Fruit and Vegetable Consumption Arizona Urban and Non-Urban Postpartum Women

by

Steven Michael Ortiz

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Graduate Supervisory Committee:

Meg Bruening, Chair
Corrie Whisner
Christina Shepard

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ABSTRACT

Background: Adequate consumption of fruit and vegetables has been shown to prevent chronic diseases, such as cardiovascular disease, high blood pressure, and type two diabetes. The majority of Americans still consume inadequate daily servings of fruit and vegetables, which include women. Inadequate consumption of fruit and vegetables can be contributed to multiple barriers that hinder consumption in both urban and non-urban areas. The Special Supplemental Nutrition Program for Women, Infant, and Children (WIC) has been shown to positively influence fruit and vegetable consumption by providing healthy foods, such as fruit and vegetables. This study aims to compare the fruit and vegetable consumption of WIC and non-WIC participants between urban and non-urban Rural-Urban Commuting Area (RUCA) codes. Methods: This study was a cross-sectional, secondary analysis of a single time point from the Snuggle Bug/Acurrucadito Study, which had a sample size of (n=53) participants. The participants were separated into two groups, WIC participants, and non-WIC participants, and then further divided based on their respected RUCA code for comparison purposes. The assessment of fruit and vegetable consumption assessment derived from the participant's 3-day food record. Results: The average consumption of fruit and vegetable consumption among participants was 3.8±2.5 servings There was an inverse relationship between WIC participation and fruit and vegetable consumption among all categories (fruit no juice -0.79, vegetables -0.32, vegetables no potato -0.32, fruit no juice and vegetables -1.1, and fruit no juice and vegetables no potato -1.1). However, none of the results were considered statistically significant. In addition, our study was unable to identify an association between fruit and vegetable consumption and locale due to the small sample

size. Conclusions: There was no link observed between fruit and vegetable consumption and WIC participation. Further research of high quality is needed to confirm the relationship between fruit and vegetable consumption of WIC and non-WIC participants in urban and non-urban populations.

DEDICATION

This thesis is dedicated to my family. Thank you for an infinite amount of love and support in my lifetime. You always have been and will always be my motivation. To my parents, thank you for equipping me with the tools to succeed, having faith in me during my difficult times, and believing in me when I stumbled. My success is a direct result of your love and guidance. To my future wife, Roxanna Lynn, thank you for being my steady hand, my shoulder to lean on, and my best friend. I am eagerly anticipating the many years to come. Lastly, my siblings and children, let this be a reminder that the sky is the limit, and I will do everything in my power to help you soar. Thank you.

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CHAPTER 1

INTRODUCTION

Overview

The Dietary Guidelines for Americans (DGAs) recommend two and a half servings of vegetables and two servings of fruit daily for adults[27] Adequate consumption of fruit and vegetables has been shown to reduce the risk of chronic diseases such as cancer[28,29], peripheral artery disease (PAD),[30] cardiovascular diseases,[1,31] heart disease,[32] high blood pressure,[33-35] and type two diabetes.[36-38] Zheng et al. found higher plasma vitamin C and total carotenoids, derived from an average consumption of 400-500 grams of fruit and vegetables (~5 or more servings), was associated with a lower risk of developing type 2 diabetes.[36] Also, consuming a greater variety of fruits and vegetables may provide greater protection from different forms of cancer[29,39,40] and chronic diseases.[41-43] For example, cruciferous and yellow-orange vegetables reduce the risk of breast cancer,[40] while flavonoids found in apples, red cabbage, strawberries, and grapes can reduce the risk of type 2 diabetes.[41] Despite present knowledge regarding fruit and vegetable consumption and the prevention of chronic disease, and consistent recommendations of the DGAs to increase consumption, many Americans continue to display sub-optimal fruit and vegetable consumption.[2] According to the 2020-2025 DGA report, 81% of Americans are consuming less than the recommended amount of fruit, and 90% of Americans are consuming less than the recommendation for vegetable intake.[44]

The importance of fruit and vegetables is echoed among nutrition professionals, and their nutritional value is well understood. Barriers often inhibit an individual's ability to consume adequate amounts and varieties of fruits and vegetables among urban and

rural populations.[13] For example, consumer barriers affecting access to healthy foods, including fruit and vegetables, can be attributed to multiple factors such as income and education level,[9-12,45-49] food cost,[3-8,50-52] geographical location,[13,53-60], and home environment.[61-71] When compared to individuals with a higher education level and higher income status, individuals with lower education and lower income, high school equivalent or less, and annual income of $20,000 or less, consumed fewer fruits and vegetables.[9] Furthermore, research has assessed the relationship between consumption and affordability; as the price of fruit and vegetables increased, the reported consumption of fruit and vegetables decreased.[3]

Unfortunately, many of these barriers were exacerbated by the 2019 Coronavirus Disease Pandemic (COVID-19).[15-23] COVID-19 was first identified in December 2019 and was declared a global pandemic on March 11^{th,} 2019, by the World Health Organization (WHO).[72] Within one month of the pandemic, the unemployment rate rose 14 percent.[16] Of note, Americans with lower education levels, high school education or lower, had the greatest unemployment rates.[16] In addition to an increase in unemployment, major food groups, fruit, and vegetables, increased in price by 1.5 percent during the pandemic.[18] Individuals reported a decrease in trips to all grocery retailers to avoid exposure to COVID-19.[20] As a result, since the start of the pandemic, researchers have found that food-insecure households further decreased their consumption of any type of fruit and vegetable (total, fresh, frozen, and canned).[22]

At first glance, urban communities appear to be at an advantage compared to rural communities, as urban areas are associated with greater consumption of fruit and vegetables when compared to their rural counterparts.[13,14] However, upon further

investigation, this may not be the case as each community faces different, yet equally impactful, barriers to consuming fruits and vegetables. Rural and urban areas are associated with barriers impacting the ability to consume the recommended daily amounts of fruit and vegetables, such as socioeconomic factors, income[3-8] and education,[9-12], and prevalence of food deserts.[13,14] Regarding rural food deserts, although the physical distance is debatable among researchers as a barrier to healthy food access,[13,54,73,74] rural areas are subject to higher prices and lower quality and variety of fruit and vegetables.[75] Similarly, the physical distance has been debated as a barrier to healthy food access among urban areas due to the proximity of smaller food retailers,[76,77] however, researchers found the quality of fresh produce was poorer, and the price of fresh produce was higher in smaller stores.[78]Also, low-income urban residents rely on public transportation. [79,80] Due to the reliance on public transportation scheduling routes and time of day negatively impact access to healthy foods.[81,82] In contrast, rural and urban residents are affected by physical distance coupled with disadvantageous socioeconomic factors which inhibit access to healthy foods, such as fruits and vegetables.

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a public health nutrition program under the jurisdiction of the United States Department of Agriculture (USDA) intended for low-income pregnant and postpartum women, infants, and children up to the age of 5 who are at nutritional risk.[24] The WIC Program provides supplemental nutritious foods, nutrition education and counseling, and referrals to other health, welfare, and social services to eligible participants.[24] The WIC program has program barriers that have affected redemption rates of healthy foods. Barriers that have impacted redemption rates are reduced access to WIC stores,[83,84] cost

of fruit and vegetables with WIC-approved stores,[25] and the WIC shopping experience.[85-87] Fortunately, the WIC program has made recent strides to improve the redemption rate by overcoming barriers experienced by the WIC population, such as shopper experience. In addition, the improvement in the shopping experience through eWIC has also enhanced the ability to gather data on redemption rates of Arizona WIC participants among urban and rural communities' individual food items, such as fruit and vegetables.

Purpose of study

The purpose of this study was to explore the relationship between fruit and vegetable consumption among WIC participants and non-WIC participants in the Phoenix area. In addition to exploring consumption based on WIC participation status, this study explored the relationship between consumption and locale (urban vs non-urban). Upon analysis of the data, this research design intends to identify the present fruit and vegetable consumption rates of WIC participants and non-WIC participants among urban and suburban communities in the Phoenix area.

Research Aim and Hypothesis

Research Question 1: What is the relationship between fruit and vegetable consumption and locale (urban vs. non-urban)?

Hypothesis: Participants residing in urban communities will consume a greater number of fruit and vegetables compared to their non-urban counterparts.

Research Question 2: Does the relationship between fruit and vegetable consumption vary by WIC participation?

Hypothesis: WIC participants will consume fruit and vegetables at a greater rate compared to their non-WIC counterparts.

