

Differences in Fruit and Vegetable Selection, Consumption, and Waste in Rural vs.
Urban Arizona Schools

by

Molly Eilish Jepson

A Thesis Presented in Partial Fulfillment
of the Requirements for the Degree
Master of Science

Approved July 2021 by the
Graduate Supervisory Committee:

Meg Bruening, Chair
Marc Adams
Traci Grgich

ARIZONA STATE UNIVERSITY

August 2021

ABSTRACT

Background: Studies show that rural schools may be less supportive of student fruit/vegetable (FV) consumption, but few studies have investigated the relationship between school locale and FVs. The aim of this research is to analyze the relationship between school locale (rural vs. urban) and students' FV selection, consumption, and waste in elementary, middle, and high schools.

Methods: A cross-sectional analysis of 37 Arizona schools evaluated differences in the selection, consumption, and waste of fresh FVs from students (n=2525; 45.7% female; 41% non-white; mean age=11.6±3.3; 23.5% rural) using objective plate waste measures. Zero-inflated negative binomial regressions examined differences in FV grams selected, consumed, and wasted by urban vs. rural locale, adjusted for sociodemographics and school.

Results: The percent of students who selected, consumed, and wasted zero grams of FVs were 14%, 21%, 20%, respectively. Among students with some (non-zero amounts), the average selected, consumed, and wasted FVs were 115.0±81.4g, 51.7.5±65.1g, 65.2±66.7g, respectively. Rural students (versus urban) had lower odds of selecting (OR=0.75), consuming (OR=0.78), and wasting (OR=0.71) any FVs, after adjusting for covariates. However, among students with some FVs on their plates, rural students selected (IRR=1.40), consumed (IRR=1.18) and wasted (IRR=1.62) more grams of FVs.

Conclusions: Rural students had reduced odds of selecting and consuming any FVs, but with lower odds of waste, perhaps due to reduced selection. Once some FVs were on the tray, likelihood of consumption and waste by rural students were

greater. Results support interventions targeting rural students' FV intake to reduce waste.

ACKNOWLEDGMENTS

I would like to thank Dr. Meg Bruening for her mentorship, guidance, encouragement, and knowledge which was immensely valuable during the completion of this thesis project. Sincere thanks also to Dr. Marc Adams and Traci Grgich for their time, knowledge, and feedback in reviewing this work. I would also like to extend my sincere gratitude to all the study coordinators and research staff whose efforts made this project possible. Finally, thank you to Arizona schools and students who opted to participate in this project. This thesis fully reflects the work of dedicated professionals engaged in promoting the health and well-being of Arizona students.

TABLE OF CONTENTS

	Page
LIST OF TABLES.....	vi
CHAPTER	
1 INTRODUCTION	1
Overview	1
Purpose of Study	4
Definition of Terms	5
Strengths, Limitations, and Delimitations	6
2 REVIEW OF LITERATURE	9
Introduction	9
Rural Health Disparities	9
Health Disparities for Rural Youth.....	11
Children’s Nutrition.....	13
The School Food Environment	14
The Rural School Food Environment and Students’ Eating Behaviors	21
Summary	30
3 METHODS	33
Study Design	33
Measures.....	34
Statistical Analysis	36
4 RESULTS	38
Descriptive Statistics	38

	Page
CHAPTER	
Analysis of FV Selection, Consumption, and Waste with Only Rural and Urban Schools.....	39
Sensitivity Analysis Including Suburban Students' FV Selection, Consumption, and Waste.....	42
5 DISCUSSION	54
6 CONCLUSION	64
REFERENCES	65
APPENDIX	
A PRINCIPAL LOCO PARENTIS FORM	76
B IRB-APPROVED ENGLISH ELEMENTARY ASSENT STATEMENT	79
C IRB-APPROVED SPANISH ELEMENTARY ASSENT STATEMENT	81
D IRB-APPROVAL FOR HUMAN SUBJECT TESTING	83

LIST OF TABLES

Table	Page
1. Participant Demographics and Key Variables Among Rural, Urban, and Suburban School Students (n=2525)	44
2. Participant Demographics and Key Variables Among Rural and Urban (Including Suburban) School Students (n=2525)	47
3. Zero-inflated Negative Binomial Regression Models Examining Association Between School Locale and Student Fruit and Vegetable Selection, Consumption, and Waste (Excluding Suburban Schools) (n=2348) ..	50
4. Zero-inflated Negative Binomial Regression Models Examining Association Between School Locale and Student Fruit and Vegetable Selection, Consumption, and Waste (Including Suburban Schools) (n=2525) ..	52

CHAPTER 1

INTRODUCTION

Overview

Fruit and vegetable (FV) consumption is important to children's health. The relationship between nutrition and health outcomes is well established, with fruit and vegetable consumption being an important factor due to the health-promoting nutrients they contain which have associations with protections against chronic diseases (Epstein et al., 2001; Lapuente et al., 2019; Wang et al., 2015). Some evidence even suggests their association with a decreased likelihood of poor weight status outcomes (Epstein et al., 2001; Wang et al., 2015). Consistently though, diets lacking FVs are shown to be associated with poorer health outcomes (*2015-2020 Dietary Guidelines for Americans, 2015; Vital Signs: Fruit and Vegetable Intake Among Children — United States, 2003–2010, 2014.; Emmett & Jones, 2015*). Research has also suggested that childhood FV intake is a potential indicator of the quality of children's diets and health outcomes, where some studies have found that greater FV intake is associated with lower energy intake and a lower risk of overweight and obesity in children and adolescents (Daly et al., 2017; Epstein et al., 2001; Hanson et al., 2019; Wang et al., 2015).

Research shows that rural populations face a greater amount of health disparities compared to urban populations, including a markedly greater risk of being diagnosed as overweight or obese (*Food Access in Rural Communities - RHHub Food Access Toolkit, 2015.; Gamm et al., 2010b; National Academies of Sciences et al., 2018*). Children and adolescents who live in rural environments are 30% more likely to be overweight or obese when compared to children and

adolescents in urban environments (Liu et al., 2012). Research which has examined the diets of rural youth have noted that this population is not meeting the recommended dietary intakes and that their diets lack fruits and vegetables (FVs)(Daly et al., 2017; Hanson et al., 2019; Jackson et al., 2015). Additionally, research has demonstrated that rural vs. urban neighborhoods have decreased access to supermarkets due to distance, which may have negative implications for opportunities to consume FVs (Gustat et al., 2015; Powell et al., 2007). However, studies comparing the diets of urban vs. rural youths show mixed evidence as to whether there is a difference in their diet qualities (A. M. Davis et al., 2011; Euler et al., 2019; Gustafson et al., 2017; Liu et al., 2012). Many of the studies investigating rural youth diet qualities also lack objective methods of measurement, analyze only certain age groups, or have small sample sizes. Therefore, comparability of these studies is difficult, and so it cannot be concluded based on current literature if and what differences in diet exist among rural and urban youth.

Evidence suggests that the school food environment can shape children's eating behaviors(Briefel et al., 2009; Fox et al., 2009). Most children and adolescents have the option to consume two out of three key meals during the school day, and have the opportunity to eat half of their recommended daily calories during the six hour school day (*School Nutrition Environment / Healthy Schools / CDC*, 2019). However, research suggests that there may be differences in the rural vs. urban school food environments that may influence student FV eating behaviors; studies of rural schools have cited several barriers and negative attitudes for rural schools in providing salad bars and fresh FVs, and that wellness programs and staff do not do enough to support healthful food choices in rural schools (Blumenschine et al., 2018;

Cornish et al., 2016; Findholt et al., 2016; Sánchez et al., 2014). With the implementation of the Healthy, Hunger-Free Kids Act of 2010 (HHFKA), schools transformed their lunches to meet the Dietary Guidelines for Americans (DGAs), and to receive a free or reduced-price lunch, students were required by HHFKA to select a half cup serving of fruit or vegetable (*Healthy, Hunger-Free Kids Act of 2010 Summary*, 2011.). Despite this change, studies on rural schools found that students were not able to meet FV recommendations due to low FV access and that rural vs. urban schools were less likely to offer fresh fruit as an option (Daly et al., 2017; Turner et al., 2016). Furthermore, research has cited complaints by rural school staff post-HHFKA implementation regarding the costs of providing healthier school meals, especially in regard to FV provision (Blumenschine et al., 2018; Cornish et al., 2016). Additionally, Turner and Chaloupka found that, with the change in school nutrition guidelines, rural schools reported a greater number of complaints, reduced purchasing, and reduced consumption of school lunch by rural students compared to that of urban schools (Turner & Chaloupka, 2014). To our knowledge, this is the only study to examine rural students' perceptions of school meals, and no studies have examined rural students' school lunch eating behaviors relative to urban students'. Overall, there is evidence to suggest that rural children may have fewer opportunities to consume healthy foods, particularly FVs, during school meals, but more research is needed examine if there are differences in rural and urban students' school lunch eating behaviors, especially FV consumption.

Fruits and vegetables are important components of children's diets (*2015-2020 Dietary Guidelines for Americans*, 2015.; *Vital Signs: Fruit and Vegetable Intake Among Children — United States, 2003–2010*, 2014.; Emmett & Jones, 2015;

Epstein et al., 2001; Lapuente et al., 2019). Therefore, engaging children in healthy eating behaviors like consuming FVs may help prevent poor health outcomes later in life. Rural children are at a greater risk for health disparities compared to urban children, and research suggests that compared to urban schools, rural schools do less to support a healthy food environment (Blumenschine et al., 2018; Cornish et al., 2016; Daly et al., 2017; Turner & Chaloupka, 2014). However, there are currently a limited number of studies that have sought to understand the relationship between school locale and associated FV consumption during school meals (Daly et al., 2017; A. M. Davis et al., 2011; Hanson et al., 2019; Liu et al., 2012). Given that school meals contribute to a great daily portion of students' total dietary intake, that rural households may have less opportunities to consume FVs, that school food environments are able to influence student eating behaviors, and because FVs are an important part of a healthful diet, measuring and comparing FV consumption in rural vs. urban students may help identify further disparities that can be targeted to shape healthier eating habits and prevent further health disparities for rural children (Daly et al., 2017; Hanson et al., 2019).

Purpose of Study

The purpose of this study is to explore if there is a significant difference in randomly selected students' fruit and vegetable (FV) selection, consumption, and waste during school lunch among rural vs. urban students in Arizona elementary, middle, and high schools participating in the National School Lunch Program. Based on research which has indicated increased barriers for rural schools to support FV intake by students, it is hypothesized that rural students will consume decreased grams of FVs compared to urban students (Blumenschine et al., 2018; Cornish et al.,

2016; Daly et al., 2017; Turner & Chaloupka, 2014). It is also hypothesized that rural vs. urban students will select and waste significantly different mean grams of FVs compared to students in 1st-12th grade.

Definition of Terms

- **Rural schools**- schools located in fringe, distant, or remote towns and fringe, distant, or remote rural territories as determined by the “Locale Lookup” tool available through NCES (Blumenschine et al., 2018; *Locale Current*, 2019; *Locale Lookup*, 2019.)
- **Urban schools**- schools located in all three types of city and suburban territories (fringe, distant, remote) as determined by the “Locale Lookup” tool available through NCES(Blumenschine et al., 2018; *Locale Current*, 2019; *Locale Lookup*, 2019.)
- **Elementary School**- defined as grades 1 through 5th grade
- **Middle School**- defined as grades 6 through 8th grade
- **High School**- defined as grades 9 – 12
- **National School Lunch Program (NSLP)** - a federal meal program available through the United States Department of Agriculture (USDA) to schools and child care centers offering funding for participating schools which offer free and reduced lunches that meet specific nutritional standards to qualifying students (*The National School Lunch Program*, 2017)
- **Healthy, Hunger Free Kids Act of 2010 (HHFKA)**- a legislative act implemented in 2012 which directed a six cent increase in reimbursement per meal served through the National School Lunch Program (NSLP) and School

Breakfast Program (SBP) and made significant changes to required nutrition standards of meals served through the NSLP and SBP (*Healthy, Hunger-Free Kids Act of 2010 Summary*, 2011)

- **School Lunch**- a time defined by individual schools or districts for students to eat a lunch meal
- **Reimbursable lunch meal**- a meal which meets requirements outlined by the Healthy, Hunger Free Act and consists of at least three or more defined meal components of which one is required to be a half serving of a fruit or vegetable (Knapton & Hennessy, 2018)
- **Fruit and vegetable serving** – 75g of fruit and vegetable
- **Fruit and vegetable plate waste**- measured in grams of fruit and vegetable weight after consumption
- **Fruit and vegetable consumption**- gram value of FV weight determined by subtracting FV plate waste from weight of FV before consumption by student
- **Fruit and vegetable**- (FV) for purposes of this study, fruits and vegetables are defined only as those which are served cold and include entrée salads, salsa, hummus, and canned fruits and vegetables; excludes juice and hot fruits and vegetables or entrees with significant fruit and vegetable components except for entrée salads

Strengths, Limitations, and Delimitations

There are several strengths of this study. First, this study is based on objective data collection methods, ensuring data and results are accurate. Next, the study design was non-invasive so as to not disrupt the eating behaviors of the

participants, also allowing for objective and accurate results. The sample size used for this study is considerably large, contributing to the generalizability of the study, and also supporting the precision of results. Finally, this study investigated all grade levels subject to regularly consuming lunch, and allowing for greater generalizability of results, as most studies on nutrition in schools are with elementary aged students.

There are some limitations that should be weighed as a part of this study; given that this secondary research was developed from a study which originally examined schools without salad bars, the study may not be appropriately powered to address the primary research questions of this study. Additionally, this research study only examined cold FV intake and excluded any entrees or hot sides (with the exception of entrée salads) which had fruit or vegetable components. Therefore, not all FV intake by students was accounted for through the study. Additionally, FV consumption was studied in aggregate, so information on separate fruit or vegetable consumptions was not available through this study. Furthermore, the confounding variable of presence and timing of recess could not be controlled for in this study. A final limitation of this secondary study is that the sample studied was a convenience sample. Only schools willing to volunteer, as well as students within those schools that were willing to volunteer had FV consumptions measured; as a result, certain characteristics that could also have influence on consumption of FVs may have influenced willingness to participate by both students and schools.

