30 days**, which statement best describes the kinds of physical activity that **you** usually did? Do not include the time you spent working at a paid job. **Read all six statements before selecting ONE.**

[ ] [1] I did not do much physical activity. I mostly did things like watching television, reading, playing cards, or playing computer games. Only occasionally, *no more than once or twice a month*, did I do anything more active such as going for a walk or playing tennis.

[ ] [2] *Once or twice a week*, I did *light activities* such as getting outdoors on the weekends for an easy walk or stroll. Or once or twice a week, I did chores around the house such as sweeping floors or vacuuming.

[ ] [3] *About three times a week*, I did *moderate activities* such as brisk walking, swimming, or riding a bike *for about 15-20 minutes each time*. Or about once a week, I did moderately difficult chores such as raking or mowing the lawn for about 45-60 minutes. Or about once a week, I played sports such as softball, basketball, or soccer for about 45-60 minutes.

[ ] [4] *Almost daily, that is five or more times a week*, I did *moderate activities* such as brisk walking, swimming, or riding a bike *for 30 minutes or more each time*. Or about once a week, I did moderately difficult chores or played sports for 2 hours or more.

[ ] [5] *About three times a week*, I did *vigorous activities* such as running or riding hard on a bike *for 30 minutes or more each time*.

[ ] [6] *Almost daily, that is five or more times a week*, I did *vigorous activities* such as running or riding hard on a bike for *30 minutes or more each time*.

2. During the last 7 days, on how many days did you bicycle for at least 10 minutes at a time to go from place to place?

_____ days per week

3. How much time did you usually spend on one of those days to bicycle from place to place?

_____ hours and _____ minutes per day

4. During the last 7 days, on how many days did you walk for at least 10 minutes at a time to go from place to place?

_____ days per week

5. How much time did you usually spend on one of those days walking from place to place?

_____ hours and _____ minutes per day

These next few questions are about food and physical activity at home.

6. How often are there fresh or frozen **fruits** available in your home?

[ ] [1] Very Often
[ ] [2] Somewhat Often
[ ] [3] Not very Often
[ ] [4] Never

7. How often are there fresh or frozen **vegetables** available in your home?

[ ] [1] Very Often
[ ] [2] Somewhat Often
[ ] [3] Not very Often
[ ] [4] Never

8. During an average week, how often do you or someone else in your family cook food at home for the evening meal? By "cook food," we mean preparing a meal from basic ingredients. We do not mean warming up pre-cooked food.

[ ] [1] Never or Almost Never
[ ] [2] 1 to 2 days a week
[ ] [3] 3 to 4 days a week
[ ] [4] 5 to 6 days a week
[ ] [5] Every day

9. During the school week, how many days do you (mom/dad) eat breakfast?

[ ] 0
[ ] 1
[ ] 2
[ ] 3
[ ] 4
[ ] 5

10. Please indicate which items you have in your home, yard, or apartment complex. (Check all that apply)

[ ] [1] Bicycle, tricycle, or scooter
[ ] [2] Basketball hoop
[ ] [3] Jump rope
[ ] [4] Sports equipment
[ ] [5] Swimming pool
[ ] [6] Roller skates
[ ] [7] Fixed play equipment
[ ] [8] Home aerobic equipment
[ ] [9] Weight lifting equipment
[ ] [10] Water or snow equipment
[ ] [11] Yoga/exercise mats
[ ] [12] Exercise/play/recreation room
[ ] [13] Trampoline
[ ] [14] Stairs

These next few questions ask about the neighborhood where you live.

11. What is the ZIP Code where you live? _____

12. Please choose the answer that best applies to you and your neighborhood.

		Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
Places for Walking or Cycling	a) There are sidewalks on most of the streets in my neighborhood.	1	2	3	4
	b) Sidewalks are separated from the road/traffic in my neighborhood by parked cars.	1	2	3	4
	c) There is a grass/dirt strip that separates the streets from the sidewalks in my neighborhood.	1	2	3	4
	d) My neighborhood streets are well lit at night.	1	2	3	4
	e) Walkers and bikers on the streets in my neighborhood can be easily seen by people in their homes.	1	2	3	4
	f) There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighborhood.	1	2	3	4
Traffic Hazards	g) There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighborhood.	1	2	3	4
	h) The speed of traffic on most nearby streets is usually slow (30 mph or less).	1	2	3	4
	i) Most drivers exceed the posted speed limits while driving in my neighborhood.	1	2	3	4
Crime	j) There is a high crime rate in my neighborhood.	1	2	3	4
	k) The crime rate in my neighborhood makes it unsafe to go on walks during the day.	1	2	3	4
	l) The crime rate in my neighborhood makes it unsafe to go on walks at night.	1	2	3	4

You are doing great—already 25% completed!