CHAPTER 2

REVIEW OF LITERATURE

Fruit and vegetable and reduced risk of chronic disease

Adequate consumption of fruit and vegetables has reduced the risk of chronic diseases such as cancer[2,3], peripheral artery disease (PAD),[4] cardiovascular conditions,[5,6] heart disease,[7] high blood pressure,[8-10] and type two diabetes.[11-13] Wu et al. found that individuals who met recommendations of 5 or more servings of fruit and vegetables per day had a 86% lower risk for reported cancer than individuals unable to consume the recommended amount of fruit and vegetables.[2] In addition, the researchers found that every additional cup equivalent to fruit and vegetable consumed reduced cancer risk by 11%.[2] Heffron et al. reported that participants reporting intakes of 3 or more fruit and vegetables had an 18% lower risk of PAD.[4,5] Individuals consuming 5 cups equivalents or greater of fruit and vegetables were shown to decrease their risk of Coronary Heart Disease (CHD) by 17%.[7].[8] Furthermore, evidence suggests that lifestyle changes, such as increasing fruit and vegetable consumption during adolescence, have improved blood pressure during adolescents[9] and blood pressure trajectory into adulthood.[10] Zheng et al. found higher plasma vitamin C and total carotenoids, derived from an average consumption of 400-500 grams of fruit and vegetables (~5 or more servings), was associated with a lower risk of developing type two diabetes.[11] Also, a greater quantity of combined fruit and vegetables, 2.5-5.0 portions per day, was associated with a 21% lower risk of type 2 diabetes.[12] Lastly, among pregnant women, daily snacks of fruit, vegetables, and milk decreased the prevalence of gestational diabetes compared to pregnant women consuming low micronutrient-rich vegetables, such as onions and

potatoes, which indicates that consumption of fruit and vegetables reduces the risk of gestational diabetes.[13] Thus, adequate consumption, or
the total number of cup equivalents, of both fruit and vegetables has improved health by combating the development of chronic disease.

Equally important, if not of greater importance, to consuming a greater number of fruit and vegetables is consuming a variety of fruits and vegetables which may provide greater protection from different forms of cancer[3,14,15] and chronic diseases.[16-18] Women with higher intakes of total fruit and total vegetables had a lower risk of bladder cancer.[14] A higher early adulthood intake of fruit and vegetables rich in alpha-carotenes was associated with a decreased premenopausal breast cancer risk.[3]. Consuming a diet rich in cruciferous and yellow-orange vegetables has been associated with a reduced risk of breast cancer.[15] In addition to vitamin C and carotenoids' positive association with the prevention of type 2 diabetes,[11] consumption of flavonoids derived from fruit and vegetables during adolescence decreases the risk of type 2 diabetes in women.[16] Of note, researchers, concluded that higher flavonoids from fruit and vegetables were independently related to higher insulin sensitivity in women.[16] Increased consumption of cruciferous vegetables were inversely associated with cardiovascular disease mortality.[18] These findings underscore the importance of the variety of fruit and vegetables in combating forms of cancer and chronic disease.

Fruit and vegetables and dietary guidelines

Every five years, the U.S. Departments of Agriculture (USDA) and Health and Human Services (HHS) work together on a joint report, the U.S Dietary Guidelines for Americans (DGAs).[87] The DGAs provide consumption recommendations to

policymakers, healthcare providers, nutrition educators, and nutrition program operators on the most appropriate foods and beverages to meet nutrient needs, promote health, and prevent disease.[87] For the average American diet of 2,000 calories, the 2015 – 2020 U.S. DGAs recommend two and a half cups equivalents of vegetables and 2 cups equivalents of fruit daily. [88] The present recommendations, 2020 – 2025 DGAs, remain consistent with the 2015 -2020 U.S. Dietary Guidelines.[19] However, the 2020 -2025 DGAs have included recommendations for toddlers 12 – 23 months.[19] For the average toddler diet that includes 700 – 1,000 calories a day, the 2020 – 2025 Dietary guidelines recommend a 1 cup equivalent of fruit and vegetables.[19]

In addition to the DGA's providing recommendations on daily caloric intake and serving sizes, the fruit and vegetables food group recommendations have been broken down further based on their subcategories. For example, fruit can be categorized into two groups, whole fruit (fresh, canned, frozen, and dried forms) and 100% fruit juice. Whole fruit and 100% fruit juice are calculated when determining the daily total cup equivalents of fruit for individuals.[19] Of note, although 1 cup of 100% fruit juice can be counted as a 1 cup equivalent to total fruit intake, it is recommended that the remaining half is derived from whole fruit sources.[19] Similarly, just as fruit is subcategorized, vegetables can be broken down as well. The DGAs recommend the consumption of a variety of vegetables weekly from the following subgroups; dark green (broccoli, amaranth leaves, bok choy, chamnamul, chard collards, kale), red and orange (calabaza, carrots, bell peppers, sweet potatoes, tomatoes, and 100% tomatoes juice), legumes (black beans, black-eyed peas, Bayo-beans, chickpeas, edamame, kidney beans, lentils), starchy (burdock root, cassava, corn, jicama, lotus root, lima beans, plantains, and white potatoes), and others (asparagus,

avocado, bamboo shoots, beets, bitter melon, Brussel sprouts, cabbage, cactus pads).[19] The USDA Dietary Guidelines provide a blueprint of dietary recommendations that aim to improve the American population's diet quality and prevent disease. In addition to outlining the recommendations, the USDA Dietary Guidelines also provide insight on dietary intake for each respected food group and assess the diet quality of individual American populations.

Women's fruit and vegetable consumption

Despite present knowledge regarding fruit and vegetables consumption and chronic disease prevention and the consistent recommendation of the U.S. Dietary Guidelines, many Americans continue to display sub-optimal fruit and vegetable consumption.[19] About 80% of the U.S. population does not meet fruit recommendations, and almost 90% of the U.S. population does not meet the recommendations for total vegetable daily servings.[19] Subsequently, the U.S. population does not meet the recommendations for any of the vegetable subgroups collectively.[19] Populations consuming inadequate fruit and vegetables include toddlers (12 – 24 months), children (two years and older), adults women, pregnant women, and lactating women consuming less than recommended amounts of fruit and vegetables.[20] Of note, pregnant and lactating women consume greater servings of fruit and vegetables than their adult counterparts.[19] In addition, pregnant and lactating women have a better overall diet quality on average than adult women.[19] Considering adequate consumption of fruit and vegetables improves diet quality.[89] It is alarming that many Americans, including high-priority populations such as toddlers, children, and perinatal women, cannot consume the recommended quantity of fruit and vegetables on a national level.

The DGA provides federal recommendations on nutrients needed to support a healthy lifestyle and prevent chronic disease.[19] To measure compliance with DGA recommendations, researchers utilize the Healthy Eating Index (HEI). The HEI is a 13 food group component tool that assesses Americans' diet quality per the DGA's recommendations and provides a score of 0-100.[90] Research published in 2016 predicted the American diet to continue to improve to score a 65 by the year 2019 – 2020, which was based on the 10 points HEI score improvement in diet quality from, 49 in 1999 - 2000 to 59 in 2011 – 2012.[91] The present DGA's indicate a lower than anticipated diet quality scores across all age ranges.[19] Pregnant women and lactating women had an HEI of 63 and 62, respectfully, although scoring better than their adult counterparts, still indicates a poor overall diet quality.[19] Poor diet quality is contributed to women during both stages continuing to consume an inadequate amount of total fruit and vegetables, 1-1.5 cup equivalents of fruit and 1-2 cup equivalents of fruit for each respective category.[19] However, the DGA's data does not specify the present consumption rates of fruit and vegetables among individual states such as Arizona. Tools, such as America's Health Rankings Annual Report of Arizona, provide insight on fruit and vegetable consumption rates amongst the adult population in Arizona.[92] Although fruit and vegetable rates among Arizona residents are suggested to be better than the national average, America's Health Rankings only provides fruit and vegetable consumption percentages for individuals 18 and older, which leaves toddlers, children, and adolescent populations unaccounted for.[92] Therefore, in addition to fruit and vegetable consumption rates recorded by America's Health Rankings of Arizona and DGA, further data are needed to identify fruit and vegetable consumption rates among the Arizona population,

which include toddlers, children, and adolescents. Thus, although tools, such as the DGA's and America's Health Rankings Annual Report of Arizona highlight the present diet quality of Americans and Arizonans, respectively; These tools are also unable to provide insight on why many individuals are unable to meet the recommendations provided.