Delimitations of this study are that the study is only generalizable for students in grades one through twelve who attend schools that participate in the National School Lunch program in Arizona, so it may not be representative of all

states and regions in the U.S. Further, this study may not apply to younger children such as pre-school aged and kindergarten students. An additional delimitation of this study is that it only reflects results of schools who do not already use salad bars during school lunch time, and so may not pertain to students who attend schools which utilize salad bars at lunch. Finally, this study does not account for schools under Native American reservation jurisdiction and only relates to non-Native American schools; however, it could pertain to Native American students attending schools not regulated by reservations.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

Rural health is a pressing issue for the United States. Rural Americans have greater disparities in several health outcomes and face unique barriers to accessing healthy foods, as well as accessing healthcare and health education. (Joens-Matre RR et al., 2008; Slack & Jensen, 2020; Tovar et al., 2012). Rural youths also face greater health disparities compared to urban youths, especially in regard to weight status (Briefel et al., 2009; Daly et al., 2017; Kubik et al., 2003, 2005; Lichter, 2012).

Because of the significantly greater risk of childhood obesity rural youths face compared to urban youths, as well as the number of health disparities effecting rural vs. urban communities, understanding more specifically what aspects of the rural environment are contributing to these discrepancies may yield insight to approaches that can better support the rural environment and improve health outcomes for rural youths, as well as prevent and reduce health disparities among rural vs. urban populations. An examination of the specific health behaviors of rural vs. urban youths may inform researchers and rural stakeholders about areas for improvement.

Rural Health Disparities

About 1 in 5 Americans live in rural communities, with 65% of American counties being classified as rural (Popat, 2014; Ratcliffe et al., 2016). However, a rural address can unfortunately come with a significant number of barriers such as poor access to supermarkets, greater poverty incidence, poor access to insurance, healthcare facilities and health education, and also a lack of infrastructure in terms of transportation and public health for rural communities (*Food Access in Rural*

Communities - RHIhub Food Access Toolkit, 2015.; USDA ERS - Rural Poverty & Well-Being, 2021; Gamm et al., 2010a; National Academies of Sciences et al., 2018).

Decreased access to supermarkets may have negative implications for opportunities for rural homes to consume FVs (Gustat et al., 2015; Powell et al., 2007). A study conducted in 2015 examined rural vs. urban county health rankings and found that rural residents had significantly lower scores in terms of health behaviors, morbidity factors, and physical environments, establishing rural residents to be at a greater risk for poor health outcomes (Anderson et al., 2015). Additionally, numerous health disparities among urban-rural populations were noted by the National Opinion Research Center (NORC) in the 2014 Update of the Rural-Urban Chartbook, including that of increased obesity rates among rural vs. urban adults (Popat, 2014). Finally, a Morbidity and Mortality Weekly Report (MMWR) published by the Centers for Disease Control and Prevention (CDC) identified that rural mortality rates related to the five leading causes of death in the United States (including heart disease, cancer, unintentional injury, chronic lower respiratory disease, and stroke) were higher than that of urban populations (Garcia, 2017). While it cannot be denied that urban communities can face unique barriers and great inequities in some instances, rural populations face, more often compared to that of urban-defined territories, poor health outcomes that cannot always be managed with “one-size fits all” policies that work for urban population sprawls (Gamm et al., 2010a; K. M. Johnson, 2006; National Academies of Sciences et al., 2018; Popat, 2014). As a response to the increasing differences in health outcomes between rural vs. urban communities, Rural Healthy People 2020 (RHP 2020) was developed to identify the specific, relevant needs of rural populations (Bolin et al., 2015; Gamm et al., 2010b).

The top ten topics of greatest concern for rural communities was outlined by RHP 2020; among these top ten topics were issues noted to primarily relate to that of non-communicable disease prevention for rural Americans including: “access to quality health services”, “nutrition and weight status”, “diabetes”, “heart disease and stroke”, and “physical activity and health” (Bolin et al., 2015).

Health Disparities for Rural Youth

In addition to the overall disparities among rural-urban populations, RHP 2020 directs attention to a number of health disparities in rural children such as an increased risk of disability or mortality related to poor emergency care access, a greater risk of engaging in and greater prevalence of substance abuse, and increased risk and incidence of childhood obesity (Bolin et al., 2015). Reported by RHP 2020 to be the second highest priority for rural populations, including rural youths, was the concern about nutrition and weight status- the RHP 2020 expressed the growing concern that rural youth face a greater risk and prevalence of childhood obesity compared to urban youth (Bolin et al., 2015). Researchers are reporting stark differences in the risk of becoming, and the prevalence of being overweight or obese as a child or adolescent among rural vs. urban populations (Liu J et al., 2008; Liu et al., 2012). Several studies have investigated the risk for becoming overweight or obese between the rural-urban locale, with one recent study reporting the risk of obesity development to be 30% higher for rural children (Joens-Matre RR et al., 2008; Liu J et al., 2008; Liu et al., 2012; Lutfiyya et al., 2007; Stochlic et al., 2017; Tovar et al., 2012). This is especially true for rural communities which comprise greater racial and ethnic diversity; in a study of 401 children from ethnically diverse

rural communities across the nation, 51% of males and 49% of females were classified as obese (Tovar et al., 2012).

Additionally, research has established that rural populations, which have historically been composed largely of non-Hispanic whites, are growing in their diversity (Bolin et al., 2015; K. M. Johnson, 2006; Lichter, 2012; Slack & Jensen, 2020). This lends to the idea that disparities between rural and urban communities could grow as studies show that ethnically diverse, rural communities show greater disparities compared to urban communities (Gamm et al., 2010a; Kenney et al., 2014). An investigation of the relationship of race and residency with obesity risk and prevalence found that non-metro black adolescents compared to that of metro adolescents had greater rates and odds of obesity, with black non-metro and metro adolescents having significantly greater rates than white metro adolescents (Kenney et al., 2014). If adolescents did not report exercising at least 60 minutes per day, non-metro black adolescents had a 70% greater increased risk of obesity than their urban counterparts (Kenney et al., 2014). This finding suggests that the risk and prevalence of obesity is even greater for black rural adolescents.

A suggested reason for these disparities among rural and urban youth is reported to be decreased access to healthy food in the school environment (Bolin et al., 2015). However, it is not known if there are specific differences in the eating behaviors of rural vs. urban youth within the school environment that are contributing to these disparities, as no known study has successfully investigated this. Understanding if disparities exist in terms of health behaviors among rural vs. urban children may better inform policy makers of the unique needs and areas of support for rural communities that can help improve childhood obesity outcomes.

Overall, evidence suggests that rural vs. urban children and adolescents experience more often and have a greater probability of becoming overweight or obese during their youth, and that this risk is amplified for minority ethnic or racial groups (Tovar et al., 2012). Because of the poorer health outcomes, decreased quality of life, and increased costs of medical care associated with obesity, preventing rural youth from experiencing the associated outcomes with being overweight or obese is a public health priority that deserves further research to understand why rural youths are more often subjected to this adverse health outcome, as well as understand where changes can be made to improve health outcomes for rural youth (*Adult Obesity Facts / Overweight & Obesity / CDC*, 2021.; Biener et al., 2017; Buttitta et al., 2014; CDC, 2016; Finkelstein et al., 2009; Gordon-Larsen et al., 2010; Guh et al., 2009).

Children's Nutrition

Eating Behaviors in Youths

Diet is a key factor related to childhood obesity; energy-dense, low-nutrient diets in children show associations with increased adiposity during childhood (Emmett & Jones, 2015). The most recent dietary guidelines for 2015-2020 suggest that Americans ages two and older should aim to consume a diet that incorporates whole grains, low-fat dairy products, a variety of FVs, and a variety of protein foods and oils (*2015-2020 Dietary Guidelines for Americans*, 2015.). The guidelines also suggest limiting consumption of added sugars, sodium, and saturated fats (*2015-2020 Dietary Guidelines for Americans*, 2015.). Compared to the dietary guidelines, school-aged children and adolescents reported dietary intakes that fall far below the recommendations for fruits, vegetables, oils, and whole grains, while exceeding

intake recommendations for solid and saturated fats, refined grains, added sugars, and sodium (*2015-2020 Dietary Guidelines for Americans*, 2015.; *Vital Signs: Fruit and Vegetable Intake Among Children — United States, 2003–2010*, 2014.).

Children’s Consumption of Fruits and Vegetables

Poor diets lacking FVs are consistently linked to poor health outcomes such as type II diabetes, cardiovascular disease, and obesity (*2015-2020 Dietary Guidelines for Americans*, 2015.; *Vital Signs: Fruit and Vegetable Intake Among Children — United States, 2003–2010*, 2014.; Emmett & Jones, 2015). FV consumption in children and adolescents is associated with a lower-energy nutritious diet, which is shown to promote normal metabolic function and health (Epstein et al., 2001; Heber, 2010). FVs contain a variety of nutrients such as fiber, vitamins, minerals, and phytochemicals (Lapuente et al., 2019). These nutrients have inflammatory-modulating abilities and antioxidant properties which are associated with being protective against non-communicable diseases such as type II diabetes, cardiovascular disease, cancer, and also reduced incidences of obesity (Lapuente et al., 2019). Because of the health benefits surrounding FV consumption, as well as associated poorer health outcomes with reduced consumption, improved consumption of FVs for children and adolescents may be influential in reducing risks for poor health outcomes in rural youth.

The School Food Environment

Effects of The School Food Environment on Student Eating Behaviors

Schools are a main location where children have the option to regularly receive and eat breakfast, lunch, and snacks, allowing the school food environment to exert great influence over children’s and adolescents’ eating behaviors. Over 56

million children attend school in the U.S. and rates of enrollment are increasing each year (*Digest of Education Statistics, 2018*, n.d.). Most youths attend school five out of seven days of the week, have the option to consume two out of three key meals during the school day, and most have the opportunity to eat half of their recommended daily calories during the six hour school day (*School Nutrition Environment / Healthy Schools / CDC, 2019*). Evidence suggests that the school food environment can have a significant influence on children's dietary behaviors, both positive and negative, even so much as linking the school food environment to the weight status of school children (Briefel et al., 2009; Fox et al., 2009). One study investigating school food practices associations with students' body mass indexes (BMI) linked the number of negative school food practices with ten percent increases in students' BMI status' (Kubik et al., 2005). In addition, a cross-sectional study analyzing data from the third *School Nutrition Dietary Assessment Study* (SNDA III) investigated policies relating to school food influences on eating behaviors (Briefel et al., 2009). This study found that sugar sweetened beverage consumption was reduced when school environments lacked store sales, snack bars, and pouring rights contracts. Significant reductions in calories from low-quality energy sources were also found in this study when schools did not offer French fries as an option to students for lunch. In regard to the relationship between FV consumption and the school food environment, Kubik et al showed that schools which offered à la carte options for lunch and vending machines saw reductions in FV consumption (Kubik et al., 2003). Interestingly, offering of fried potatoes for lunch was associated with increased FV intake, which was attributed to fried potatoes being considered a vegetable option by schools (Kubik et al., 2003).

Overall, evidence supports the idea that the school food environment is an influencer of student eating behaviors.^{14,15,35,36} Within the school food environment there are several policies and programs in place that dictate many aspects of the school food environment.

Programs, Policies, and The School Food Environment

The National School Lunch Program (NSLP) offers free and reduced meals during school lunch to students who qualify (*Nutrition Standards in the National School Lunch and School Breakfast Programs*, 2012). Schools using NSLP must meet daily and weekly nutrition requirements in regard to energy restrictions, portion sizes of FVs, provision of milk, meat/meat alternatives, sodium restrictions, saturated fat restrictions, and finally whole grain serving requirements (*Healthy, Hunger-Free Kids Act of 2010 Summary*, 2011.; *Nutrition Standards in the National School Lunch and School Breakfast Programs*, 2012). In order for students to receive a free and reduced lunch, and for schools to be reimbursed for students' lunches, students must be served at least three of five types of menu component offerings, including a half cup of a fruit or vegetable option that (Knapton & Hennessy, 2018; *Nutrition Standards in the National School Lunch and School Breakfast Programs*, 2012). Rates of NSLP participation were over 29.7 million with over 4.8 billion total served lunches in the 2018 fiscal year (*Child Nutrition Tables / USDA-FNS*, 2021.). Rates of free total lunches was 20.1% for fiscal year 2018 (*Child Nutrition Tables / USDA-FNS*, 2021.). Given the high rates of participation, it is likely that the NSLP would specifically influence children's eating behaviors.

Studies on the effects of participation in the NSLP are mixed; some studies have associated participation in the NSLP with diets that are high in fat, and have even linked NSLP participation with a greater risk for greater weight statuses in youths (Capogrossi & You, 2017; Cullen & Chen, 2016; Gleason & Suitor, 2003). However, the USDA reported that students qualifying for free or reduced school lunch prices and participated in the NSLP adhered more closely to the 2005 compared to non-participating students, demonstrating the effectiveness of the NSLP in promoting children's diet qualities (*Diet Quality of American School Children by National School Lunch Program Participation Status: Data from the National Health and Nutrition Examination Survey, 2005-2010* / USDA-FNS, 2015.). An additional study which analyzed NHANES 2001-2004 data found positive associations for participants such as reduced food insecurity, improved health outcomes, and reductions in obesity incidence (Gundersen et al., 2012). An additional study showed an association of NSLP participation with increased intake of important nutrients such as fiber and key vitamins and minerals, as well as a decreased likelihood of consuming added sugars (Gleason & Suitor, 2003).