These next few questions ask about your experiences with your child when your child is *not* at preschool.

13. Please choose the best answer for how often you complete each of the following ***physical activity*** practices with your 3-5 year old child.

How often do you…	Never	Rarely	Sometimes	Often	always
a) Take your child to sport practice or game in which he/she is enrolled?	1	2	3	4	5
b) Set an example for your child by exercising in front of him/her?	1	2	3	4	5
c) Play active games with your child (such as playing ball or racing)?	1	2	3	4	5
d) NOT let your child play actively for fear of him/her getting dirty?	1	2	3	4	5
e) Take your child to the park?	1	2	3	4	5
f) Tell your child he/she is not good enough at sports or active games?	1	2	3	4	5
g) Go on a walk with your child?	1	2	3	4	5
h) Allow your child to watch TV for long periods of time?	1	2	3	4	5
i) Find age appropriate games that get your child moving?	1	2	3	4	5
j) Say positive things to motivate your child to be more active?	1	2	3	4	5
k) Carry your child because he/she does not want to walk?	1	2	3	4	5
l) Teach your child new and different ways to be active?	1	2	3	4	5
m) Play a sport or active game together as a family?	1	2	3	4	5
n) Give your child choices of what physical activities to do?	1	2	3	4	5
o) Set aside time for active play?	1	2	3	4	5
p) Drive your child, when it was easy to walk?	1	2	3	4	5
q) Allow your child to pick an active game to do together?	1	2	3	4	5
r) Allow your child to play a lot of videogames?	1	2	3	4	5
s) Dance with your child?	1	2	3	4	5
t) Tell your child he/she will get hurt if he/she plays actively?	1	2	3	4	5

How often do you...	Never	Rarely	Sometimes	Often	always
u) Play sports games with your child (such as soccer or baseball)?	1	2	3	4	5
v) Discipline your child for being too active?	1	2	3	4	5
w) NOT register your child for sports or dance due to lack of money?	1	2	3	4	5
x) NOT let your child play outside because you are worried about traffic?	1	2	3	4	5
y) Push your child in a stroller instead of letting him/her walk?	1	2	3	4	5
z) Let your child go outside to play around your home?	1	2	3	4	5
aa) Teach your child that being active is good for his/her health?	1	2	3	4	5
bb) Reward your child for being still?	1	2	3	4	5
cc) Have outdoor toys available for your child?	1	2	3	4	5
dd) NOT let your child play outside because you are worried about crime?	1	2	3	4	5
ee) NOT let your child play outside because you are worried about strangers?	1	2	3	4	5
ff) Keep your child occupied by letting him/her watch TV?	1	2	3	4	5

14. Please choose the best answer for how often you do each of the following ***fruit and vegetable*** practices with your 3-5 year old child.

How often do you...	Never	Rarely	Sometimes	Often	always
a) Place fruit and vegetables where your child can easily reach them.	1	2	3	4	5
b) Encourage your child to try a couple of bites of the fruit or vegetable.	1	2	3	4	5
c) Make eating fruit and vegetables fun, like cutting into shapes.	1	2	3	4	5
d) Ask your child to select fruit and vegetables at the grocery store.	1	2	3	4	5
e) Beg your child to eat fruit and vegetables.	1	2	3	4	5
f) Tell your child to eat fruit or vegetables, but not eat any yourself.	1	2	3	4	5