Barriers to consuming fruit and vegetable

Overview of barriers

The importance of total fruit and vegetable consumption and their role in preventing chronic disease has been extensively investigated. Similarly, the importance of adequate consumption of fruit and vegetables to prevent the development of chronic disease has been echoed for decades; however, many Americans continuously cannot consume the recommended serving of fruit and vegetables provided by the DGA year after year.[19,88] Research indicates that barriers inhibit the ability to consume adequate amounts and variety of fruits and vegetables among urban and rural populations.[21] For example, consumer barriers affecting access to healthy foods, including fruit and vegetables, can be attributed to multiple factors such as income and education level,[22-30] food cost,[31-39] geographical location,[21,40-47] home environment,[48-58] and more recently, the 2019 Coronavirus Disease Pandemic (COVID-19).[59-67] Thus, the evidence explored provides context to why many Americans cannot make healthier choices and meet the dietary recommendations provided by the DGA. The evidence underscores the numerous variables that collectively create barriers to adequate consumption of fruit and vegetables.

Socioeconomic barriers

Socioeconomic factors, such as education and income, are key factors that contribute to the consumption of the recommended daily servings of total fruits and vegetables. Regarding education attainment and income, individuals with a higher education level and higher income status, such as completion of a college degree and an annual income of $40,000 or greater; individuals with lower education and lower income, high school equivalent or less and annual income of $20,000 or less consumed less fruit and vegetables.[23] Similar research supports these findings. Individuals with a higher education level and higher annual income were associated with an increase in consumption of fruit and vegetables.[22,26] In addition to an increase in total fruit and vegetable consumption among individuals with high income and education levels,[22,23,26] evidence has shown that parental education level positively correlates with a child's daily fruit and vegetable intake.[24,25] When examining income alone, lower-income status is negatively associated with fruit and vegetable consumption.[35,39] For example, low-income individuals having an annual income of less than or equal to $25,000 reported the greatest barrier to fruit and vegetable consumption was the price compared to those with a yearly income of $65,000 or greater.[35] According to the U.S. Bureau of Labor Statistics, individual earnings are associated with educational attainment in which those individuals who have completed a bachelor's degree earn nearly twice the weekly income as individuals who have completed high school or less.[27] Education level is of added importance when considering only 30 percent of individuals in Arizona have a bachelor's degree or higher,[28] which is lower than the national average.[29] Thus, approximately 70 percent or 5 million individuals living in Arizona are at higher risk of decreased fruit and

vegetable consumption based on educational attainment alone. Nearly one hundred thousand individuals residing in Arizona live at the federal poverty line, $12,880 annual income.[30] The relationship between income and education attainment and fruit and vegetable consumption is not only important when considering the frequency of consumption alone, but it is also of equal or greater importance when considering the present education level of individuals in Arizona and the number of households living in poverty.

Food cost barriers

The perceived cost of healthier food, such as fruit and vegetables, has also been identified as a barrier to adequate fruit and vegetable consumption among the low-income population.[32,33] Qualitative research identified the perceived cost of fruit and vegetables as a barrier that negatively impacts the consumption of fruit and vegetables among low-income individuals.[32] Similar evidence by Chapman et al. identified the perceived cost of fruit and vegetables as a significant barrier for low-income individuals earning less than $30,000 annually.[31] Furthermore, research has assessed the relationship between consumption and affordability; as the price of fruit and vegetables increased, the reported consumption of fruit and vegetables decreased.[34] The derogative perception of fruit and vegetable cost can be attributed to the rate at which prices increase over time; Gupta et al. found, within twelve years, ultra-processed foods increased by $0.14 while unprocessed foods had a much greater increase of $0.41.[37] Not only did the cost of ultra-processed foods increase at a lower rate, ultra-processed foods already had a lower initial price when compared to unprocessed foods.[37] To combat the actual and perceived cost of fruit and vegetables, research has shown that a 20 percent discount on fresh fruit and

vegetables increased the purchase of fruit and vegetables by 12 percent and 15 percent, respectively.[38] Thus, the perceived price of healthier food has been identified as a barrier to adequate fruit and consumption among low-income households.

Geographical environment barriers

Environmental barriers such as food mirages,[44] food swamps,[42,43] density of healthy food outlets,[45] physical distance to healthy food outlets,[21,40,41] and perceived geographic accessibility to healthy food outlets,[43,46,47] have negatively influenced fruit and vegetable consumption. Geographical barriers such as food mirages, which are geographical locations with an abundance of grocery stores with prices that are unaffordable for low-income households, have been identified as a barrier to healthy food access.[44] Food swamps, which are geographical areas with an abundance of unhealthy food outlets, such as convenience stores and fast-food restaurants, were also identified as barriers to healthy food access. They are associated with a decrease in fruit and vegetable consumption.[42,43,45] In addition to the density of healthy foods in a given geographical location, the distance between an individual's residence and healthy food stores influences fruit and vegetable consumption. A shorter distance to a food store was associated with an increase in consumption of fruit, and vegetables.[21,40,41] Of note, although geographical distance to the nearest supermarkets can be similar in a given neighborhood, the perception of foods access has also been shown to impact dietary choices.[93] Despite living in the same proximity to the nearest supermarket, within 2 miles, when compared to food-secure households, individuals living in food-insecure households and very low food security households with children were shown to have a poorer perception of availability, quality, and affordability of fruit and vegetables.[93]

Haynes-Maslow et al. have argued that the perception of food access is not a significant barrier to healthy food consumption.[94] A larger body of evidence suggests that perception is a barrier to consuming fruit and vegetables.[43,46,47] Researchers have found that closer proximity from household residences to supermarkets has increased the perception of healthy food access.[43] Co et al. found that when supermarkets were within a 400-meter radius of individual residents; individuals reported an increase in perceptions of access to quality fruit and vegetables. Also, findings have reported that improved perception of fruit and vegetable access increased daily fruit and vegetable consumption.[46] The evidence suggests that decreased access to healthy stores negatively impacts the perception of fruit and vegetable access and ultimately negatively influences fruit and vegetable consumption.

Home environment barriers

Similar to the geographical environment, the home environment has also influenced fruit and vegetable consumption.[56] A decrease in fruit and vegetable consumption in the home is attributed to taste,[48,51] cooking efficacy,[46,53-55] and role modeling.[49,50,57] Regarding taste, Kourouniotis, S. et al. surveyed individuals, and 82% of the surveyed population rated taste as a very or extremely important factor when choosing food to consume.[48] Researchers found individuals who rated taste as an important factor were likely to consume a low-quality diet and were more likely to consume less fruit and vegetables.[48] Fortunately, cooking may be an effective strategy to overcome unfavored natural flavors in foods, such as vegetables. An increase in cooking efficacy, or confidence in personal ability to cook food, has been found to have a positive association with fruit and vegetable consumption.[53-55] Similarly, Carvalho de Menezes, et

al. also found that greater self-efficacy of time to cook and cooking skills were positively associated with consumption of fruit and vegetables.[46] Of note, in addition to an increased cooking efficacy, the greatest increase in consumption of fruit and vegetables was achieved among the individuals that were also confident about their financial stability.[46] Parent and child dyad interventions, including vegetable-focused cooking demonstrations, meal preparation, nutrition education, and a meal, have been shown as effective strategies to increase cooking self-efficacy of vegetables and increase the variety of vegetables within the home.[57] Although interventions are successful, choosing and preparing palatable food can be considered a luxury in some households.[52] When compared to higher-income households, low-income households have fewer resources to spend on un-eaten or rejected foods, which leads parents to provide foods the child prefers.[52] In doing so, the parent's risk aversion ultimately affects the child's taste acquisition.[52] Factors, such as the taste of available food, cooking efficacy, role modeling, and food security construct the food environment within the home. Thus, like the geographical environment, the environment within the home is of equal importance when assessing potential barriers to adequate fruit and vegetable consumption.