The Healthy, Hunger Free Kids Act of 2010 (HHFKA) greatly transformed the school food environment when it was implemented into schools utilizing federal nutrition programs in 2012. The act enabled new guidelines regarding the USDA school meal programs, designed to promote the adequate provision of nutritious meals served at schools in an effort to positively influence student health outcomes. Prior to the implementation of the HHFKA, school meals were only required to meet outdated guidelines; studies from this period showed that consuming a school meal was associated with poor weight outcomes (Crepinsek et al., 2009). With the

adaptation of the HHFKA, school nutrition standards for meals were updated and required to be aligned with the 2010 DGAs (*Nutrition Standards in the National School Lunch and School Breakfast Programs*, 2012). These guidelines include age-appropriate breakdowns of nutrient targets for school meal offerings in nutrient areas such as calories, sodium, saturated fats, whole grains, and FVs (*Nutrition Standards in the National School Lunch and School Breakfast Programs*, 2012). The act also increased funding for school meal reimbursement by six cents, set nutrition requirements and limitations for competitive foods sold in schools (e.g. vending machines, a la carte food items, etc.) and allowed enrollment by eligible schools into the *Community Eligibility Provision* (CEP), a program which permits schools that demonstrate that they serve forty percent or more students eligible for free school meals to automatically qualify for breakfast and lunch reimbursement for all students (*Community Eligibility Provision / USDA-FNS*, 2019.; *Healthy, Hunger-Free Kids Act of 2010 Summary*, 2011.).

CEP was implemented during the 2014-2015 school year and allows all students attending the CEP-enrolled school to be able to receive breakfasts and lunches for free (*Community Eligibility Provision / USDA-FNS*, 2019). The most recent report for the 2018-2019 school year has found that 64.6% of eligible schools have taken advantage of CEP (“More Low-Income Students Receive Free School Meals in the 2018–2019 School Year Through Community Eligibility,” 2019.). Aside from improving access to school lunch, CEP offers improvements in student school meal consumption and a reduction of negative stigma associated with school meals (“More Low-Income Students Receive Free School Meals in the 2018–2019 School Year Through Community Eligibility,” 2019.). Since its implementation during the

2014-2015 school year, studies have begun to report significant improvements in meal participation related to CEP (Bartfeld et al., 2019; Pokorney et al., 2019; Turner et al., 2019). Almost 29,000 schools across the U.S. have since adopted CEP (*Community Eligibility Data*, n.d.). More evidence is needed to understand the implications of CEP; however, emerging research has suggested CEP participation has associations with decreases in average student BMI and increased rates of healthy weights, showing the positive associations with health related to a shift in the school food environment (W. Davis & Musaddiq, 2019). Because more children are consuming school lunches due to CEP, it is necessary to understand if school lunches are able to promote healthy consumption of foods.

Studies have showed the positive impacts HHFKA has had on schools and school children. An examination of 1,030 children from four urban school districts found that in 2013 (one year post-HHFKA implementation), vegetable consumption increased by 16.2% (Cohen et al., 2014). Additionally, while fruit consumption did not show significant increases, fruit selection did increase significantly by 23% (Cohen et al., 2014). The study also found that increasing portion sizes of FV servings was not associated with increases in overall plate waste- a profound finding given concerns of increased plate waste with HHFKA implementation (Cohen et al., 2014). Similarly, a study in urban, low-income schools examined meal consumption before and after implementation of HHFKA (Schwartz et al., 2015). The study found higher selection and consumption of fruits, lower selection and higher consumption of vegetables, (overall vegetable consumption increased by 20% in students who selected vegetables) (Schwartz et al., 2015). Overall, with the new HHFKA policy,

studies are showing that the diet quality of students participating in the NSLP showed improvements in terms of energy intake and other nutrient intakes (*Diet Quality of American School Children by National School Lunch Program Participation Status: Data from the National Health and Nutrition Examination Survey, 2005-2010* / USDA-FNS, 2015; Gleason & Suitor, 2003; Gundersen et al., 2012; D. B. Johnson et al., 2016). Thus, policy relating to school lunch can shape childhood eating behaviors and therefore also health outcomes.

HHFKA has also been shown to be related to improvements in weight status. A recent study found an association between reduced increases in BMI Z-scores in third grade boys and the implementation of the HHFKA, although this study noted several limitations (e.g., did not measure diet quality or food consumption) (Vericker et al., 2019). More studies are necessary to better understand the effect the HHFKA has on student consumption and health outcomes. However, current research demonstrates overall positive associations in student consumption. These studies also support the view that legislation which affects the school food environment has the power to directly influence children's diets, eating behaviors, and indirectly influence children's health outcomes. However, no known studies have examined rural students' improvements relative to HHFKA implementation.

HHFKA policy also created new guidelines regarding what schools could sell in terms of competitive foods, implemented in 2014 (Schneider et al., 2012). A study on these policies for the 2009-2010 school year found that less than five percent of studied districts supported wellness policies that regulated competitive foods to be within the 2010 DGAs, and that district demographics or urbanicity were not shown to have significant differences between the alignment of school wellness policies with

the 2010 DGAs (Schneider et al., 2012). A review on school food policies did find that schools which implemented competitive food and beverage standards saw reductions in unhealthy snacks and beverages (Micha et al., 2018). While no known studies to date have examined effects on student consumption of FVs related to changes in standards for competitive foods in schools, a recent study in 36 Massachusetts middle and high schools has shown that the dietary quality of foods sold in schools was improved (Gorski et al., 2016). Therefore, school policies, like those addressing competitive sales of food and beverages, are an important and growing part of the school food environment, and likely play a role in influencing diet qualities of students, may also impact the FV consumption of students.

The Rural School Food Environment Influences Students' Eating Behaviors

The Rural School Food Environment

School environments have been shown to exert a significant influence over children's eating behaviors (Briefel et al., 2009; Fox et al., 2009; Kubik et al., 2003, 2005). However, studies have shown that rural school food environments may host several barriers and negative influences for healthy eating in rural school students, and that attempts to improve the dietary quality of school lunch were met with opposition and concerns over costs and waste, especially related to FV (Blumenshine et al., 2018; Cornish et al., 2016; Findholt et al., 2016; *Healthy, Hunger-Free Kids Act of 2010 Summary*, 2011.; Sánchez et al., 2014; Turner & Chaloupka, 2014). The rural school food environment is potentially a driver in the health disparities among rural and urban populations, and even possibly childhood obesity disparities for rural youth, as there may be greater barriers for students to accessing healthy options like FVs; however no studies have successfully examined

the school food intakes of rural vs. urban students, though studies on the perceptions by a sample of rural school staff supported the idea that increased provision of FVs during lunch were well-received by students (Daly et al., 2017; Turner & Chaloupka, 2014). Given that differences exist in FV access in rural schools and the negative perceptions of rural food service staff in providing FVs (even though rural children might receive opportunities to consume FVs well) poor access to FVs in schools may be resulting in poor dietary intakes of FVs.

Rural School Nutrition and School Wellness Policies

School wellness policies are meant to encourage healthy eating environments; however, available evidence suggests that the wellness policies in place by rural schools have been found to have poor implementation of policies and/or have wellness policies that are not supportive of healthy eating behaviors (Caspi et al., 2015; Merlo, 2016; Nanney MS, et al., 2013; Sánchez et al., 2014). A study of the wellness policies in two rural school districts deemed that nutrition policies were implemented irregularly and highlighted several areas for improvement to better implement school wellness policies (Sánchez et al., 2014). Variability in implementation of nutrition policies was attributed to a lack of advocates to help facilitate policies, and also poor accountability for facilitating the policies (Sánchez et al., 2014). Additionally, the study noted barriers for consumption of healthy foods was a lack of availability of appealing food from the cafeteria school lunch and the presence of competitive food sales within and surrounding the school. These findings suggest that promotion of a healthy school food environment may require greater support for rural schools so that wellness policies can be more consistently implemented, along with ensuring that rural school food is both nutritious and

appealing to students.

Furthermore, when compared to that of urban schools, some studies have shown that rural schools may have wellness policies that are not as supportive of a healthy school food environment. A study published by the CDC noted that urban districts did more to prohibit school marketing and sales of soft drinks compared to rural districts (Merlo, 2016). An additional finding of this study is that more urban than rural school districts involved students and families in school nutrition services and made available to them the nutrition information (Merlo, 2016). This suggests that rural school districts engaged less in promotion of healthy eating practices for students. Similarly, Nanney et al assessed the nutrition policies and practices reported in 2008 by 6,500 schools across the US (Nanney MS, et al., 2013). Findings from these results showed decreased nutrition policies and practices surrounding healthy eating among schools in rural and town communities compared to schools in urban communities (Nanney MS, et al., 2013). Specifically, rural and town schools had decreased likelihood of having FVs available through vending machines, less limits on portion sizes of foods, significantly less limits on the advertising of “low-nutrient, energy dense” (LNED) foods, and overall significantly lower numbers of implemented healthy eating strategies (Nanney MS, et al., 2013). Furthermore, a study of nutrition policies and practices in Minnesota schools found similar results, with school location (compared to other characteristics of schools) holding the strongest connection with school nutrition policies; urban schools were less likely to have vending machines, sell sport drinks, and more likely to not market LNED foods compared to rural schools (Caspi et al., 2015). The combined findings from these studies provide considerable evidence that rural schools do less to implement

wellness and nutrition policies that are supportive of a healthy food environment that encourages students to participate in healthy eating behaviors, which may give reason to believe that school food environments may negatively influence rural students' eating behaviors. These findings may also show implications for the poorer health outcomes of rural children.

Food Offerings in Rural Schools

Food offerings in rural schools may be counterproductive to promoting students' adequate nutrition and health. First, a study of the health beliefs and eating behaviors of rural elementary and middle school teachers determined that while about 98% of school teachers reported believing in the importance of healthy school food environments, the classroom food environments of the staff from the study reported practices that do not fully foster a healthy school food environment (Findholt et al., 2016). When surveyed on the type of foods staff consumed in the classroom, over 78% of rural school teachers reported consumption of unhealthy snacks and over 42% reported consumption of sweetened beverages (Findholt et al., 2016). Additionally, about 86% of teachers reported provision of candy as a reward for students (Findholt et al., 2016). These findings suggest that the classroom food environments of rural schools may negatively influence rural children's eating behaviors as the eating habits of rural teachers do not model healthy eating behaviors, and rural teachers provide unhealthy snack rewards for children during classroom time (Findholt et al., 2016). In addition to classroom environments, a study published in 2017 by Daly et al investigated student FV consumption during school meals and attributed the overall finding of low FV serving intake of rural school students during school to the finding that FV access in the school is fairly

limited (Daly et al., 2017). The school under study did not offer students a variety of FVs and only offered one serving of FV for meals (Daly et al., 2017). Research supports that offering a variety of FVs to children can increase FV consumption (Just et al., 2012). Therefore, the results from this research further demonstrate that rural schools may not be doing enough to foster healthy eating habits in rural students, and that a potential barrier for rural students to consume healthy options could be that schools are not offering enough servings of FV to allow children to meet DGA recommendations (Daly et al., 2017).

Food Offerings in Rural vs. Urban Schools

Available research investigating whether differences in the food offerings exist among rural and urban schools yields some insight of the greater barriers to healthy eating habits for rural students and provides a better knowledge for why disparities exist in the health outcomes of rural vs. urban children. A study investigating menu offerings by rural vs. urban school districts compared several nutrition components of the menus and found that rural vs. urban district menus did not significantly differ in amounts of energy, fat, or sodium present in offered menu items, but that both districts served menu items that were considered high in energy, fat, protein, and sodium (Addison et al., 2006). This study demonstrated that while both menus offered higher than recommended amounts of nutrients considered less healthy in great amounts, since the nutritional value of menu items did not significantly differ among rural vs. urban schools, rural children may consume similarly high amounts of less healthy nutrients as urban children (Addison et al., 2006). Therefore, both urban and rural schools may offer menu items that may pose a barrier to healthy eating in the children consuming lunch from

school. However, of note from this study is that FV servings from the menus were not compared, so it cannot be understood from this study whether FV offerings differ in rural vs. urban schools (Addison et al., 2006). Additionally, the study by Addison et al. was published prior to HHS implementation, so its findings may not hold true for today. Another study similarly examined student diets among rural vs. urban schools using the Healthy Eating Index (HEI); this study found that among rural vs. urban schools, there were no differences in diet quality, even when considering FV (Joyce et al., 2020). However, this study only examines differences based on school menus vs. actual consumption. Only one known study has been able to provide evidence on disparities in FV offerings for rural compared to urban students. This study investigated the likelihood of offering fresh FV options in 4,630 schools from across the nation (Turner & Chaloupka, 2014). Results of this study indicated that among rural vs. urban vs. suburban schools, both suburban and urban schools were more likely to offer fresh fruit options compared to rural schools (Turner & Chaloupka, 2014). While no differences were found in the likelihood of offering fresh vegetables were detected, the finding that rural schools were not as likely to offer fresh fruit options may have implications for the dietary intakes of rural vs. urban children, and therefore may have further implications for the eating behaviors and health outcomes of rural children (Turner & Chaloupka, 2014). Overall there is a gap in understanding if FV offerings differ between rural and urban schools. More research is still needed to determine if FV access truly differs among rural and urban students, to what degree, and if this impacts the dietary behaviors of children.