How often do you...	Never	Rarely	Sometimes	Often	always
g) Make fruit and vegetables easy to eat, such as cutting, cleaning, or peeling them.	1	2	3	4	5
h) Tell your child eating fruit or vegetables will make him/her strong and healthy.	1	2	3	4	5
i) Offer fruit or vegetables without forcing your child to eat them.	1	2	3	4	5
j) Tell your child that his/her favorite cartoon characters eat fruit and vegetables.	1	2	3	4	5
k) Tell your child how much effort it took to make the fruit or vegetable dish.	1	2	3	4	5
l) Serve several fruit or vegetables and let your child decide which he/she would eat.	1	2	3	4	5
m) Reward your child with sweets if he/she eats his/her fruit and vegetables.	1	2	3	4	5
n) Praise your child when you see him/her eat fruit or vegetables.	1	2	3	4	5
o) Ask your child to help with fruit or vegetable preparation.	1	2	3	4	5
p) Promise your child something other than food if he/she finishes his/her fruit and vegetables.	1	2	3	4	5
q) Buy fruit and vegetables instead of cookies, chips, and candy.	1	2	3	4	5
r) Keep your child from having sweets if he/she doesn't finish his/her vegetables.	1	2	3	4	5
s) Include some form of fruit and vegetables in most meals.	1	2	3	4	5
t) Physically struggle with your child to get him/her to eat fruit or vegetables.	1	2	3	4	5
u) Yell at your child for not eating his/her fruit or vegetables.	1	2	3	4	5
v) Ask your child to choose the fruit and vegetables for meals and snacks.	1	2	3	4	5
w) Allow your child to serve himself/herself fruit or vegetables.	1	2	3	4	5
x) Show your child that you enjoy eating fruit and vegetables.	1	2	3	4	5

How often do you…	Never	Rarely	Sometimes	Often	always
y) Make your child feel guilty when he/she doesn't eat fruit or vegetables.	1	2	3	4	5
z) Use fruit and vegetables for your child's snacks.	1	2	3	4	5
aa) Tell your child that fruit and vegetables taste good.	1	2	3	4	5
bb) Give your child fruit or vegetables they like.	1	2	3	4	5
cc) Insist your child sit at the table until he/she eats his/her fruit or vegetables.	1	2	3	4	5
dd) Mix fruit and vegetables with other foods your child likes.	1	2	3	4	5
ee) Keep your child from going to play if he or she don't eat his/her fruit or vegetables.	1	2	3	4	5

15. These next questions are about the food eaten in your household in the last 12 months, and whether you were able to afford the food that you need. For these statements, please tell me whether the statement was often true, sometimes true, or never true for your household.

a) The first statement is, "The food that (I/we) bought just didn't last, and (I/we) didn't have money to get more." Was that often, sometimes, or never true for (you/your household) in the last 12 months?

[ ] ¹ Often true
[ ] ² Sometimes true
[ ] ³ Never true

b) "(I/we) couldn't afford to eat balanced meals." Was that often, sometimes, or never true for (you/your household) in the last 12 months?

[ ] ¹ Often true
[ ] ² Sometimes true
[ ] ³ Never true

c) In the last 12 months, since last (name of current month), did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?

[ ] ¹ Yes
[ ] ⁰ No (skip to question e)

d) [IF YES ABOVE] How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?

[ ] ¹ Almost every month
[ ] ² Some months but not every month
[ ] ³ Only 1 or 2 months

e) In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?

[ ] 1 Yes
[ ] 0 No

f) In the last 12 months, were you every hungry but didn't eat because there wasn't enough money for food?

[ ] 1 Yes
[ ] 0 No

Your survey is now over 70% completed! Keep up the good work!

These next questions are about your *child* that is participating in the SAGE program.

16. How would you describe your child's weight?

[ ] Severely underweight
[ ] Underweight
[ ] Normal weight
[ ] Overweight
[ ] Severely Overweight

17. During the school week, how many days does your child eat breakfast at home?

[ ] 0
[ ] 1
[ ] 2
[ ] 3
[ ] 4
[ ] 5

18. During the school week, how many days does your child eat breakfast on the way to school?

[ ] 0
[ ] 1
[ ] 2
[ ] 3
[ ] 4
[ ] 5
[ ] 999 I prefer not to answer

19. How many days per week does your child eat breakfast at school?

[ ] 0
[ ] 1
[ ] 2
[ ] 3
[ ] 4
[ ] 5

The following questions are about your child's sleep habits and possible difficulties with sleep. Think about *the past week* in your child's life when answering the questions. If last week was unusual for a specific reason (such as your child had an ear infection and did not sleep well or the TV set was broken) choose the most recent *typical week*.

20. Write in child's bedtime: _____

21. Write in child's usual wake time: _____

22. Child's usual amount of sleep each night (no naps): _____ hours and _____ minutes

23. Child's usual amount of sleep each day (naps): _____hours and _____minutes

For these next questions…

- Answer USUALLY if something occurs **5 or more times** in a week.
- Answer SOMETIMES if it occurs **2-4 times** in a week.
- Answer RARELY if something occurs **never or 1 time** during a week.