COVID-19 Pandemic barriers

Lastly, the most recent documented factor that has influenced the lives of Americans and their access to adequate fruit and vegetables has been the 2019 Coronavirus Disease Pandemic (COVID-19).[59-67] COVID-19 has exacerbated previously identified barriers to food access, such as income and education, price of food, and accessibility within the geographical and home environments. The unemployment rate in 2019 was the lowest in 50 years, at 3.5 percent.[59] At the peak of COVID-19, the

unemployment rate jumped to 14 percent by April of 2020.[60] Of note, Americans with lower education levels, high school education or lower, had the greatest unemployment rates.[60] Recent data, over a year into the pandemic, highlight the continued hardships due to changes in income status; As of August 2021, 1 in 9 adults with children reported a lack of sufficient food in the last seven days, which was due to the household's inability to afford food.[61] Due to the COVID-19 pandemic, the U.S. increased significant food groups.[62] As of April 2021, the price of fruit and vegetables rose 1.5 percent,[62], which is likely due to the substantial amount of products imported from source countries.[63] Also, data shows a decrease in grocery retail, such as grocery stores or bulk stores, convenience and dollar stores, general stores, and ethnic food markets.[64] Many individuals reported a decrease in the number of trips to grocery stores to avoid exposure to COVID-19.[64] In addition to decreased trips to stores, Niles et al. found a 33 percent increase in food insecurity since the COVID-19 outbreak began.[65] Research has found that food-insecure households consume less fruit and vegetables than food-secure homes.[36,66] Furthermore, since the start of the pandemic, researchers have seen food insecure households further decrease the consumption of any type of fruit and vegetable (total, fresh, frozen, and canned).[66] The decrease in consumption was attributed to poor quality, poor availability, high prices, reduced store trips, and concerns of contamination.[66] Although COVID-19 exacerbated individual barriers to food access, COVID-19 is a multi-variable barrier, which previous successful interventions have not remedied. For example, despite providing a 15 percent and 30 percent discount on fruit and vegetables to participants, Atene et al. found a significant increase in energy-dense food consumption during COVID-19 rather than fruit and vegetables.[67] This indicates that COVID-19 is a

significant barrier to adequate fruit and vegetable consumption and thus requires a multi-level approach to improve fruit and vegetable consumption among Americans.

COVID-19 is a barrier to healthy food access by exacerbating previously documented barriers to food access and, subsequently, decreased adequate consumption of fruit and vegetables. However, at present, there is no research available that has attempted to identify the impact on households within the state of Arizona. Subsequently, no known evidence has assessed shopping behaviors among urban and rural populations and the changes in their fruit and vegetable purchasing behaviors. Therefore, to assess fruit and vegetable consumption rates, further research is required to measure the extent to which COVID-19 has impacted individual states such as Arizona.

Rural vs urban consumption of fruit and vegetables

Defining rural areas

The United States Census Bureau (Census) and the Office of Management and Budget define rural areas; however, the two definitions do not accurately depict many individuals residing in rural areas.[95] For example, the census defines Urban as Urban Areas, which are areas with 50,000 or more people, and Urban Clusters, which are 2,500 – 49,999 people.[95] The census considers rural to include all people, housing, and territory outside of an urban area as rural. However, the census does not follow city or county boundaries, which often leads to overestimating the number of people in rural areas.[95] The Office of Management and Budget (OMB) determines which counties are metropolitan (metro areas), which are areas with 50,000 or more people, and micropolitan (micro areas), which are areas with 10,000 to 49,999 people or neither.[95] Micro areas and counties outside of metro areas or micro areas (neither) are classified as

rural.[95] Due to the broad classification based on county lines, OMB undercounts the number of people in rural areas.[95] A third definition has been proposed by Health Resources & Services Administration (HRSA) and identifies rural areas using Rural-Urban Commuting Area (RUCA) codes.[95] The RUCA codes were created by the U.S. Department of Agriculture (USDA) Economic Research Services (ERS) using U.S. Census data.[95] RUCA codes classify U.S. Census tracts by using population density, urbanization, and daily commuting measures.[96] Presently, RUCA codes are based on the 2010 decennial census tract and the 2006-10 American commuting survey.[96] Each RUCA code can be divided into two levels, whole numbers 1-10 delineate metropolitan, micropolitan, small towns, and rural commuting areas based on their respected size and commuting flow.[96] Whole numbers 4-10 define rural areas.[95] Also, metro counties census tract that has at least 400 square miles with a population density of 35 or less per square mile are defined as rural and are assigned RUCA code 2-3.[95] Effectively identifying rural geographical areas through the HRSA definition will provide an objective and systematic approach during the classification process.

An individual's residential location impacts many aspects of daily living and consumption of foods, such as fruit and vegetables. For example, when comparing fruit and vegetable consumption among rural and urban communities, urban areas were associated with greater consumption of fruit and vegetables when compared to their rural counterparts.[21,69] However, further research indicates both rural and urban areas are associated with barriers impacting the ability to consume the recommended daily amounts of fruit and vegetables, such as socioeconomic factors, income[34-39] and education,[22-25] and prevalence of food deserts.[21,69] The USDA defines food deserts or

food desert census tracts as “low-income tracts where a substantial number or substantial share of residents do not have easy access to a supermarket or large grocery store.”[97] The USDA utilizes census tract level data which they have found to have low income, and residents are 1 mile in urban areas and 10 miles in rural areas from the nearest supermarket.[97]

Recent evidence suggests socioeconomics is associated with the quality of resources available in their respected environments.[98] Disadvantaged areas, such as low socioeconomic areas, have a higher frequency of convenience stores when compared to higher socioeconomic areas.[98] The cultivation of socioeconomic factors and limited food access among rural and urban areas demonstrates the prevalence of barriers impacting adequate consumption of fruit and vegetable for women and children among both urban and rural communities. Also, as the prevalent barriers among urban and rural communities vary, preferred processing variation of fruit and vegetables (i.e., fresh, frozen, canned) may be more desirable over others to meet living arrangements. However, limited research is available for preferred processing variations among urban and rural communities.

Although urban areas are believed to have improved access to fruit and vegetables, proximity to stores remains an issue.[21,69] When assessing the impact of geographical distance to supermarkets among urban and rural communities, evidence indicates that as the distance to supermarkets in urban areas increases the average consumption of fruit and vegetable decreases.[41] In addition researchers have argued that the definition of food deserts is one-dimensional and does not adequately encompass multifactorial disadvantages within the urban communities’ experience, and therefore

fails to identify food deserts accurately.[99] As previously notated, the USDA defines an urban food desert when proximity to a grocery store exceeds a mile radius.[97] Thus, with the inclusion of the USDA's definition of food desert as a starting point, researchers have attempted to identify urban food deserts by including different aspects of food inaccessibility, such as personal commuting behaviors,[100-102] public transportation commuting,[78,79] surveyed shopping behaviors,[75,103,104] and the concentration of food stores.[43,105]

Although researchers have identified an increase in food access when considering individual commuting behaviors, it is important to note that these individuals had access to a vehicle.[100] Vehicles were used the most for grocery shopping in urban areas. However, lower incomes households and households in the inner city were less likely to utilize vehicles for shopping.[102] Access to available food vendors is dependent on routes and scheduling of public transportation for populations dependent on public transportation.[78,79] Food deserts have become prevalent and are shaped based on the time of day an individual can shop.[78,79] The reliance on public transportation is of added importance when considering recent urban Arizona data trends. In 2014, public transportation increased significantly in urban locations, such as Phoenix, Tucson Flagstaff, and Yuma.[76] Arizona has seen a 15% decrease in car ownership from 2012 – 2019.[77]

In addition to transportation contributing to the food desert environment, some researchers have argued that accessibility through ethnic markets,[73] and small-medium-sized stores[74] improve access to food as these stores serve low-income communities. However, this may not be the case when considering access to fruit and vegetables.

Researchers found that fresh produce was limited in smaller stores, the quality was poorer, and the price was higher.[75] As previously notated, perception,[106] and price[32,33] of fruit and vegetables are barriers contributing to a decreased fruit and vegetable consumption among low-income women and children. Furthermore, when researchers collectively evaluated socioeconomics, food access, and geographical location and compared their findings with USDA data, they identified at-risk food access areas. The results found previously identified areas, which were not identified as a food deserts, but were found to be high-risk urban areas within urban communities.[99] Therefore, it is abundantly clear that food deserts depend on multifactorial components. Although they do not initially appear on USDA tracking tools, such as Food Access Research Atlas, food deserts are likely to be prevalent among urban communities. Also, when multifactorial barriers are considered, such as socioeconomics, geographical location, and food access, low-income women and children residing in urban food deserts are at greater risk for inadequate fruit and vegetable consumption.