Perceived Barriers to Healthy Lunches for Rural Schools

In addition to a less supportive rural school food environment, studies have published perceived barriers for rural schools in serving healthier school lunches, especially in terms of serving fresh FVs. A study by Blumenschine et al found that the school nutrition managers of school food service programs reported more often that barriers to salad bar implementation were costs of fresh FVs and a lack of funds to purchase salad bars (Blumenschine et al., 2018). From this same study, another notable concern regarding salad bar implementation that was viewed as a barrier by school nutrition managers is the potential for food waste (Blumenschine et al., 2018). The findings from this study suggest that rural schools may be less likely to provide fresh FVs due to fears regarding the cost of providing fresh FVs that is associated with maintaining a salad bar (Blumenschine et al., 2018). While the study concluded that there was no difference in salad bar implementation among rural vs. urban schools, the finding of more often greater concerns related to FV provision may have implications for rural schools being less likely to provide healthy foods like FVs (Blumenschine et al., 2018). A different study on the costs of school lunches that meet the HHPKA standards found that on average meals were nine cents greater per lunch compared to lunch menus prior to the new requirements (Newman, 2013). This study attributed the increased costs for lunches to the greater inclusion of vegetables in lunches (Newman, 2013). Given these findings, rural schools may have some cause for concern regarding costs of providing healthy items like vegetables. Additionally, a report by the USDA cited that rural schools, especially those in smaller districts, may face greater costs of lunches per meal related to greater cost of food transport, as well as a reduced number of students to serve (Ollinger & Guthrie, 2015). Finally, the USDA reported that rural schools

have a low participation rate of 33% in CEP; despite that CEP can help increase meal participation by students, increase reimbursement rates, and reduce the burden of certifying/claiming reimbursements, USDA research suggests rural schools may be less likely to participate in CEP due to the associated increase in administrative time and labor that would be required to meet demand, as well as increased costs of meals (Rogus et al., 2018). Overall, rural schools may face more often than urban schools, barriers such as costs in of providing healthy food items, and consequently may not be able to support as easily, a healthy school food environment. More research is necessary to understand if these barriers affect food offerings such as FVs, and also the dietary behaviors of rural children.

Rural Staff, Parents', and Students' Perceptions

Finally, studies have cited that rural school staff have greater negative perceptions in implementing healthier school lunches and that students and parents both perceived the changes imposed by the HHFKA negatively. When Turner and Chaloupka explored the reactions of elementary students to changes in school lunches, it was found that rural school staff reported more often that children reacted with complaints regarding the new school lunch and that students were less likely to purchase school meals compared to both suburban and urban school staff (Turner & Chaloupka, 2014). Also reported by rural school staff was that for the students who did get school lunch, less of the lunch was consumed (Turner & Chaloupka, 2014). These perceptions provide evidence that rural children, even given the greater opportunity to consume healthy foods, may be less apt to consume healthy food items. A study by Jeffries et al provides somewhat of a better understanding for the reporting of rural children complaining about and declining to

purchase or fully consume school lunch; interviews with parents and school staff suggested that school lunches were believed to be nutritious, but overall unappealing and bland (Jeffries, 2015). Cornish et al similarly interviewed rural school food service directors and found that they viewed HHFKA as costly and burdensome in terms of preparation of food, stating that “it’s hard to stay afloat” and that the “fruits are so expensive” (Cornish et al., 2016). Additionally, staff felt that the standards made preparing school lunches more complicated and stressful (Cornish et al., 2016). While many perceptions of the rural food service staff were negative, staff also reported positive findings like improved FV consumption and positive attitudes by students towards FVs with the new standards (Cornish et al., 2016).

While the perceptions of staff, students, and parents suggest that reactions to increased access to healthy foods were generally negative for various reasons, reports from a sample of rural school food service directors suggest that the increased FV provision in their schools, as a result of HHFKA, were able to influence positive responses and eating behaviors in children (Cornish et al., 2016; Jeffries, 2015; Turner & Chaloupka, 2014). Since research suggests that there are greater costs for rural schools in providing FVs, and evidence suggests that rural schools offer less FVs during lunch , this insight provides promise that improvements in the FV access during school could help shape better eating habits for children attending rural schools (Blumenschine et al., 2018; Daly et al., 2017; Turner & Chaloupka, 2014). The examination of perceptions provides some insight about the attitudes towards school food of rural vs. urban children, but few studies have assessed if

there are differences in rural and urban FV consumption. More research is needed to confirm if these perceptions translate into behaviors.

Rural vs. Urban Student Fruit and Vegetable Behaviors

One study investigating rural vs. urban implementation of the Fresh Fruit and Vegetable Program (FFVP) found that at baseline, a higher frequency of “city and suburb” students reported consuming fruit and vegetable sources daily compared to “town and rural” students (Lin & Fly, 2016). Urban vs. rural students also reported more frequently that they consumed a variety of fruits and vegetables. This study unfortunately reflects FV consumption of both outside and within the school food environment. Finally, one study published in 2013 did conduct a small-scale plate waste study in an elementary school of a southwest rural county; this study found that compared to the plate waste outcomes of a 2009 study in urban middle school students, lower proportions of FV waste were found; however, it does not investigate selection, which may greatly influence waste if FVs are not selected (Byker et al., 2014). Furthermore, this study compared its results to a study completed prior to HHFKA implementation in a middle school, whereas the study itself was examining plate-waste one year after HHFKA implementation in an elementary school, making for poor fit comparison. While these studies provide some insight about the potential effects of school locale on FV eating behaviors, these studies are extremely limited as they used small sample sizes, poor-fitting comparisons, or did not measure true student FV consumption.

Summary

Rural youths have greater health disparities compared to urban youths, of which the risk of obesity is estimated to be 30% greater for rural youth

(Joens-Matre RR et al., 2008; Liu J et al., 2008; Liu et al., 2012; Lutfiyya et al., 2007; Strohlic et al., 2017; Tovar et al., 2012). Healthy dietary behaviors such as consumption of FVs have been associated with a decreased risk of poor health outcomes, including poor weight status outcomes (Epstein et al., 2001; Lapuente et al., 2019).

Evidence suggests that rural school food environments are less supportive of healthy eating behaviors, and that most perceptions of changes directed at healthier food options were mainly negative (Caspi et al., 2015; Merlo, 2016; Nanney MS, et al., 2013; Sánchez et al., 2014). Overall, rural schools have been found to host negative influences on eating behaviors through poor role modeling of eating behaviors and encouragement of unhealthy snacks by rural staff, as well as through school wellness and nutrition policies that do less to support a healthy food environment compared to urban schools (Caspi et al., 2015; Merlo, 2016; Nanney MS, et al., 2013; Sánchez et al., 2014). Additionally, rural schools were found to provide reduced FV access and face greater barriers to providing FVs such as costs, further showing that rural schools may not be able to support as well a healthy school food environment (Blumenschine et al., 2018; Cornish et al., 2016; Daly et al., 2017; Turner et al., 2016). Finally, rural food service staff report greater opposition towards HHKFA and staff, parents and students seem in agreement that foods corresponding to HHFKA guidelines are bland and unappealing, which is in contrast to the reactions of urban school students (Cornish et al., 2016; Jeffries, 2015; Turner & Chaloupka, 2014).

The combination of these results suggests the need for understanding if a less healthy rural school food environment is associated with poorer school diets of rural children compared to that of urban-classified school children. However, to date, no study has compared the diets of rural vs. urban children. For now, there is not yet enough evidence to understand if the diets of rural students are less reflective of a healthy diet compared to that of urban students. More research is necessary to better understand the influence the rural school environment has on the diets of rural children, especially in comparison to that of urban children due to the differences in health outcomes found between the two groups.

Despite the evidence suggesting that differences in the rural school environment could be perpetuating differences in fruit and vegetable eating behaviors, no studies have yet compared urban and rural student fruit and vegetable consumption. Further research in this area is therefore warranted to better understand if the rural school food environment may be negatively influencing rural students' diets.

CHAPTER 3

METHODS

Study Design

This study is a cross-sectional, secondary analysis of baseline data from a cluster-randomized intervention study, which examined the efficacy of school salad bars to increase students FV consumption in elementary (n=13), middle (n=12), and high schools (n=12) across Arizona (Adams et al., 2019). Due to the low risk of the study, participating schools' principals acted in *loco parentis* for students and provided written informed consent prior to data collections (see appendix A). While schools could not be randomly selected for participation, student selection was randomized prior to each data collection by researchers, which allowed for a representative sample from each school. Participants were oversampled at each school data collection date with at least 63 or greater students randomly selected. Participating students stated verbal assent after being provided an IRB-approved explanation of the study aims and process by RAs in either verbalized English or verbalized or written Spanish, as needed, at each data collection time point (see appendix B and C). All students were blinded from the specific purpose and measures of the study, and research assistants and school staff were instructed to not disclose to any students the specific aims of the study, to prevent influencing behaviors.

Baseline data was collected over 3 years between 2017 and 2019. Data was entered in quadruplicate by trained RAs for statistical assessment. Post-data entry, data was inspected for any issues, necessary omissions, and cleaned. Rural and urban classified school students' baseline FV selection, consumption, and waste data

will be the focus of this study. This study was approved by the Arizona State University (ASU) Institutional Review Board (IRB).

Measures

Locale Classification

The National Center for Education Statistics (NCES) partnered with the U.S. Census Bureau to develop the Education Demographic and Geographic Estimates (EDGE) program with the intent to inform the public and interested parties of geographic characteristics for each school (Geverdt, 2019). As the basis of the program, locales are defined and categorized into four potential types of locale: city, suburban, town, and rural. Each locale can further be broken down into three additional subcategories so that schools have the potential to be classified by the program into one of the twelve types of locales. Classification of participating schools was determined through the NCES tool, “Locale Lookup”, an easy to use tool which allows the U.S. school name to be searched and then a locale classification is provided based on the EDGE program definitions (*Locale Lookup*, 2019.).

Categories are termed and defined as follows (*Locale Current*, 2019):

1. City- territory inside an urbanized area and within principal city
 - a. Large (population of 250,000+)
 - b. Midsize (population $\geq 100,000$ and $< 250,000$).
 - c. Small (population $< 100,000$)
2. Suburban- territory within an urbanized area but outside a principal city
 - a. Large (population 250,000+)
 - b. Midsize (population $\geq 100,000$ and $< 250,000$).
 - c. Small (population $< 100,000$)

3. Town- territory within an urban cluster
 - a. Fringe- ≤ 10 mi from urbanized area
 - b. Distant- >10 but <35 mi from urbanized area
 - c. Remote- >35 mi from urbanized area
4. Rural- census-defined rural territory
 - a. Fringe- ≤ 5 mi from urbanized area AND ≤ 2.5 mi from urban cluster
 - b. Distant- >5 mi but <35 mi from urbanized area AND >2.5 mi but < 10 mi from urban cluster
 - c. Remote- >25 mi from urbanized area AND > 10 mi from urban cluster

Using the methodology of a previous related study, participating schools were placed into either an urban, suburban, or rural locale category for comparison and sensitivity analysis (Blumenschine et al., 2018). Urban schools were composed of schools which were classified as any of the three types of city (fringe, distant, or remote), while suburban schools were classified as any of the three types of suburban territories (fringe, distant, or remote). Rural schools were composed of schools in town territories (fringe, distant, and remote) and all types of rural territories (fringe, distant, or remote) (Blumenschine et al., 2018). For analysis purposes, schools were coded: rural schools were denoted as “0”, urban schools were denoted as “1”, and suburban schools were denoted as “2”.

Fruit and Vegetable Selection, Consumption, and Waste

Collection of FV plate waste data included photographing and weighing (grams) assented student trays before and after student lunch consumption by trained RAs using calibrated scales. Tray FVs were measured and photographed separate from other lunch items. FVs were measured and recorded in aggregate to the nearest 2 grams. Any issues with student trays during the eating period (e.g. sharing of food items) or data collection (e.g. spilling of tray items) which may affect accuracy of results were recorded and consequently removed from the sample. Hot fruit/vegetable items, entrees with significant fruit or vegetable components (except for entrée salads), and potato-based items or juice were excluded from the definition of FV items. FV consumption was calculated by subtracting the weight of FV waste (grams of FVs post-consumption) from the weight of FV selection(s) (grams of FVs pre-consumption). In addition to FV waste in grams, FV waste is also represented as a proportion of FV selection. Data was entered in quadruplicate by trained RAs and recoded for statistical analysis.

Sociodemographic Information

Schools and/or districts reported sociodemographic information for students consisting of race/ethnicity, free/reduced lunch eligibility, age, school year, and sex. Using these measures, data was statistically adjusted to account for any potential confounding variables.

Statistical Analysis

Descriptive data was developed using a combination of Chi Square tests, one-way ANOVA tests, and two-sample t-tests with unequal variances. Outlier scores greater than three standard deviations from each associated mean were removed. Additionally, if FV waste weight exceeded FV selection weight, or if either FV

selection or waste values were missing, the corresponding data values were excluded. The final analytical sample was 2525 student participants.

Given that an examination of the data showed an increased frequency of zero values throughout the count data, a zero-inflated negative binomial regression model was used to examine the association among locale and FV selection, consumption, waste, and waste as a proportion. All models were adjusted for grade, gender, race/ethnicity, free/reduced lunch, and within-school clustering. A sensitivity analysis was conducted using the same methods to see how including suburban schools changed results. Regression outputs were exponentiated and presented as incidence rate ratios and odds ratios. Analyses were run using Stata Statistical Software (version 15, College Station, TX, 2017) and the alpha level was set at $p < 0.05$.

CHAPTER 4

RESULTS

Descriptive Statistics

Among the 37 schools that data was collected from, there were 22 urban-classified schools (including four suburban-classified schools), and nine rural-classified schools. Based on descriptive analyses, overall participant demographics were found to be somewhat balanced with slightly more males than females (54% male). Students were mainly white (59% white vs. 41% non-white), and the majority of students were eligible for free/reduced price lunch (60%) (Table 1 and 2). Rural, urban, and suburban students had similar demographic proportions for gender, race/ethnicity, and lunch status, although rural students had greater rates of free and reduced price lunch (FRL) eligible students and suburban-classified schools had slightly greater rates of students not eligible for FRL (Table 1). In the sensitivity analyses, when urban classification included suburban schools, demographic trends appeared similar to that of rural schools (Table 2).