24.

	Usually (5-7)	Sometimes (2-4)	Rarely (0-1)
a) Child wakes up by him/herself	1	2	3
b) Child wakes up in a negative mood	1	2	3
c) Adults or siblings wake up my child	1	2	3
d) Child has difficulty getting out of bed in the morning	1	2	3
e) Child takes a long time to become alert in the morning	1	2	3
f) Child seems tired in the morning	1	2	3
g) Child snores loudly	1	2	3
h) Child seems to stop breathing during sleep	1	2	3
i) Child snorts and/or gasps during sleep	1	2	3

25. Child has appeared very sleepy or fallen asleep during the following (check all that apply):

	0 Not Sleepy	1 Very Sleepy	2 Falls Asleep
a) Watching TV	☐	☐	☐
b) Riding in a car	☐	☐	☐

These next few questions ask you to describe yourself and your family.

26. Did a doctor, nurse or other health care worker ever tell you that you had any of the following health problems and/or do you take medication for these health problems?

	No	No, but I take medication	Yes, but I don't take medication	Yes, and I do take medication
a. Diabetes (high blood sugar), not during pregnancy	1	2	3	4
b. Hypertension (high blood pressure), not during pregnancy	1	2	3	4
c. High cholesterol	1	2	3	4

27. Are you currently working?

[ ] [1] Employed for wages
[ ] [2] Self-employed
[ ] [3] Out of work for 1 year or more
[ ] [4] Out of work for less than 1 year
[ ] [5] A Homemaker
[ ] [6] A Student
[ ] [7] Retired

28. What was your total family income last year before taxes? Please mark one box below that includes your total family income, including your income and the income of your husband or partner (if living with you last year) and your children. (Please include income from all sources, including jobs, welfare, Disability, Unemployment, child support, interest, dividends, and support from family members.)	
[ ]	$0 to $16,000
[ ]	$16,001 to $20,000
[ ]	$20,001 to $24,000
[ ]	$24,001 to $28,000
[ ]	$28,001 to $31,000
[ ]	$31,001 to $36,000
[ ]	$36,001 to $39,000
[ ]	$39,001 to $47,000
[ ]	$47,001 to $55,000
[ ]	$55,001 to $59,000
[ ]	$59,001 to $63,000
[ ]	$63,001 to $71,000
[ ]	$71,001 to $78,000
[ ]	$78,001 to $83,000
[ ]	$83,001 to $94,000
[ ]	$94,001 to $107,000
[ ]	$107,001 to $110,000
[ ]	$110,001 to $126,000
[ ]	$126,001 to $142,000
[ ]	$142,001 or more

29. How many adults, including yourself, live in your house?

_____

30. How many children live in your house?

_____

31. When was your most recent baby born?

_____ _____, _____

Month Date Year

Thank you for completing the survey!

APPENDIX C

MEAL OBSERVATION FORM

SAGE ECE Food Observation Form

ECE Site: ________________ Observer Initials: ___________ Date: ___________

Menu items:
- ☐ Entrée: 1 ________________ 2________________ 3________________
- ☐ Milk: 1 ________________ 2________________ 3________________
- ☐ Fruit: 1 ________________ 2________________ 3________________
- ☐ Vegetable: 1 ________________ 2________________ 3________________
- ☐ Grain: 1 ________________ 2________________ 3________________
- ☐ Other: 1 ________________ 2________________ 3________________

Mealtime observed:
- ☐ Breakfast
- ☐ a.m. Snack
- ☐ Lunch
- ☐ p.m. Snack

Notes:

PID	Foods served	Amount served	Additional helpings	Amount consumed
	☐ Entrée ___			
	☐ Milk ___			
	☐ Fruit ___			
	☐ Vegetable ___			
	☐ Grain ___			
	☐ Other___			
	☐ Entrée ___			
	☐ Milk ___			
	☐ Fruit ___			
	☐ Vegetable ___			
	☐ Grain ___			
	☐ Other___			
	☐ Entrée ___			
	☐ Milk ___			
	☐ Fruit ___			
	☐ Vegetable ___			
	☐ Grain ___			
	☐ Other___			
	☐ Entrée ___			
	☐ Milk ___			
	☐ Fruit ___			
	☐ Vegetable ___			
	☐ Grain ___			
	☐ Other___			

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