Similar to urban food deserts, rural food deserts are largely defined by the USDA criteria, which identify food deserts as low-income areas that also have a 10 mile or greater distance between residential locations and the nearest supermarkets.[97] Researchers have argued that rural food access may also be inaccurate as factors, such as physical distance,[21,41,70,71] the prices of quality food in rural areas,[72,107] and socioeconomics, [108,109] should be considered when identifying food deserts. Research has identified physical distance as a barrier to adequate fruit and vegetable consumption in rural communities, which ranged from .7 miles to 29.6 miles to the nearest food outlet.[21] However, distance to food outlets has been debated. Researchers have argued that physical distance is not

the main barrier in rural areas.[41,71] Regarding the price of quality food in rural areas, researchers have utilized tools, such as Nutritional Environmental Measures Survey for Stores (NEMS-S), to measure fruit and vegetables' availability, price, and quality.[72] Shanks et al., found the further the store was located from an urban area, the lower the store scored, which indicated the store was more likely to have a reduced availability, quality, and increase in the price of fruit and vegetables.[72] As previously addressed, the price of food is a barrier to adequate fruit and vegetable consumption for low-income families, which includes women and children.[35] Also, rural food deserts overlap with areas with rates of high poverty.[108,109] which also have a prevalence of lower education attainment[110,111] and lower annual income.[107,111,112]

These inequities between urban and rural communities have become abundantly clear and underscore the barriers impacting rural communities. For example, USDA data indicates that residents from rural areas are less likely to obtain higher education when compared to their urban resident counterparts.[110] Also, educational attainment is expanding at a slower rate. Between 2000 – 2018, completion of a bachelor's degree or higher education rose by 5% among rural residents and 10% among urban residents.[110] Also, research conducted in Arizona verifies federal findings as Arizona residents have had a decrease in educational attainment. In addition, David R Berman found that Arizona residents living in rural communities were less likely to complete high school and were twice as unlikely to complete college.[111] Furthermore, although federal poverty rates have declined among rural residents in the last 50 years, rural areas have a higher rate of poverty when compared to urban areas.[112] Of note, poverty is defined as having an income below the federally determined threshold, which indicates an individual or family

is unable to purchase basic needs, such as food, shelter, clothing, and other goods or services.[112] Lastly, rural Arizonan residents had on average a $10,000 annual income deficit when compared to urban residents. In addition, rural Arizonan residents were shown to have a higher poverty rate when compared to urban residents (26.4% to 14.3%, respectively).[111] The overlap of poverty and lower annual income[39], and a lower education attainment[25,113] are of added importance when considering each barrier that has been identified to reduce fruit and vegetable consumption among low-income women and children. Therefore, physical distance to available food stores may not solely depict rural food deserts. Rural food deserts are significantly impacted by the cost of healthy food in rural areas and the compounding socioeconomic factors, such as educational attainment and income. Due to the disadvantages that socioeconomic factors present among rural areas, including rural Arizona communities, rural communities are at a high risk of inadequate fruit and vegetable intake.

Limited available research investigates the relationship between the residential location of low-income women and children (rural and urban) and fruit and vegetable consumption. A study comparing fruit and vegetable consumption between urban and rural individuals found that urban individuals consumed 3.6 daily servings of fruit and vegetables and rural individuals consumed 3.3 servings daily.[21] Of note, a greater proportion of rural respondents included in the study were women with poverty-level incomes. Studies investigating fruit and vegetable consumption of local women and children participating in food assistance programs have been fruitful; findings indicate that urban children consume a greater number of fruit and vegetable servings when compared to their rural counterparts. Although it is important to note that this study only

included one race and does not reflect the entirety of low-income families participating in food assistance programs.[114] Further research is required to investigate the relationship between rural and urban communities housing women and children and their respected fruit and vegetable consumption. In addition, before this relationship can be identified, foundational research must be conducted as a starting point. Thus, research assessing present fruit and vegetable consumption trends among both rural and urban communities is important moving forward. Food assistant programs such as the Special Supplemental Nutrition Program for Women, Infants, and Children may play a role in assessing fruit and vegetable consumption trends for low-income women and children.

WIC and Food Access

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a public health nutrition program under the jurisdiction of the USDA for low-income pregnant and postpartum women, infants, and children up to the age of 5 who are at nutritional risk.[80] The WIC program began in 1972 as a pilot program aiming to improve the health of pregnant women, infants, and children in response to malnutrition among low-income families.[80] The WIC Program provides supplemental nutritious foods, nutrition education and counseling, and referrals to other health, welfare, and social services to eligible participants. Since its establishment, the WIC program has successfully reduced premature births, low birth weight, infant deaths, and incidence of iron-deficiency anemia; while simultaneously increasing prenatal care earlier in pregnancy, consumption of key nutrients, immunization rates, access to regular healthcare, and improved diet quality.[80]

To improve health outcomes and diet quality of participants, the WIC program provides supplemental nutritious foods, such as commercially prepared infant food, infant formula, milk, whole grains cereal, whole wheat bread, light tuna, beans or peanut butter, cheese, juice, eggs, and fruit and vegetables.[80] Upon assessment of diet quality among WIC participants, researchers found WIC participants to have a slightly better diet quality than the public for respected age groups, such as 2-4 years of age,[115,116], and perinatal women.[117,118] In addition to improved overall diet quality, WIC participants have also demonstrated increased consumption of both fruit and vegetables.[83,119] Researchers have associated an increase in fruit and vegetable consumption with the frequency of monthly benefit redemption.[120] Singleton et al. found that as WIC Cash Value Vouchers (CVV) redemption rates of fruit and vegetables increase, consequently, consumption of fruit and vegetable increases among WIC participants.[120] Of note, although the impact of WIC on diet quality and fruit and vegetable consumption has been assessed, researchers have relied heavily on self-reported information, such as questionnaires, surveys [116,117,120,121], and dietary recalls.[115,118,119]

The WIC program has improved overall diet quality but also has barriers that have historically negatively impacted redemption rates of WIC benefits, such as access to WIC stores,[81,82] costs of fruit and vegetables with WIC approved stores,[83] and the WIC shopping experience.[84-86] Recent evidence has indicated that WIC redemption rates are lower in urban areas.[122] This has been attributed to access to WIC-approved stores as WIC participants living in urban areas identified as food deserts travel further to shop.[82] Also, despite providing cash value benefits to purchase fruit and vegetables, the price of fruit and vegetables varies among approved WIC vendors.[83] Thus, the dollar amount

received for fruit and vegetables received can spread thinner among stores with higher-priced foods.[83] Lastly, Bermann et al., assessed shopping behaviors among Arizona WIC participants and identified specific shopping behaviors, such as in-store confusion and negative interactions with stores, that contributed to a decrease in redemption rates of WIC-approved foods.[85]

Fortunately, the WIC program has made strides to improve redemption rates by taming barriers experienced by the WIC population, such as shopper experience. The Healthy Hunger-Free Kids Act of 2010 (HHFKA) included provisions to mandate all WIC state agencies to implement electronic benefit transfers (EBT) by October 1st, 2020.[123] Arizona state WIC agencies transferred from paper checks to EBT in 2017, which Arizona refers to as WIC.[124] Due to the decrease in stigma associated with WIC and reduced transaction time during shopping, evidence suggests that this transition has led to an increase in the redemption rate of WIC-eligible foods.[86,125] However, although eWIC has improved the shopping experience, WIC participants still find identifying WIC-Eligible foods challenging in stores.[86] In addition to eWIC, Arizona state WIC agencies have also implemented a downloadable application for cellular phones, referred to as EzWIC.[126] The WIC application helps clarify WIC-approved foods by providing a digital copy of the food list, scanning items and verifying whether they are WIC approved, and accessing the current benefit balance.[126] Therefore, the questions remain: to what extent does eWIC improve redemption rates of fruit and vegetables among Arizona WIC participants, how do redemption rates of rural and urban Arizona WIC participants compare and do participants' locations influence the variety of products purchased?

Summary

In summary, adequate consumption of fruits and vegetables is positively associated with a healthy lifestyle, as evidence indicates that both quantity and variety of fruit and vegetables prevent the onset of various forms of cancer[2,3,14,15] and chronic disease[4,5,6-13,16-18] among adolescents and adults. However, limited data are available for younger populations, such as during toddlerhood (12 – 24 months of age) and childhood (3 – 5 years of age), and the prevention of chronic disease. Fortunately, resources such as the USDA Dietary Guidelines provide insight on dietary recommendations to achieve, which includes fruit and vegetables daily servings and weekly variety, to promote health and prevent chronic disease.[19] However, although these recommendations have remained consistent for the last decade, about 80% of Americans do not meet fruit recommendations and almost 90% of Americans do not meet the recommendations for total vegetable daily servings.[19] Of note, this includes high priority populations such as toddlers, children, and perinatal women.[19] Thus, what barriers are individuals facing that prevent adequate consumption of fruit and vegetables?