The average overall age of participating students was about 12 years; however, the average age of urban-classified students (excluding suburban students) (12.4 +/- 3.4 years) was found to be significantly older than that of rural students (10.3 +/- 2.3 years) (Table 1). Chi-square tests also determined that there was a statistically significant association between school locale and race/ethnicity, lunch status, FV selection, FV consumption, and FV waste. Similar results were found with the sensitivity analysis (Table 2).

Additionally, overall rates of FV selection, consumption, and waste with greater than zero grams on the tray are 86%, 79%, and 80%, respectively (Table 1).

Among rural vs. urban students, rural students more frequently had more than zero grams of FVs selected, consumed, and wasted. On the other hand, the zero-gram rates by suburban students for each FV measure were greatest compared to rural and urban students, but urban vs. rural rates were also greater (Table 1). Mean gram weights for FV selection, consumption, waste, and waste as a proportion when zeroes were included and excluded were also examined by school locale status. All differences were significant when means including zero were examined; compared to urban and suburban students, rural students selected, consumed, and wasted a higher average weight of FVs (Table 1). Similarly, when zero-gram values were removed from analyses, mean values for FV selection, consumption, waste, and waste as a proportion were still statistically greater for rural students compared to urban and suburban students, where suburban students had the lowest mean values. All of these findings were consistent in the sensitivity analysis, except that for FV consumption excluding zeroes, there was no statistically significant difference between rural vs. urban (including suburban) students (Table 2).

Analysis of FV Selection, Consumption, and Waste with Only Rural and Urban Schools

Results from the zero-inflated negative binomial regression yielded several statistically significant results when FVs were on the tray (Table 3). First, rural students were statistically significantly more likely to select FVs compared to urban students (IRR= 1.40, 95% CI: 1.33, 1.48). Also, with every increase in grade level, there is an increased likelihood of FV selection (IRR= 1.03, 95% CI: 1.02, 1.04). However, students who were eligible for free/reduced lunch were statistically less likely to select FVs (IRR= 0.95, 95% CI: 0.91, 1.00). No other statistically significant

relationships were observed when race/ethnicity and gender were analyzed for FV selection outcomes.

Rural vs. urban FV consumption was also statistically more likely when FVs were on the plate (IRR= 1.18, 95% CI: 1.06, 1.31). FV consumption results for other variables from the regression model were also significant (Table 3). When FVs are on the plate, as grade level increases, likelihood for consumption is significantly greater (IRR= 1.06, 95% CI: 1.04, 1.08). No statistically significant results were found for FV consumption by gender, race/ethnicity, and FRL status when FVs were on the tray.

Likelihood of FV waste was found to be significantly different among rural vs. urban-classified students (Table 3). Compared to urban students, rural students were significantly more likely to waste FVs when FVs were on the plate (IRR=1.62, 95% CI: 1.51, 1.75); this finding is sustained even when waste is adjusted for selection (IRR=1.07, 95% CI: 1.00, 1.13). When FVs were on the plate, results were not significant based on grade and gender; however, when waste was adjusted for selection as a proportion by grade level, with each increase in grade level, likelihood for FV waste was increased (IRR=1.07, 95% CI: 1.00, 1.13). Additionally, when students were eligible for FRL, they were statistically less likely to waste FVs (IRR=0.82, 95% CI: 0.76, 0.88). Among those eligible for free and reduced lunch though, when FVs were present on the tray, FRL status students were significantly less likely to waste FVs when presented as a proportion of FV selection (IRR=0.84, 95% CI: 0.79, 0.89). Among non-Hispanic students compared to Hispanic students, likelihood to waste was significantly 2% less likely (IRR: 0.98, 95% CI: 0.95, 1.02); when FV waste was again examined as a proportion, compared to Hispanic students,

non-Hispanic students were still somewhat less likely (5% less) to waste FVs (IRR=0.95, 95% CI: 0.93, 0.98). Finally, among females vs. males, when waste was adjusted for selection, females were slightly more likely to waste FVs when FVs were on the plate (IRR=1.05, 95% CI: 0.98, 1.12).

When FV selection is adjusted for zero values, rural students were, though not statistically significantly, 25% less likely to select FVs (OR= 0.75, 95% CI: 0.53, 1.05). Additionally, with every increase in grade level, there are also statistically greater odds of FV selection (OR=1.34, 95% CI: 1.29, 1.39). Only when zeros were accounted for was there a significant difference between genders, where females had significantly lower odds of selecting FVs versus males (OR= 0.71, 95% CI: 0.54, 0.92). FRL eligible students had significantly lower odds of selecting FVs (OR=0.32, 95% CI: 0.24, 0.42) vs. students who were not eligible for FRL.

When student trays with zero FVs were accounted for, odds of rural student FV consumption were lower (OR=0.78, 95% CI: 0.58, 1.05), but like with odds of FV selection, this was not found to be statistically significant (Table 3). The odds of FV consumption were statistically significant and even greater than that of when FVs were on the tray as grade level increases (OR= 1.22, 95% CI: 1.18, 1.27). Odds of FV consumption were statistically reduced for females versus males (OR=0.76, 95% CI: 0.60, 0.95), non-Hispanic students versus Hispanic students (OR= 0.86, 95% CI: 0.76, 0.98), and for students eligible for FRL (OR= 0.45, 95% CI: 0.36, 0.57).

Further, the odds of FV waste for rural vs. urban students when zeros were accounted for were found to be statistically reduced (OR=0.71, 95% CI: 0.53, 0.95) (Table 3). However, when waste was adjusted for both zero values and FV selection, results were insignificant and locale status had no effect on the odds of FV waste

(OR=1.00, 95% CI: 0.91, 1.10). Next, examination of covariates found that first, when adjusted for zero values, FV waste had significantly lower odds of occurring by females compared to males (OR=0.69, 95% CI: 0.56, 0.86) and students eligible for FRL (OR= 0.53, 95% CI: 0.42, 0.66), and FRL status students had even further significantly reduced odds of FV waste when presented as a proportion of FV selection (OR=0.73, 95% CI: 0.65, 0.79). Further, FV waste had significantly greater odds of occurring as grade level increased (OR= 1.28, 95% CI: 1.24, 1.33). When FV waste was adjusted for both selection and zero values, non-Hispanic vs. Hispanic students had reduced odds of waste (OR=0.93, 95% CI: 0.88, 0.98).

Sensitivity Analysis Including Suburban Students' FV Selection, Consumption, and Waste

Sensitivity analyses results from the zero-inflated negative binomial regression model indicated that once FVs were on the plate, rural students were still statistically more likely than urban students to select FVs (IRR=1.46, 95% CI: 1.39, 1.54) (Table 4). Rural vs. urban FV consumption was also significantly more likely when FVs were on the plate (IRR= 1.20, 95% CI: 1.08, 1.33); these are similar results to when suburban schools were excluded from urban classification. Finally, compared to urban students, rural students were significantly more likely to waste FVs when FVs were on the plate (IRR=1.71, 95% CI: 1.59, 1.84), and this remains true when waste is adjusted for selection (IRR=1.11, 95% CI: 1.04, 1.18).

Once FV selection is adjusted for zero values, though, FV selection by rural students had 16% lower odds of occurring compared to urban students (OR=0.84, 95% CI: 0.60, 1.18), but this finding was not significant. (Table 4). Similar to primary results, when student trays with zero FVs were accounted for, odds of rural

student FV consumption were lower (OR=0.87, 95% CI: 0.66, 1.16), but this was again, not found to be statistically significant (Table 4). When zero values were accounted for, the odds of FV waste were significantly decreased (OR=0.71, 95% CI: 0.53, 0.95). However, once waste is presented as a portion of selection, in addition to adjusting for zero values, there are significantly increased odds of FV waste for rural vs. urban/suburban students (OR=1.31, 95% CI: 1.16, 1.48); this is slightly different compared to primary findings in that there were greater odds of rural FV waste as a ratio when suburban students are included.

Compared to primary analyses, similar incidence rate ratios and odds ratios were found for all covariates while examining FV selection, consumption, and waste when suburban students were included in urban classification (Table 4). However, there are some differences in likelihood and odds of waste proportion. First, as grade level increased, when proportion of waste adjusted for zeroes, there was no significant finding for odds for waste proportion by grade level and this was different from primary analyses where there was a significant difference. As for gender, while there was no significant difference by gender seen in primary analyses, when suburban students were included, the odds of wasting FVs (as a proportion) were 28% lower for females vs. males (OR:0.72, 95% CI: 0.66, 0.79). Lastly, waste as a proportion was not significant when FRL eligibility were examined, but for primary analyses, but sensitivity analyses results found that odds of waste as a proportion were statistically significantly reduced by 27% (OR: 0.73, 95% CI: 0.66, 0.79).

Table 1. Participant demographics and key variables among rural, urban, and suburban school students (n=2525).

	Total Students	Rural	Urban	Suburban	
	% (n)	% (n)	% (n)	% (n)	<i>P</i> value
Gender					
Male	54 (1585)	57 (336)	53 (1108)	56 (141)	0.224
Female	46 (1325)	43 (250)	47 (964)	44 (111)	
Race/Ethnicity					
Hispanic	26 (806)	23 (135)	26 (560)	30 (111)	< 0.01
White	59 (1871)	58 (342)	60 (1306)	60 (223)	
Black	6 (177)	9 (50)	5 (34)	5 (19)	
Asian	3 (93)	3 (19)	3 (35)	2 (8)	
Other	7 (205)	7 (42)	7 (5)	3 (13)	
Lunch Status					
Paid	40 (1251)	23 (134)	42 (928)	51 (189)	< 0.01
Free/Reduced	60 (1900)	77 (454)	58 (1262)	49 (184)	
FV Selection					
Greater than Zero Grams	86 (2718)	92 (542)	86 (1873)	81 (303)	< 0.01
Zero Grams	14 (434)	8 (46)	14 (317)	19 (71)	
FV Consumption					
Greater than Zero Grams	79 (2493)	85 (500)	78 (1701)	78 (292)	< 0.01
Zero Grams	21 (659)	15 (88)	22 (489)	22 (82)	
FV Waste					
Greater than Zero Grams	80 (2510)	87 (513)	79 (1740)	69 (257)	< 0.01
Zero Grams	20 (642)	13 (75)	21 (450)	31 (117)	
FV Waste					

	Proportion					
	Greater than	94 (2,962)	94 (554)	95 (2,089)	85 (319)	< 0.01
	Zero Grams					
	Zero Grams	6 (190)	6 (34)	5 (101)	15 (55)	
		Mean +/- SD	Mean +/- SD	Mean +/- SD	Mean +/- SD	<i>P</i> value
		(years)	(years)	(years)	(years)	
	Age	12.0 +/- 3.3	10.3 +/- 2.3	12.0 +/- 3.4	14.8 +/- 2.0	< 0.01
		Mean +/- SD (g)	Mean +/- SD (g)	Mean +/- SD (g)	Mean +/- SD (g)	<i>P</i> value
	FV Selection					
	Including	115.0 +/- 81.4	150.9 +/- 85.6	109.7 +/- 77.8	88.3 +/- 77.0	< 0.01
	Zero Grams					
	Excluding	134.4 +/- 71.7	163.9 +/- 76.4	129.6 +/- 67.6	109.6 +/- 70.8	< 0.01
	Zero Grams					
45	FV Consumption					
	Including	51.7 +/- 65.4	62.3 +/- 69.2	48.6 +/- 63.9	56.9 +/- 56.4	< 0.01
	Zero Grams					
	Excluding	68.5 +/- 65.7	74.1 +/- 69.4	65.3 +/- 66.3	75.6 +/- 53.0	< 0.01
	Zero Grams					
	FV Waste					
	Including	65.2 +/- 66.7	92.8 +/- 72.7	62.6 +/- 64.4	35.5 +/- 52.7	< 0.01
	Zero Grams					
	Excluding	83.0 +/- 64.8	106.9 +/- 67.6	79.9 +/- 62.6	53.3 +/- 56.8	< 0.01
	Zero Grams					
	FV Waste					
	Proportion					
	Including	0.56 +/- 0.37	0.60 +/- 0.33	0.58 +/- 0.37	0.37 +/- 0.39	< 0.01

Zero Grams Excluding Zero Grams	0.61 +/- 0.35	0.65 +/- 0.30	0.62 +/- 0.35	0.47 +/- 0.39	<0.01
---------------------------------------	---------------	---------------	---------------	---------------	-------

Table 2. Participant demographics and key variables among rural and urban (including suburban) school students (n=2525).

	Total Students	Rural	Urban^a	
	% (n)	% (n)	% (n)	<i>P</i> Value
Gender				
Male	54 (1585)	57 (336)	54 (1249)	0.118
Female	46 (1325)	43 (250)	46 (1075)	
Race/Ethnicity				
Hispanic	26 (806)	23 (135)	26 (671)	< 0.01
White	59 (1871)	58 (342)	60 (529)	
Black	6 (177)	9 (50)	5 (127)	
Asian	3 (93)	3 (19)	3 (74)	
Other	7 (205)	7 (42)	6 (163)	
Lunch Status				
Paid	40 (1251)	23 (134)	44 (1117)	< 0.01
Free/Reduced	60 (1900)	77 (454)	56 (1446)	
FV Selection				
Greater than Zero Grams	86 (2718)	92 (542)	85 (2176)	< 0.01
Zero Grams	14 (434)	8 (46)	15 (388)	
FV Consumption				
Greater than Zero Grams	79 (2493)	85 (500)	78 (1993)	< 0.01
Zero Grams	21 (659)	15 (88)	22 (571)	
FV Waste				
Greater than Zero Grams	80 (2510)	87 (513)	78 (1997)	< 0.01
Zero Grams	20 (642)	13 (75)	22 (567)	

	FV Waste Proportion				
	Greater than Zero Grams	94 (2,962)	94 (554)	94 (2408)	0.781
	Zero Grams	6 (190)	6 (34)	6 (156)	
		Mean +/- SD (years)	Mean +/- SD (years)	Mean +/- SD (years)	<i>P</i> value
	Age	12.0 +/- 3.3	10.3 +/- 2.3	12.4 +/- 3.4	< 0.01
		Mean +/- SD (g)	Mean +/- SD (g)	Mean +/- SD (g)	<i>P</i> value
	FV Selection				
	Including Zero Grams	115.0 +/- 81.4	150.9 +/- 85.6	106.5 +/- 78.0	< 0.01
	Excluding Zero Grams	134.4 +/- 71.7	163.9 +/- 76.4	126.7 +/- 68.4	< 0.01
48	FV Consumption				
	Including Zero Grams	52.3 +/- 64.4	62.3 +/- 69.2	49.9 +/- 62.9	< 0.01
	Excluding Zero Grams	68.5 +/- 65.7	74.1 +/- 69.4	66.9 +/- 64.6	0.02
	FV Waste				
	Including Zero Grams	65.2 +/- 66.7	92.8 +/- 72.7	58.7 +/- 63.6	< 0.01
	Excluding Zero Grams	83.0 +/- 64.8	106.9 +/- 67.6	76.6 +/- 62.4	< 0.01
	FV Waste Proportion				
	Including Zero Grams	0.56 +/- 0.37	0.60 +/- 0.33	0.55 +/- 0.38	< 0.01

Excluding Zero Grams	0.61 +/- 0.35	0.64 +/- 0.30	0.60 +/- 0.36	< 0.01
-------------------------	---------------	---------------	---------------	--------

^aSuburban locale data is included.

Table 3. Zero-inflated negative binomial regression models examining association between school locale and student fruit and vegetable selection, consumption, and waste (excluding suburban schools) (n=2348)^{a,b}.

	Selection			Consumption			Waste			Waste Proportion		
	Incidence Rate Ratio	CI (95%)		Incidence Rate Ratio	CI (95%)		Incidence Rate Ratio	CI (95%)		Incidence Rate Ratio	CI (95%)	
Locale	Reference			Reference			Reference			Reference		
Urban	Reference			Reference			Reference			Reference		
Rural	1.40	1.33	1.48*	1.18	1.06	1.31*	1.62	1.51	1.75*	1.07	1.00	1.13*
Grade	1.03	1.02	1.04*	1.06	1.04	1.08*	1.00	0.99	1.01	0.97	0.96	0.98*
Gender	1.03	0.99	1.08	0.94	0.85	1.04	1.05	0.98	1.12	1.05	0.98	1.12
Race/Ethnicity	0.99	0.97	1.02	1.03	0.98	1.08	0.98	0.95	1.02	0.95	0.92	0.98*
Free/Reduced Price Lunch	0.95	0.91	1.00*	1.08	0.95	1.23	0.82	0.76	0.88*	0.84	0.79	0.89*
School	1.01	1.00	1.01*	0.99	0.99	1.00*	1.02	1.01	1.02*	1.01	1.00	1.01*

	Selection			Consumption			Waste			Waste Proportion		
	Odds Ratio	CI (95%)		Odds Ratio	CI (95%)		Odds Ratio	CI (95%)		Odds Ratio	CI (95%)	
Locale	Reference			Reference			Reference			Reference		
Urban	Reference			Reference			Reference			Reference		
Rural	0.75	0.53	1.05	0.78	0.58	1.05	0.71	0.53	0.95*	1.00	0.91	1.10
Grade	1.34	1.29	1.39*	1.22	1.18	1.27*	1.28	1.24	1.33*	1.01	1.00	1.03*
Gender	0.71	0.54	0.92*	0.76	0.60	0.95*	0.69	0.56	0.86*	0.92	0.85	1.00
Race/Ethnicity	0.88	0.75	1.04	0.86	0.76	0.98*	1.02	0.90	1.15	1.08	1.03	1.13*
Free/Reduced Price Lunch	0.32	0.24	0.42*	0.45	0.36	0.57*	0.53	0.42	0.66*	1.05	0.94	1.18

School	0.97	0.96	0.99*	0.99	0.98	1.00	0.96	0.95	0.97*	1.00	1.00	1.00*
---------------	------	------	-------	------	------	------	------	------	-------	------	------	-------

^aModel adjusted for gender, grade level, race/ethnicity, free/reduced price lunch status, and within-school similarities.

^bSuburban locale data is excluded.

*Indicates a statistically significant value at $P < 0.05$ level.

Table 4. Zero-inflated negative binomial regression models examining association between school locale and student fruit and vegetable selection, consumption, and waste (including suburban schools) (n=2525)^a.

	Selection			Consumption			Waste			Waste Proportion		
	Incidence Rate Ratio	CI (95%)		Incidence Rate Ratio	CI (95%)		Incidence Rate Ratio	CI (95%)		Incidence Rate Ratio	CI (95%)	
Locale	Reference			Reference			Reference			Reference		
Urban	Reference			Reference			Reference			Reference		
Rural	1.46	1.39	1.54*	1.20	1.08	1.33*	1.71	1.59	1.84*	1.11	1.04	1.18*
Grade	1.02	1.01	1.03*	1.06	1.04	1.08*	0.99	0.98	1.00	0.96	0.95	0.97*
Gender	1.04	1.00	1.09	0.95	0.86	1.04	1.06	1.00	1.13	1.06	1.00	1.11*
Race/Ethnicity	1.00	0.98	1.02	1.03	0.99	1.08	0.99	0.95	1.02	0.95	0.93	0.98*
Free/Reduced Price Lunch	0.95	0.91	0.99*	1.07	0.96	1.21	0.79	0.73	0.84*	0.84	0.79	0.89*
School	1.01	1.01	1.01*	0.99	0.99	1.00*	1.02	1.01	1.02*	1.01	1.01	1.01*

	Selection			Consumption			Waste			Waste Proportion		
	Odds Ratio	CI (95%)		Odds Ratio	CI (95%)		Odds Ratio	CI (95%)		Odds Ratio	CI (95%)	
Locale	Reference			Reference			Reference			Reference		
Urban	Reference			Reference			Reference			Reference		
Rural	0.84	0.60	1.18	0.87	0.66	1.16	0.71	0.53	0.95*	1.31	1.16	1.48*
Grade	1.30	1.26	1.35*	1.19	1.15	1.23*	1.29	1.25	1.34*	1.00	0.99	1.01
Gender	0.70	0.55	0.90*	0.74	0.60	0.92*	0.68	0.55	0.84*	0.72	0.66	0.79*
Race/Ethnicity	0.90	0.78	1.04	0.88	0.78	0.99*	1.05	0.93	1.18	0.93	0.88	0.98*
Free/Reduced Price Lunch	0.30	0.24	0.39*	0.40	0.32	0.50*	0.51	0.42	0.63*	0.73	0.65	0.79*

School	0.98	0.97	0.99*	0.99	0.98	1.00	0.96	0.95	0.97*	0.98	0.97	0.98*
---------------	------	------	-------	------	------	------	------	------	-------	------	------	-------

^aModel adjusted for gender, grade level, race/ethnicity, free/reduced price lunch status, and within-school similarities.

*Indicates a statistically significant value at $P < 0.05$ level.

CHAPTER 5

DISCUSSION

The purpose of this study is to determine if there is a difference in fruit and vegetable selection, consumption, and waste among students attending rural versus urban schools, examining inclusion of suburban students in sensitivity analyses. To our knowledge, this is the first study to investigate rural vs. urban school FV selection, consumption, and waste using objective measures such as weight. Study results indicated that compared to urban students, rural students had reduced odds of selecting, consuming, and wasting FVs, but, when odds of waste were examined as a proportion of FV selection, odds of FV waste were no different than for urban students. However, once FVs were on the tray, likelihood of FV selection, consumption, and waste by rural vs. urban students was greater, even when waste results were adjusted for selection. When suburban schools were included in urban school classification in sensitivity analyses, findings were similar, but with a slightly greater incidence rate ratio. When examining whether there was any amount of FVs on the tray, the odds of rural students selecting, consuming, and wasting FVs were still reduced compared to urban students, but to a lesser degree. These findings suggest differences in FV eating behaviors based on school locale that could potentially influence health outcomes for children. While it is not clear from this study if rural children are consuming recommended daily FVs, this study suggests that there could be differences in the rural school environment which may be

influencing overall reduced odds of FV selection, consumption, and waste compared to urban students. More research is needed to confirm this disparity and understand where changes could be implemented to improve odds of rural FV consumption for students. Interventions and/or school policies that can influence increased rural student FV selection and consumption may alleviate disparities found in FV-related lunch behaviors among rural vs. urban students. Overall, future research should aim to validate our study's results, and clarify potential areas of improvement in rural school food environments and effective interventions that may reduce the disparities in FV behaviors between rural and urban schools.

Higher frequencies of rural students selecting, consuming, and wasting more than zero grams of FVs, combined with lower frequencies of rural students selecting, consuming, and wasting zero grams of FVs, was an unexpected finding of this study since research has shown reduced opportunities for FV selection , as well as reduced daily intake of FVs by rural vs. urban students though some research does suggest there is no difference in diet quality among rural vs. urban school menus (Daly et al., 2017; Joyce et al., 2020; Lin & Fly, 2016). Our study findings do imply more frequent overall FV selection and consumption by rural students compared to urban students, with lower incidences of no FV selection and no FV consumption. However, greater frequency of FV waste with more than zero grams implies that rural students may waste FVs more often. Therefore, interventions that reduce FV waste while maintaining consumption once FVs are on the plate may be beneficial,

especially since fears of food waste have been seen as barriers to methods that can promote FV consumption, such as salad bars (Blumenschine et al., 2018). While still meaningful, since these results are not adjusted for, they may be influenced by confounding variables, and so may not most accurately represent the association between school locale and FV school eating behaviors.

The finding that once FVs were on the plate, rural students were statistically more likely to select, consume, and waste FVs at lunch compared to urban students did not align with our hypothesis. No studies have successfully investigated rural vs. urban school FV consumption; however, there is one plate waste study published in 2013 by Byker et al, conducted in an elementary school of a southwest rural county that does suggest support for our study's findings (Byker et al., 2014). Byker et al compared it's student plate waste outcomes to that of a study completed by Cohen et al in 2009 in an urban middle school (Byker et al., 2014; Cohen et al., 2013). It indicated that compared to urban students, rural students had lower proportions of FV waste, implying greater FV consumption; however, this finding by Byker et al was extremely limited by several factors (i.e., a small study sample size, no statistical analysis, no accounting for confounding variables such as selection, and a poor comparison to a study since Cohen et al.'s study was conducted prior to HHFKA implementation, and also in a middle school) likely influencing results. Greater quality research is needed to corroborate the findings of our present research, and better understand how rurality influences FV eating behaviors. Regardless of the

lack of literature to back our study's results, the finding that rural vs. urban students have a greater likelihood of selecting and consuming FVs once FVs are on the tray is positive as it suggests that once FV's are selected by rural students, FV consumption is more likely to occur (at least compared to urban students). This means that interventions targeting FV selection may be successful in achieving even greater rates of FV consumption among rural students. However, rural students are also more likely to waste FVs, once selected, compared to urban students; this is likely associated with the greater frequency of FV selection by rural students. Therefore, if interventions to increase FV selection in rural schools are implemented, identifying and implementing strategies to reduce food waste by students should also be explored. Future research should focus on determining more clearly if rural vs. urban FV intake differs, and if these differences have meaning for rural vs. urban student diet qualities and health.

Another major result of this study is that compared to urban students, once zero values were accounted for as part of the zero-inflated model, the odds of rural FV selection, consumption, and waste were reduced. The reduced odds of FV waste are likely a byproduct of reduced FV selection. When waste is adjusted for selection however, the odds of FV waste were not found to be influenced by school locale. Notably, only school locale results for FV waste and waste proportion were statistically significant. Still, these results are interesting given the greater likelihoods associated with rural students when some FVs are on the plate. Previous

research indicates possible reasons for these differences between rural vs. urban student FV intake: rural school environments have been studied to be less supportive of student FV consumption, including by having reduced FV offerings, especially of fresh FVs (Blumenschine et al., 2018; Daly et al., 2017; Turner & Chaloupka, 2014). Rural schools also have been shown to have poorer quality and implementation of school wellness policies reduced staff support of serving fresh FVs due to fears of food waste and reported greater costs associated with providing fruits and vegetables (Blumenschine et al., 2018; Caspi et al., 2015; Merlo, 2016; Nanney MS, et al., 2013; Newman, 2013; Ollinger & Guthrie, 2015). A study by Lin and Fly also does somewhat confirm our study's finding of reduced odds of FV consumption by rural vs. urban students (Lin & Fly, 2016). Lin and Fly investigated rural vs. urban implementation of the Fresh Fruit and Vegetable Program (FFVP) and found that at baseline, a greater frequency of urban students reported consumption of fruit and vegetable sources daily compared to rural students. However, this study by Lin and Fly reflects reported student FV intake as a reflection of overall student diets (not just school-related diets), which may skew results. Since no research has yet successfully measured rural vs. urban student lunch FV consumption, these findings should be replicated in future studies. Further investigation of rural vs. urban diets may yield a better understanding of where FV eating behaviors may be falling short and could be targeted.