Fortunately, research has identified consumer barriers that negatively impact access to healthy foods and ultimately decreased fruit and vegetable consumption, such as income and education attainment,[22-30] food cost,[31-39] geographical location,[21,40-47], and the home environment.[48-58] Research indicates barriers, which inhibit the ability to consume adequate amounts and variety of fruits and vegetables, are present among both urban and rural populations.[21] However, due to growing definitions of food deserts, the extent of these barriers has not been fully assessed in both urban and rural geographical locations. Unfortunately, due to the recent 2019 Coronavirus Disease Pandemic (COVID-

19), many of these previously identified barriers have been exacerbated in recent months.[59-67] This places significant importance on identifying the fruit and vegetable consumption rates before the COVID-19 pandemic in both rural and urban communities and investigating the changes 1 year into the COVID-19 pandemic. Upon identifying present consumption rates in both geographical locations and the changes in consumption rates, interventions can be formed accordingly to improve overall consumption rates and work toward improving diet quality.

In addition, programs such as The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) serve low-income pregnant and postpartum women, infants, and children up to the age of 5 who are at nutritional risk in urban and rural communities.[80] The WIC program has effectively shown an increase in diet quality among WIC participants, such as 2-4 years of age[115,116] and perinatal women,[117,118] and is associated with an increase and fruit and vegetable consumption.[83,119] Although the program has had success, the WIC program has had obstacles that have hindered further success, such as derogative shopping experiences.[85] As of April 2017 the Arizona WIC program launched its version of Electronic Benefits Transfers (EBT) and a mobile device application, respectively called eWIC[86,125] and EzWIC[126], in an attempt to improve the shopping experience. The inclusion of eWIC also provides an opportunity to assess redemption rates of fruit and vegetables among WIC participants. Thus, rather than relying on self-reported information,[115,117,120,121] researchers in Arizona will be able to effectively determine if WIC participants are taking full advantage of the WIC benefits provided in both urban and rural communities and assess the impact that COVID-19 had on redemption rates

CHAPTER 3

METHODS

Study Design

This study was a cross-sectional, secondary analysis of a single time point from the Snuggle Bug/Acurrucadito Study.[127] This study aims to compare fruit and vegetable consumption of WIC participants and non-WIC participants between urban and suburban RUCA codes in the Phoenix area. Participants were assigned as urban, or other based on their respected residential address and corresponding RUCA code. Diet records, 3-day food records, collected during a single three-week period were assessed and compared between the two subgroups, WIC participants and non-WIC participants. No individual data were used for this study, this study was exempt from the Arizona State University (ASU) Institutional Review Board (IRB).

Participants and Procedures

Recruitment

For the Snuggle Bug/Acurrucadito Study a variety of recruitment strategies were utilized. Potential participants were identified by providers and research staff through in-person recruitment from an obstetrics and pediatrics unit at a local hospital, and a network of Supplemental Nutrition Program for Women, Infant, and Children (WIC) clinics in the Phoenix area. Advertisements were also distributed through various social media outlets, Arizona State University (ASU) Intuitional listservs, word-of-mouth, flyers, community events, and health professional referrals.

Once screened, eligible participants provided their contact information (primary) and the contact information of a family member or friend (secondary). Participants

communicated with researchers through their preferred mode (e.g., text, email, phone) to determine their infant's date of birth, if eligibility was maintained, and schedule the next step in the study, such as an in-home visit. Enrollment in the study and consent occured at the first in-home visit, 3-weeks post-delivery.

Inclusion and exclusion criteria

Inclusion criteria for maternal participants in the Snuggle Bug/Acurrucadito Study included: English, and/or Spanish speaking mothers from the Phoenix, Arizona community in their 3rd trimester of pregnancy through 3 weeks postpartum; not intending to move from the Phoenix area for 1.25 years; between 18 to 40 years of age; have telephone contact.

Exclusion criteria included: Mothers with a medical history of a chronic disease that impacts fetal growth (e.g., types 1 and 2 diabetes, and cardiovascular disease); experienced a high-risk pregnancy (e.g., preeclampsia, HIV infection); delivered a small (< 2500 g) or large (> 4000 g) for gestational age infant; hospitalization after delivery discharge; separation from the infant; experiencing significant postpartum complications; reports of alcohol, tobacco, and marijuana use in the second or third trimester; or reports of illicit substance use during any trimester.

Measures

WIC participation

During enrollment in the Snuggle Bug/Acurrucadito Study participants disclosed whether they were presently participating in an Arizona WIC program or not. Participants were then further divided into two subgroup groups, (0) WIC participants, and (1) non-WIC participants.

Locale classification

The Federal Office of Rural Health Policy (FORHP), in collaboration with the Economic Research Service, U.S. Department of Agriculture (USDA-ERS), and FORHP collaborated to develop the Rural-Urban Commuting Areas (RUCA) codes system as an additional method to determine rurality among metropolitan counties.[128] RUCAs are a census tract-based classification arrangement that collectively utilizes the Census Bureau Urbanized Areas, Urban Clusters, and commuting information to denote the nations nation's census tract to their respected rural or urban status.[128] As the basis for this study, local agency WIC clinics within corresponding zip codes were assigned a RUCA code 1-10 to determine potential types of locales.[128] Classification of participating clinics was determined through the Rural Health Information Hub (RHIH) tool, "Am I rural" which is an easily accessible tool that allows zip codes to be searched, and then a locale classification is provided based on the RUCA definition.[129]

Categories are termed and defined as follows[128]:

1. Metropolitan – Areas containing a core urban population of 50,000 or more
2. Nonmetropolitan – Areas containing a population of less than 50,000

Code classification is defined as follows[96]:

Code 1. Metropolitan area core: Primary flow within an Urbanized Area (UA)

Code 2. Metropolitan area high commuting: Primary flow 30% or more to a UA

Code 3. Metropolitan area low commuting: Primary flow 10% - 30% to a UA

Code 4. Micropolitan area core: Primary flow within an urban cluster (UC) of 10,000 to 49,999 (large UC)

Code 5. Micropolitan high commuting: Primary flow 30% or more to a large UC

Code 6. Micropolitan high commuting: Primary flow 30% or more to a large UC

Code 7. Small town core: Primary flow within an urban cluster of 2,500 to 9,999 (small UC)

Code 8. Small town high commuting: Primary flow 30% or more to a small UC

Code 9. Small town low commuting: Primary flow 10% to 30% to a small UC

Code 10. Rural areas: Primary flow to a tract outside a UA or UC

For comparison purposes participating local agency clinics were denoted as either rural or urban. Urban participants were located within zip codes within metropolitan counties and assigned RUCA code 1. Non-urban participants were within zip codes assigned with micropolitan counties or metropolitan counties and assigned RUCA codes 2-10. For analysis purposes, clinics were coded: urban participants' clinics were denoted as "1", while non-urban participants were denoted as "0".

Diet record

At all home visits, bilingual researchers (speak English and Spanish) explained how to complete a 3-day diet record. Once completed, along with subsequent data, participants were instructed to mail back the completed diet recall forms in pre-stamped boxes. Diet records were entered into the Nutrition Data System for Research (NDSR), which is a Windows-based dietary analysis program designed for the analysis of food records. The following were assessed:

- Average fruits and vegetables per day: The average number of fruits (without juice) consumed per day per participant, respectively. The average number of vegetables (with and without potatoes) consumed per day per participant,

respectively. Fruits and vegetables were summed to create aggregated variables: Fruits (no juice) and vegetables, as well as fruits (no juice) and vegetables (no potatoes).

- Days per participant: The average number of days logged during their 3-food record per participant.

Ethnicity

For ethnicity, participants were categorized as either Hispanic, not Hispanic, or unknown. Those who preferred not to answer or did not respond were identified as unknown.

Race

For race, participants were categorized as either white, non-white, or unknown. Participants who reported black, American Indian or Alaskan Native, Asian, Native Hawaiian or other pacific islanders, and other (multi-race) were identified as non-white. The participant who preferred not to answer or did not respond were identified as unknown.

Annual income

Annual income was divided into four categories: Annual income of less than or equal to $19,000, annual income between $20,000 and $49,000, an annual income equal to or greater than $50,000, or unknown. The participant who preferred not to answer or did not know their annual income w identified as unknown.

Education attainment

Educational attainment was divided into four categories: Less than or equal to a high school graduate or graduate equivalency diploma (GED), some college no degree,

equal to or greater than college or unknown. Equal to or greater than college included the completion of a college degree (associate's, bachelor's, master's, or doctoral degree), or technical or vocational degree. The participant who preferred not to answer were identified as unknown.

Household occupants

Household occupants was the number of individual people living in the same household as the participant.

Children under five

The reported number of children under the age of 5 years of age living in the same household as the participant.