Results of the sensitivity analysis were very similar to that of the primary analyses, but with a few key differences. When FVs were on the plate, there was a slightly greater degree of likelihood for rural vs. urban student FV selection, consumption, waste, and waste as a proportion. A potential explanation behind this is that when FVs are on the tray, suburban students were even less likely to select, consume, and waste FVs compared to urban students- a theory backed by the finding that suburban students had the lowest frequencies of FV selection, consumption, and waste that were greater than zero grams. Inclusion of suburban schools in urban classification therefore, likely reduced urban student likelihoods of FV selection, consumption, and waste when compared to rural students, causing rural likelihoods to increase. On the other hand, odds of rural students selecting, consuming, and wasting FVs were still reduced compared to urban students when suburban students were also included, but to a lesser degree than when suburban students were excluded from urban classification; this slight increase may be due to suburban students having greater odds of FV selection, consumption, and waste when either any or no FVs are on the tray. Evidence suggests that suburban and urban schools have healthier school wellness policies in place compared to rural and town schools, and that they also were more frequently reported daily FV consumption compared to rural students, which may partly explain why results were influenced this way with the sensitivity analysis (Lin & Fly, 2016; Nanney MS, et al., 2013). Sensitivity results also indicated that when compared to urban-

classified students, rural students had increased odds of FV waste when framed as a proportion of FV selection; this is very different from primary analyses and may be attributed to the finding that when suburban schools were included in urban classification, the frequency of zero grams of FV waste as a proportion increased by 1% from when suburban schools were excluded, possibly increasing for rural students the odds of waste as a proportion when any or no FVs were selected. These findings may demonstrate how differences exist among more specific locale types and that different classification methods can significantly influence results. In conclusion, these results indicate differences in fruit and vegetable lunch behaviors based on school locale that could potentially influence the health outcomes of children.

Though this study has several strengths, there are some limitations that should be addressed. First, since this study is secondary to the original research purpose, it is possible that this study is not appropriately powered to the purpose of this current study. However, given the large sample size, the analyses were likely powered. Next, this study used a convenience sample in that only schools that agreed to participate were utilized. However, students at each school were randomly selected to participate in the study, allowing findings to be generalized to a school level. In addition, this study only examined aggregate fruit and vegetable plate waste data, as opposed to separate, making it more difficult to understand more specifically which factors of FV intake may need addressing. The study also only

assessed that of cold FV intake, so it is possible that some forms of FVs were excluded, such as hot FV sides or those in entrées (with the exception of entrée salads), and which may affect the accuracy of the results. Additionally, whether condiments (e.g. dressing, tain) were served with FVs was not accounted for in this study and may be a factor that could influence results. Further, whether school lunch services utilized Offer versus Serve (OVS) or required children to take what was being served was not accounted for in this study, which may influence results, too. Time to eat may also be a factor in FV eating behaviors, but this was not accounted for in this study (Cohen et al., 2016). Timing of recess and timing of lunch (e.g. morning or midday) may also influence eating behaviors, but this also was not taken into consideration by this research (Chapman et al., 2017). Finally, there was a greater number of urban-classified vs. rural-classified schools, which may impact the reliability of this study's results.

There are many strengths of this research. First, this research uses objective measures, which promotes the accuracy of the results. This study also used a validated form of locale classification based on geocoding to classify schools by locales. Next, the overall sample size used in this study was relatively large, allowing for more precise results. The sample was also diverse, with a balance of students from both white and non-white backgrounds. Further, this study used non-invasive methods of measurement which prevented disrupting of participant eating behaviors and potentially skewing results. Finally, this study also incorporated

students from elementary, middle, and high school, promoting its generalizability to children across grades.

Future research on this topic may lend a better understanding of the relationship between school locale and student FV selection, consumption, and waste; more specifically, future research should investigate more closely rural school food environments given the finding that their students have reduced odds of selecting, consuming, and wasting FVs compared to that of urban schools. Our study does support though, that if FV selection can be targeted, likelihood of FV consumption will be greater for rural compared to urban students. Many barriers have been identified for rural schools in providing FVs, which may be influencing student eating behaviors, and therefore their health. Fears of waste have been cited as a concern for rural schools in previous studies (Blumenschine et al., 2018). Therefore, interventions and/or school policies that can influence increased student fruit and vegetable selection and consumption, while minimizing waste in rural students at lunch time may be able to promote greater fruit and vegetable consumption for students in rural schools and influence positive health outcomes. A systematic review of by Hoffman et al has already identified several strategies for rural schools to overcome costs of providing FVs and their other unique barriers such as lack of food acceptance by students (Hoffman et al., 2018). These suggestions include the use of salad bars, taste testing, cooperative purchasing, and FFVP; however, more research is needed to examine how urban vs. rural schools vary in

their implementation and effectiveness in these programs. Additionally, one intervention has already been successfully tested to be ideal for improving FV consumption by rural schools; the USDA FFVP was found by Lin and Fly to be very successful in increasing the likelihood for town and rural vs. city and suburb students to eat greater FVs daily, as well as a greater variety of FVs (Lin & Fly, 2016). Given that cost barriers and fear of waste may be prohibiting rural schools from maximizing student FV consumption, a federally assisted program such as FFVP may be an excellent intervention for at least rural elementary schools. Future research should determine a baseline for rural students' diet quality, specifically regarding their FV consumption. In addition, future studies should also determine whether the results of this present study can be reproduced and are generalizable to other regions of the country, identify where rural schools may have room for improvement, and understand interventions that may be successfully adapted by rural schools to improve FV intake.

CHAPTER 6

CONCLUSION

Given the health disparities among rural vs. urban populations, it is important that rural students are engaging in healthy lifestyle and nutrition habits. This research provides new findings for the association between school locale and students' fruit and vegetable selection, consumption, and waste. Findings from this study indicate that among rural vs. urban students, rural students are more likely to select, consume, and waste fruits and vegetables once fruits and vegetables are on the tray. On the other hand, when some vs. no fruits and vegetables are on student trays, there are lower odds of FV selection, consumption, and waste for rural students. This study may help inform school stakeholders, policymakers, and researchers about the disparities in the rural school food environment, as well as areas of rural student FV behaviors for future interventions to target. Future research may help further understand if and how rurality influences student fruit and vegetable behaviors in school, identify interventions which may address any disparities, and even inform policy to better target nutrition in rural schools. Overall, more studies are needed to close the gap in understanding by identifying if differences exist among rural vs. urban schools, and determine best practices for rural schools to maximize FV consumption so that disparities in fruit and vegetable consumption among children in rural schools are reduced.

REFERENCES

- 2015-2020 Dietary Guidelines for Americans*. (2015). 144.
- Adams, M. A., Ohri-Vachaspati, P., Richards, T. J., Todd, M., & Bruening, M. (2019). Design and rationale for evaluating salad bars and students' fruit and vegetable consumption: A cluster randomized factorial trial with objective assessments. *Contemporary Clinical Trials*, *77*, 37–45. <https://doi.org/10.1016/j.cct.2018.12.007>
- Addison, C. C., Jenkins, B. W., White, M. S., & Young, L. (2006). Examination of the food and nutrient content of school lunch menus of two school districts in Mississippi. *International Journal of Environmental Research and Public Health*, *3*(3), 278–285. <https://doi.org/10.3390/ijerph2006030034>
- Adult Obesity Facts / Overweight & Obesity / CDC*. (2021). Retrieved February 5, 2020, from <https://www.cdc.gov/obesity/data/adult.html>
- Anderson, T. J., Saman, D. M., Lipsky, M. S., & Lutfiyya, M. N. (2015). A cross-sectional study on health differences between rural and non-rural U.S. counties using the County Health Rankings. *BMC Health Services Research*, *15*, 441. <https://doi.org/10.1186/s12913-015-1053-3>
- Bartfeld, J. S., Berger, L., & Men, F. (2019). Universal Access to Free School Meals through the Community Eligibility Provision Is Associated with Better Attendance for Low-Income Elementary School Students in Wisconsin. *Journal of the Academy of Nutrition and Dietetics*. <https://doi.org/10.1016/j.jand.2019.07.022>
- Biener, A., Cawley, J., & Meyerhoefer, C. (2017). The High and Rising Costs of Obesity to the US Health Care System. *Journal of General Internal Medicine*, *32*(Suppl 1), 6–8. <https://doi.org/10.1007/s11606-016-3968-8>
- Blumenschine, M., Adams, M., & Bruening, M. (2018). Prevalence of and Differences in Salad Bar Implementation in Rural Versus Urban Arizona Schools. *Journal of the Academy of Nutrition and Dietetics*, *118*(3), 448–454. <https://doi.org/10.1016/j.jand.2017.09.004>
- Bolin, J. N., Bellamy, G. R., Ferdinand, A. O., Vuong, A. M., Kash, B. A., Schulze, A., & Helduser, J. W. (2015). Rural Healthy People 2020: New Decade, Same Challenges. *The Journal of Rural Health*, *31*(3), 326–333. <https://doi.org/10.1111/jrh.12116>

- Briefel, R. R., Crepinsek, M. K., Cabili, C., Wilson, A., & Gleason, P. M. (2009). School food environments and practices affect dietary behaviors of US public school children. *Journal of the American Dietetic Association, 109*(2 Suppl), S91-107. <https://doi.org/10.1016/j.jada.2008.10.059>
- Buttitta, M., Iliescu, C., Rousseau, A., & Guerrien, A. (2014). Quality of life in overweight and obese children and adolescents: A literature review. *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation, 23*(4), 1117–1139. <https://doi.org/10.1007/s11136-013-0568-5>
- Byker, C. J., Farris, A. R., Marcenelle, M., Davis, G. C., & Serrano, E. L. (2014). Food Waste in a School Nutrition Program After Implementation of New Lunch Program Guidelines. *Journal of Nutrition Education and Behavior, 46*(5), 406–411. <https://doi.org/10.1016/j.jneb.2014.03.009>
- Capogrossi, K., & You, W. (2017). The Influence of School Nutrition Programs on the Weight of Low-Income Children: A Treatment Effect Analysis. *Health Economics, 26*(8), 980–1000. <https://doi.org/10.1002/hec.3378>
- Caspi, C. E., Davey, C., Nelson, T. F., Larson, N., Kubik, M. Y., Coombes, B., & Nanney, M. S. (2015). Disparities persist in nutrition policies and practices in Minnesota secondary schools. *Journal of the Academy of Nutrition and Dietetics, 115*(3), 419-425.e3. <https://doi.org/10.1016/j.jand.2014.08.029>
- CDC. (2016, December 15). *Causes and Consequences of Childhood Obesity*. Centers for Disease Control and Prevention. <https://www.cdc.gov/obesity/childhood/causes.html>
- Chapman, L. E., Cohen, J., Canterberry, M., & Carton, T. W. (2017). Factors Associated with School Lunch Consumption: Reverse Recess and School “Brunch.” *Journal of the Academy of Nutrition and Dietetics, 117*(9), 1413–1418. <https://doi.org/10.1016/j.jand.2017.04.016>
- Child Nutrition Tables / USDA-FNS*. (2021). Retrieved July 16, 2021, from <https://www.fns.usda.gov/pd/child-nutrition-tables>.
- Cohen, J. F. W., Jahn, J. L., Richardson, S., Cluggish, S. A., Parker, E., & Rimm, E. B. (2016). Amount of Time to Eat Lunch Is Associated with Children’s Selection and Consumption of School Meal Entrée, Fruits, Vegetables, and Milk. *Journal of the Academy of Nutrition and Dietetics, 116*(1), 123–128. <https://doi.org/10.1016/j.jand.2015.07.019>

- Cohen, J. F. W., Richardson, S., Austin, S. B., Economos, C. D., & Rimm, E. B. (2013). School Lunch Waste Among Middle School Students. *American Journal of Preventive Medicine*, *44*(2), 114–121. <https://doi.org/10.1016/j.amepre.2012.09.060>
- Cohen, J. F. W., Richardson, S., Parker, E., Catalano, P. J., & Rimm, E. B. (2014). Impact of the New U.S. Department of Agriculture School Meal Standards on Food Selection, Consumption, and Waste. *American Journal of Preventive Medicine*, *46*(4), 388–394. <https://doi.org/10.1016/j.amepre.2013.11.013>
- Community Eligibility Data*. (n.d.). Retrieved February 5, 2020, from <https://frac.org/community-eligibility-database/>
- Community Eligibility Provision / USDA-FNS*. (2019). Retrieved December 3, 2019, from <https://www.fns.usda.gov/school-meals/community-eligibility-provision>
- Cornish, D., Askelson, N., & Golembiewski, E. (2016). “Reforms Looked Really Good on Paper”: Rural Food Service Responses to the Healthy, Hunger-Free Kids Act of 2010. *The Journal of School Health*, *86*(2), 113–120. <https://doi.org/10.1111/josh.12356>
- Crepinsek, M. K., Gordon, A. R., McKinney, P. M., Condon, E. M., & Wilson, A. (2009). Meals Offered and Served in US Public Schools: Do They Meet Nutrient Standards? *Journal of the American Dietetic Association*, *109*(2), S31–S43. <https://doi.org/10.1016/j.jada.2008.10.061>
- Cullen, K. W., & Chen, T.-A. (2016). The contribution of the USDA school breakfast and lunch program meals to student daily dietary intake. *Preventive Medicine Reports*, *5*, 82–85. <https://doi.org/10.1016/j.pmedr.2016.11.016>
- Daly, C. M., Foote, S. J., & Wadsworth, D. D. (2017). Physical Activity, Sedentary Behavior, Fruit and Vegetable Consumption and Access: What Influences Obesity in Rural Children? *Journal of Community Health*, *42*(5), 968–973. <https://doi.org/10.1007/s10900-017-0343-6>
- Davis, A. M., Bennett, K. J., Befort, C., & Nollen, N. (2011). Obesity and Related Health Behaviors Among Urban and Rural Children in the United States: Data from the National Health and Nutrition Examination Survey 2003–2004 and 2005–2006. *Journal of Pediatric Psychology*, *36*(6), 669–676. <https://doi.org/10.1093/jpepsy/jsq117>
- Davis, W., & Musaddiq, T. (2019). *Estimating the Effects of Universal Free School Meal Enrollment on Child Health: Evidence from the Community Eligibility*

Provision in Georgia Schools (SSRN Scholarly Paper ID 3155354). Social Science Research Network. <https://papers.ssrn.com/abstract=3155354>

Diet Quality of American School Children by National School Lunch Program Participation Status: Data from the National Health and Nutrition Examination Survey, 2005-2010 / USDA-FNS. (2015.). Retrieved December 3, 2019, from <https://www.fns.usda.gov/diet-quality-american-school-children-national-school-lunch-program-participation-status-data>

Digest of Education Statistics, 2018. (n.d.). Retrieved December 3, 2019, from https://nces.ed.gov/programs/digest/d18/tables/dt18_105.20.asp

Emmett, P. M., & Jones, L. R. (2015). Diet, growth, and obesity development throughout childhood in the Avon Longitudinal Study of Parents and Children. *Nutrition Reviews, 73*(Suppl 3), 175–206. <https://doi.org/10.1093/nutrit/nuv054>

Epstein, L. H., Gordy, C. C., Raynor, H. A., Beddome, M., Kilanowski, C. K., & Paluch, R. (2001). Increasing fruit and vegetable intake and decreasing fat and sugar intake in families at risk for childhood obesity. *Obesity Research, 9*(3), 171–178. <https://doi.org/10.1038/oby.2001.18>

Euler, R., Jimenez, E. Y., Sanders, S., Kuhlemeier, A., Van Horn, M. L., Cohen, D., Gonzales-Pacheco, D., & Kong, A. S. (2019). Rural–Urban Differences in Baseline Dietary Intake and Physical Activity Levels of Adolescents. *Preventing Chronic Disease, 16*. <https://doi.org/10.5888/pcd16.180200>

Findholt, N. E., Izumi, B. T., Shannon, J., & Nguyen, T. (2016). Food-related practices and beliefs of rural US elementary and middle school teachers. *Rural and Remote Health, 16*(2), 3821.