Statistical analysis

Post-data entry, data were inspected for any issues, necessary omissions, and cleaned. Descriptive data are presented as mean +/- standard deviation and percentages. We examined differences in WIC participation for the mean difference in FV consumption [all F only, Vegetable only, FV (no juice), and FV (no juice and no potatoes)] data using linear regression, adjusting for ethnicity, age and WIC participation. All analyses were done using Stata analytical software version 15. Statistical significance was assessed at $p<0.05$.

CHAPTER 4

RESULTS

The sample of participants (n=53) were female with a majority reported as non-Hispanic (52.8%; Table 1) and the participants had an age range being 26 – 37 years (mean 31.7±5.3; Table 1). Of note, the majority of the participants reported high educational attainment with over 66% reporting an education of college or more, and a higher annual income with 50.9% reporting an annual income of ≥ $50,000 The average fruit and vegetable consumption, not including juice and potatoes, was 3.8 servings per day.

Table 1. Participant demographics and key data (n=53)

	All n=53	Non-urban n=8	Urban n=45
Age, mean±SD	31.7±5.3	29.2±7.79	32±4.8
WIC participation, % Yes (n) No (n)	32.1 (17) 67.9 (36)	37.5 (3) 62.5 (5)	31.1 (14) 68.9 (31)
Ethnicity, % Hispanic (n) Non-Hispanic (n) Unknown (n)	45.3 (24) 52.8 (28) 1.9 (1)	50 (4) 37.5 (3) 12.5 (1)	53.3 (24) 46.7 (21)
Race, % Non-white (n) White (n) Unknown (n)	28.3 (15) 58.5 (31) 13.2 (7)	37.5 (3) 37.5(3) 25 (2)	26.7 (12) 62.2 (28) 11.1 (5)
Marital status, % Married (n) Not Married (n) Unknown (n)	69.8 (37) 28.3 (15) 1.9 (1)	25 (2) 62.5 (5) 12.5 (1)	28.9 (13) 71.1 (32)
Education, % ≤ High school graduate or GED (n) Some colleges have no degree(n) ≥ College (n) Unknown (n)	26.4 (14) 5.7 (3) 66 (35) 1.9 (1)	12.5 (1) 12.5 (1) 62.5 (5) 12.5 (1)	28.9 (13) 4.4 (2) 66.7 (30)
Income, % Annual income ≤ $19,000 (n) Annual income $20,000 – $49,999 (n) Annual income ≥ $50,000 (n) Unknown (n)	11.3 (6) 15.1 (8) 50.9 (27) 22.6 (12)	12.5 (1) 12.5 (1) 50 (4) 25 (2)	11.1 (5) 15.6 (7) 51.1 (23) 22.2 (10)
Household occupants, mean±SD	4.9±2.1	4.29±0.76	5±2.28
For children under five, mean±SD	1.3±1	0.86±1.21	1.47±0.97
3-day diet recall, mean±SD	2.3±1.2	1.1±1.6	2.5±1.1
Fruit no juice, mean±SD	1.5±1.2	1.85±1.67	1.58±1.72
Vegetables, mean±SD	2.6±1.7	1.7±0.34	2.7±1.79
Vegetable no potato, mean±SD	2.2±1.7	1.03±0.6	2.33±1.82
Fruit no juice and vegetables, mean±SD	4.2±2.4	3.55±1.33	4.28±2.51
Fruit no juice and vegetables no potato, mean±SD	3.8±2.5	2.88±1.7	3.9±2.6

Due to the small sample size and incomplete data collected from non-urban participants (see Table 1), we were unable to assess an association between fruit and vegetable consumption and locale. Descriptively, among the three participants that completed their 3-day diet recall, the average consumption of total fruit and vegetables and vegetables consumed was 2.88±1.7 servings of fruit and vegetables per day compared to 3.8±2.6 servings consumed per day by their urban counterparts.

Table 2. Association self-reported servings of fruit and vegetable consumption and WIC participation (n=42)

	Fruit no juice β (95% CI)	Veg β (95% CI)	Veg no potato β (95% CI)	Fruit no juice and vegetables β (95% CI)	Fruit no juice and vegetables no potatoes β (95% CI)
WIC participation	-0.79 (-2.29, 0.7)	-0.32 (-1.84, 1.19)	-0.32 (-1.88, 1.24)	-1.1 (-3.3, 1.0)	-1.1 (-3.3, 1.07)
Age	0.02 (-0.09, 0.14)	-0.11 (-0.23, 0.003)	-0.09 (-0.21, 0.03)	-0.09 (-0.03, 0.07)	-0.07 (-0.24, 0.1)
Ethnicity	-0.18 (-1.47, 1.1)	-0.58 (-1.88, 0.71)	0.82 (-2.16, 0.52)	-0.8 (-2.6, 1.1)	-0.99 (-2.88, 0.88)

The regression analysis indicated there were an inverse relationship between WIC participation and fruit and vegetable consumption among all categories (fruit no juice, vegetables, vegetables no potato, fruit no juice and vegetables, and fruit no juice and vegetables no potato; Table 2). However, none of the relationships between fruit and vegetable consumption and WIC participation were statistically significant. Also, the regression analysis identified an inverse relationship between the participant's Hispanic ethnicity and fruit and vegetable consumption among all categories. Similar to WIC participation and fruit and vegetable consumption, none of the associations identified were considered statistically significant.

CHAPTER 5

DISCUSSION

Overview

The purpose of this secondary analysis study was to determine the association between fruit and vegetable consumption and WIC participation in participants who participated in the Snuggle Bug/Acurrucadito Study. Also, the relationship between fruit and vegetable consumption in urban and non-urban locales was assessed. Unfortunately, there were too few non-urban mothers participating who had completed dietary data to examine differences by locale. We did not observe any statistically significant associations between WIC participation and fruit and vegetable consumption. Literature to date supports that participation in the WIC program contributes to an increase in fruit and vegetable consumption.[83,119] Of note, previous literature has relied upon similar first-person accounts to document WIC's influence on fruit and vegetable consumption.[115,118,119] This study supports the notion that future research is needed to assess fruit and vegetable consumption among WIC participants in varied approaches, which may include redemption data and participant shopping receipts. In addition to consumption and WIC participation, this study emphasizes the need for larger studies, which include greater non-urban participants, to help determine how locale influences fruit and vegetable consumption among low-income populations.

Although this study did not yield any statistically significant results, there were characteristics from this study that align with previously published research. For example, a high annual income and greater educational attainment have been associated with an increase in fruit and vegetable consumption.[23] The majority of the participants

from this study had a reported annual income of $50,000 or greater. In addition to income, most participants from this study had higher educational attainment, such as a college degree, or vocational degree. This supports previously documented positive association between fruit and vegetable consumption, and income and educational attainment. Future research is needed to assess the barriers impacting individuals from lower-income and educational levels.

Although the results are not statistically significant, some findings from this study diverge from the present literature since research to date has shown a positive relationship between fruit and vegetable consumption and WIC participation.[83,119] However, although not statistically significant, this study found an inverse relationship between WIC participation and fruit and vegetable consumption among all areas assessed. The present body of literature emphasizes WIC's ability to improve fruit and vegetable consumption among low-income populations by providing cash value vouchers for fruit and vegetables.[80,83,119,120] Considering the sample population from this study consisted of a majority of participants from households with a higher annual income and higher educational attainment, the inverse association may be attributed to areas of WIC participation that have not been fully explored in the present research. For example, the relationship between households who were previously financially stable (income above the WIC eligibility guidelines) but due to unforeseen circumstances had recently faced financial instability and newly qualified for WIC. Additionally, data collected for the Snuggle Bug/Acurrucadito study collected data entrees during the COVID-19. During the pandemic the unemployment rate jumped from 3.5% in 2019 to 14% by April 2020.[60] Furthermore, as of August 2021, evidence has found 1 in 9 adults with children reported

a lack of sufficient food for their households due to the inability to afford food.[61] Therefore, unforeseen circumstances impacting financial stability and leading families to utilize food assistance programs, such as WIC, could have been a result of the COVID-19 pandemic. Future considerations for research should include the investigation of new families participating in the program as a result of financial hardship brought on by the COVID-19 pandemic, and the relationship between WIC participation and fruit and vegetable consumption for the newly qualified WIC families.

The COVID-19 pandemic may have impacted WIC participants' ability to consume adequate fruit and vegetables in other areas as well. During the COVID pandemic, the in-person shopping experience declined as shoppers attempted to reduce their exposure to COVID.[64] To overcome this barrier, many shoppers during the pandemic opted for online ordering and curbside pick-up.[130] At this time Arizona WIC participants cannot purchase WIC-approved foods online and were not granted this luxury. Additionally, there was an increase in the buying of shelf-stable foods during the COVID-19 pandemic.[131] This increase in buying of shelf-stable foods, also known as panic buying, impacts WIC participants as many of the WIC-approved foods are shelf-stable, such as canned and frozen fruit and vegetables. Further limiting the ability of WIC participants ability to purchase fruit and vegetables. Thus, the COVID-19 pandemic disproportionally impacted WIC participants' ability to purchase WIC-approved food, such as fruit and vegetables, and ultimately decreased consumption. The panic buying during the COVID-19 pandemic could have contributed to the decrease in fruit and vegetable consumption for the WIC participant in this study. Therefore, this study supports the present body of research as it indicates that COVID-19 exacerbated barriers

to consuming fruit and vegetables. Further research, which investigates self-identified barriers during this period, could verify these findings and support them.

Although research has shown urban individuals consume a greater amount of fruit and vegetables compared to their rural counterparts;[21,69] Recent literature highlights the need for further research to understand the relationship between fruit and vegetable consumption and locale.[99] The present literature indicates that food deserts are not well defined and may be more abundantly present for low-income individuals in urban areas than previously identified.[99] In addition to distance to food access, researchers have expanded the definition of food deserts to include sociodemographic factors, such as income[34-39] and education.[22-25] Also, the present body of literature indicates that low-income individuals rely on public transportation for shopping.[78,79,100-102] Due to transportation routes and the time of day, food deserts can be created for low-income individuals.[78,79] While these results are not statistically significant, this study supports this notion as those who participated in the WIC program, low-income individuals, were shown to have a decrease in fruit and vegetable consumption in urban areas. As these low-income individuals may be facing barriers, such as food deserts, that have not been previously considered. Regarding non-urban participants, the small sample size provided limited complete data and reduced the validity of the data collected for the non-urban participants. Therefore, this study helps support the need for future research, with a larger sample size of both urban, non-urban, and rural participants, to assess the relationship between fruit and vegetable consumption and WIC participation in urban various locales.

Study strengths and limitations

There are several strengths and limitations that need to be considered when interpreting the findings from this study. Strengths of this study include the methods of obtaining data, the utilization of validated measures, and the inclusion of 3-day food record to assess the fruit and vegetable consumption of participants. Although a secondary analysis, the original study design that provided the data was a well-designed cross-sectional study. The cross-sectional study design is a simple and inexpensive design that allows researchers to assess participants at similar points in time. Also, the utilization of well-defined measures, such as demographic, WIC participation, and fruit and vegetable categories, supports the accuracy of the results obtained. Lastly, the inclusion of food records is commonly utilized in the present literature to assess fruit and vegetable consumption among study participants, more specifically, WIC participants.[115,118,119] Of note, researchers in the original study designed a guide on how to complete their respected food diaries, further supporting the accuracy of the results obtained.

Although there were strengths in this study, the limitations of this study are of added importance. Because this study was a secondary analysis, which the purpose of this study differed from Snuggle Bug/Acurrucadito's original purpose, may have hindered the power purpose to examine the research questions. For example, the sample size, and recruitment strategies may have contributed to the results which were not considered statistically significant. The sample size for this study was relatively small (n=53) and there were a limited number of participants from rural areas, which limited the ability to identify trends among rural specific participants and the ability to compare participants by their respected locales. Of those that were rural-urban, a limited number completed

their dietary recalls, which further limited the comparison between urban and non-urban-rural areas and the accuracy of the results. Although there was an expansive recruitment attempt (Pediatric units at hospitals, WIC offices, social media, health fair events, etc.) many of these locations were in the Phoenix area, and limited recruitment from non-urban-rural areas. Finally, as a cross-sectional study, causality cannot be determined.

CHAPTER 6

CONCLUSION

To our knowledge, this is the first study that examined fruit and vegetable consumption of Arizona WIC participants in rural and urban areas. We hypothesized individuals residing in urban communities would consume a greater number of fruit and vegetables compared to their non-urban counterparts. In addition, we hypothesized WIC participants will consume fruit and vegetables at a greater rate compared to their non-WIC counterparts. Although the results of this study do not support the hypothesis, there are implications for future research to better understand the relationship between fruit and vegetable consumption and the locale of WIC participants. The WIC participants of this study were majority from urban areas and had a decrease in fruit and vegetable consumption. This implies that low-income individuals participating in the WIC program face an unseen barrier in urban communities that reduce overall fruit and vegetable consumption. Future research is needed to confirm the relationship between locale and WIC participation among both urban and rural participants. Additionally, future research needs to be conducted in a manner that further supports the WIC program's ability to improve diet quality through increased fruit and vegetable consumption.

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APPENDIX A

SNUGGLE BUG IRB

Valleywise Health

MIHS IRB — Approval Notification

To: Sarada Panchanathan, MD, MS
From: William Dachman, MD, IRB Chair
Subject: Protocol #2019-060
Date: 10/07/2019

On **10/07/2019,** the project **Investigating the Influences of Sleep-Wake Patterns and Gut Microbiome Development in Infancy on Rapid Weight Gain, an Early Risk Factor for Obesity** was approved by the MIHS Institutional Review Board (IRB) by expedited review, under the following categories:

(4) Collection of data through noninvasive procedures

The approval of your study is valid through No Expiration Date, by which time you must submit an annual report either closing the protocol or requesting permission to continue the protocol for another year. Please submit your report by so that the IRB has time to review and approve your report if you wish to continue it for another year.

This approval includes:

Additional Documentation
08/19/2019 ASU Sleep Study_Procedures Figure 5_Table 4.pdf
08/19/2019 I1 _ 2-Birth History and Child Demographics (1).pdf
08/19/2019 I3-Infant Medical History.pdf
08/19/2019 I4-ExtendedBriefInfantSleepQuesti.pdf
08/19/2019 I5a-Pediatric AMI Actigraph Instructions.pdf
08/19/2019 I5b-CSD-core with Naps.pdf
08/19/2019 I5c-Infant_Sleep_diary_revised.pdf
08/19/2019 I6-Infant WHO Breast and Solids Feeding Questionnaire.pdf
08/19/2019 I7-INFANT24HourFoodRecall.pdf
08/19/2019 I8a-How to collect the fecal sample.pdf
08/19/2019 I8b-Fecal Sample Collection Data.pdf
08/19/2019 PF1-Demographic instrument.pdf
08/19/2019 I9-Infant Anthropometric Data.pdf
08/19/2019 PF2-Maternal pregnancy factors.pdf
08/19/2019 PF3-BriefARSMA-II.pdf
08/19/2019 PF4.1-Eng_EPDS_1987.pdf
08/19/2019 PF4.2-DASS-21.pdf
08/19/2019 PF5-Breastfeeding Attrition Prediction Tool.pdf
08/19/2019 PF6-PSQI.pdf
08/19/2019 PF9-ADULT24HourFoodRecall.pdf
08/19/2019 PF10 _ E2-Return to Work _ Daycare.pdf
08/19/2019 E1-Infant-Toddler_HOME.pdf
08/19/2019 E3-USDA food seq short2012.pdf
08/19/2019 E4-Tobacco Exposure.pdf
08/19/2019 Recruitment Snuggle Bug Study Flyer.pdf
08/20/2019 ICF Sleep Study READABILITY.doc
08/20/2019 2019-060 Sleep Study IRB Checklist.pdf
08/20/2019 2019-060 Sleep Study Transmittal Form.pdf
08/21/2019 FINAL ASU Sleep Study Protocol 1-30-19 CP (8).docx
08/21/2019 Redlined ASU Sleep Study Protocol 1-30-19 CP (8).docx
08/21/2019 FINAL Recruitment Microbiome Research.docx
08/21/2019 Redlined Recruitment Microbiome Research.docx
08/23/2019 REDLINED ICF Sleep Study FINAL8.23.19.doc
08/23/2019 ICF Sleep Study FINAL8.23.19.pdf
09/04/2019 R01 OSMB 9.2.19.pdf

Approved Consent Form 10/07/2019 ICF Sleep Study FINAL8.23.19 clean copy for stamping.pdf

As Principal Investigator, you are responsible for assuring that:

- The approved protocol is followed exactly and prior IRB approval is obtained prior to any changes (including changes in recruitment procedures, subjects, population, location, protocol, or staff).
- Any problems are reported promptly to the IRB.
- After your study has been conducted you must submit a final closure report.

William Dachman, MD
IRB Chair

Attachments:
- ICF Sleep Study FINAL8.23.19 clean copy for stamping.pdf