Finkelstein, E. A., Trogon, J. G., Cohen, J. W., & Dietz, W. (2009). Annual Medical Spending Attributable To Obesity: Payer-And Service-Specific Estimates. *Health Affairs, 28*(Supplement 1), w822–w831. <https://doi.org/10.1377/hlthaff.28.5.w822>

Food Access in Rural Communities—RHHub Food Access Toolkit. (2015). Retrieved November 30, 2019, from <https://www.ruralhealthinfo.org/toolkits/food-access/1/rural-specific-concerns>

Fox, M. K., Dodd, A. H., Wilson, A., & Gleason, P. M. (2009). Association between school food environment and practices and body mass index of US public school children. *Journal of the American Dietetic Association, 109*(2 Suppl), S108-117. <https://doi.org/10.1016/j.jada.2008.10.065>

- Gamm, L., Hutchison, L., Dabney, B., & Dorsey, A. (2010a). *Rural Healthy People 2010* (p. 275). School of Rural Public Health, The Texas A&M University System Health Science Center. <https://srhrc.tamhsc.edu/docs/rhp-2010-volume1.pdf>
- Gamm, L., Hutchison, L., Dabney, B., & Dorsey, A. (2010b). *The Texas A&M University System Health Science Center School of Rural Public Health Southwest Rural Health Research Center College Station, Texas*. 275.
- Garcia, M. C. (2017). *Reducing Potentially Excess Deaths from the Five Leading Causes of Death in the Rural United States*. MMWR. Surveillance Summaries, 66. <https://doi.org/10.15585/mmwr.ss6602a1>
- Geverdt, D. (2019). Education Demographic and Geographic Estimates Program (EDGE): Locale Boundaries File Documentation. *National Center for Education Statistics*. https://nces.ed.gov/programs/edge/docs/EDGE_NCES_LOCALE.pdf
- Gleason, P. M., & Sutor, C. W. (2003). Eating at School: How the National School Lunch Program Affects Children's Diets. *American Journal of Agricultural Economics*, 85(4), 1047–1061. <https://doi.org/10.1111/1467-8276.00507>
- Gordon-Larsen, P., The, N. S., & Adair, L. S. (2010). Longitudinal trends in obesity in the United States from adolescence to the third decade of life. *Obesity (Silver Spring, Md.)*, 18(9), 1801–1804. <https://doi.org/10.1038/oby.2009.451>
- Gorski, M. T., Cohen, J. F. W., Hoffman, J. A., Rosenfeld, L., Chaffee, R., Smith, L., & Rimm, E. B. (2016). Impact of Nutrition Standards on Competitive Food Quality in Massachusetts Middle and High Schools. *American Journal of Public Health*, 106(6), 1101–1108. <https://doi.org/10.2105/AJPH.2016.303139>
- Guh, D. P., Zhang, W., Bansback, N., Amarsi, Z., Birmingham, C. L., & Anis, A. H. (2009). The incidence of co-morbidities related to obesity and overweight: A systematic review and meta-analysis. *BMC Public Health*, 9, 88. <https://doi.org/10.1186/1471-2458-9-88>
- Gundersen, C., Kreider, B., & Pepper, J. (2012). The impact of the National School Lunch Program on child health: A nonparametric bounds analysis. *Journal of Econometrics*, 166(1), 79–91. <https://doi.org/10.1016/j.jeconom.2011.06.007>
- Gustafson, A., Jilcott Pitts, S., McDonald, J., Ford, H., Connelly, P., Gillespie, R., Liu, E., Bush, H., Brancato, C., Babatande, T., & Mullins, J. (2017). Direct Effects of the Home, School, and Consumer Food Environments on the Association between Food Purchasing Patterns and Dietary Intake among Rural

Adolescents in Kentucky and North Carolina, 2017. *International Journal of Environmental Research and Public Health*, 14(10).
<https://doi.org/10.3390/ijerph14101255>

Gustat, J., O'Malley, K., Luckett, B. G., & Johnson, C. C. (2015). Fresh produce consumption and the association between frequency of food shopping, car access, and distance to supermarkets. *Preventive Medicine Reports*, 2, 47–52.
<https://doi.org/10.1016/j.pmedr.2014.12.009>

Hanson, K. L., Garner, J., Connor, L. M., Jilcott Pitts, S. B., McGuirt, J., Harris, R., Kolodinsky, J., Wang, W., Sitaker, M., Ammerman, A., & Seguin, R. A. (2019). Fruit and Vegetable Preferences and Practices May Hinder Participation in Community-Supported Agriculture Among Low-Income Rural Families. *Journal of Nutrition Education and Behavior*, 51(1), 57–67.
<https://doi.org/10.1016/j.jneb.2018.08.006>

Healthy, Hunger-Free Kids Act of 2010 Summary. (2011.). Retrieved November 5, 2019, from <http://www.ncsl.org/research/human-services/healthy-hunger-free-kids-act-of-2010-summary.aspx>

Heber, D. (2010). An integrative view of obesity. *The American Journal of Clinical Nutrition*, 91(1), 280S-283S. <https://doi.org/10.3945/ajcn.2009.28473B>

Hoffman, V., Srinivasan, M., Levin, M., & Scarmo, S. (2018). Operating School Meal Programs in Rural Districts: Challenges and Solutions. *Journal of Child Nutrition & Management*, 42(1).

Jackson, J. A., Smit, E., Manore, M. M., John, D., & Gunter, K. (2015). The Family-Home Nutrition Environment and Dietary Intake in Rural Children. *Nutrients*, 7(12), 9707–9720. <https://doi.org/10.3390/nu7125495>

Jeffries, J. K. (2015). Rural Adults' Perspectives on School Food in a North Carolina County. *Preventing Chronic Disease*, 12. <https://doi.org/10.5888/pcd12.140484>

Joens-Matre RR, Welk GJ, Calabro MA, Russel DW, Nicklay E, & Hensley LD. (2008). Rural-urban differences in physical activity, physical fitness, and overweight prevalence of children. *The Journal of Rural Health*, 24(1), 49–54.
<https://doi.org/10.1111/j.1748-0361.2008.00136.x>

Johnson, D. B., Podrabsky, M., Rocha, A., & Otten, J. J. (2016). Effect of the Healthy Hunger-Free Kids Act on the Nutritional Quality of Meals Selected by Students and School Lunch Participation Rates. *JAMA Pediatrics*, 170(1), e153918–e153918. <https://doi.org/10.1001/jamapediatrics.2015.3918>

- Johnson, K. M. (2006). *Demographic trends in rural and small town America* (Volume 1, Number 1; Reports on Rural America, pp. 7–31). Carsey Institute, University of New Hampshire.
<https://scholars.unh.edu/cgi/viewcontent.cgi?article=1004&context=carsey>
- Joyce, J. M., Rosenkranz, R. R., & Rosenkranz, S. K. (2020). Evaluation of Variability in Dietary Quality of School Lunches Meeting National School Lunch Program Guidelines by Socioeconomic Status and Rurality. *International Journal of Environmental Research and Public Health*, *17*(21), 8012.
<https://doi.org/10.3390/ijerph17218012>
- Just, D. R., Lund, J., & Price, J. (2012). The Role of Variety in Increasing the Consumption of Fruits and Vegetables Among Children. *Agricultural and Resource Economics Review*, *41*(1), 72–81.
<https://doi.org/10.1017/S1068280500004196>
- Kenney, M. K., Wang, J., & Iannotti, R. (2014). Residency and Racial/Ethnic Differences in Weight Status and Lifestyle Behaviors Among US Youth. *The Journal of Rural Health*, *30*(1), 89–100. <https://doi.org/10.1111/jrh.12034>
- Knapton, L., & Hennessy, K. (2018). *Making it Count with Offer vs Serve*. #ANC18 Webinar Series, Las Vegas, NV.
https://schoolnutrition.org/uploadedFiles/2_Meetings_and_Events/Presentation_PDFs/ANC_2018/Making-it-Count-with-Offer-vs-Serve.pdf
- Kubik, M. Y., Lytle, L. A., Hannan, P. J., Perry, C. L., & Story, M. (2003). The Association of the School Food Environment With Dietary Behaviors of Young Adolescents. *American Journal of Public Health*, *93*(7), 1168–1173.
- Kubik, M. Y., Lytle, L. A., & Story, M. (2005). Schoolwide Food Practices Are Associated With Body Mass Index in Middle School Students. *Archives of Pediatrics & Adolescent Medicine*, *159*(12), 1111–1114.
<https://doi.org/10.1001/archpedi.159.12.1111>
- Lapuente, M., Estruch, R., Shahbaz, M., & Casas, R. (2019). Relation of Fruits and Vegetables with Major Cardiometabolic Risk Factors, Markers of Oxidation, and Inflammation. *Nutrients*, *11*(10), 2381. <https://doi.org/10.3390/nu11102381>
- Lichter, D. T. (2012). Immigration and the New Racial Diversity in Rural America. *Rural Sociology*, *77*(1), 3–35. <https://doi.org/10.1111/j.1549-0831.2012.00070.x>
- Lin, Y.-C., & Fly, A. D. (2016). USDA Fresh Fruit and Vegetable Program Is More Effective in Town and Rural Schools Than Those in More Populated

Communities. *The Journal of School Health*, 86(11), 769–777.
<https://doi.org/10.1111/josh.12432>

Liu J, Bennett KJ, Harun N, & Probst JC. (2008). Urban-rural differences in overweight status and physical inactivity among US children aged 10-17 years. *The Journal of Rural Health*, 24(4), 407–415. <https://doi.org/doi:10.1111/j.1748-0361.2008.00188.x>.

Liu, J.-H., Jones, S. J., Sun, H., Probst, J. C., Merchant, A. T., & Cavicchia, P. (2012). Diet, Physical Activity, and Sedentary Behaviors as Risk Factors for Childhood Obesity: An Urban and Rural Comparison. *Childhood Obesity*, 8(5). <https://www.ncbi.nlm.nih.gov/pubmed/23061499>

Locale Current. (2019, May 9). <https://data-nces.opendata.arcgis.com/datasets/nces::locale-current-1/about>

Locale Lookup. (2019). Retrieved November 11, 2019, from <https://nces.ed.gov/programs/maped/LocaleLookup/>

Lutfiyya, M. N., Lipsky, M. S., Wisdom-Behounek, J., & Inpanbutr-Martinkus, M. (2007). Is Rural Residency a Risk Factor for Overweight and Obesity for U.S. Children? *Obesity*, 15(9), 2348–2356. <https://doi.org/10.1038/oby.2007.278>

Merlo, C. L. (2016). Differences in Food and Beverage Marketing Policies and Practices in US School Districts, by Demographic Characteristics of School Districts, 2012. *Preventing Chronic Disease*, 13. <https://doi.org/10.5888/pcd13.160163>

Micha, R., Karageorgou, D., Bakogianni, I., Trichia, E., Whitsel, L. P., Story, M., Peñalvo, J. L., & Mozaffarian, D. (2018). Effectiveness of school food environment policies on children’s dietary behaviors: A systematic review and meta-analysis. *PLoS ONE*, 13(3). <https://doi.org/10.1371/journal.pone.0194555>

More Low-Income Students Receive Free School Meals in the 2018–2019 School Year Through Community Eligibility. (2019). *Food Research & Action Center*. Retrieved October 26, 2019, from <https://frac.org/news/more-low-income-students-receive-free-school-meals-in-the-2018-2019-school-year-through-community-eligibility>

Nanney MS, et al. (2013). Rural Disparities in the Distribution of Policies that Support Healthy Eating in US Secondary Schools. *Journal of the Academy of Nutrition and Dietetics*, 113(8), 1062–1068. <https://doi.org/10.1016/j.jand.2013.04.021>

National Academies of Sciences, E., Division, H. and M., Practice, B. on P. H. and P. H., Equity, R. on the P. of H., & Improvement, R. on P. H. (2018). *Potential Challenges and Opportunities in Rural Communities*. National Academies Press (US). <https://www.ncbi.nlm.nih.gov/books/NBK531871/>

The National School Lunch Program. (2017). <https://fns-prod.azureedge.net/sites/default/files/resource-files/NSLPPFactSheet.pdf>

Newman, C. (2013, April). The Food Costs of Healthier School Lunches. *Amber Waves; Washington*, 15–17.

Nutrition Standards in the National School Lunch and School Breakfast Programs. (2012, January 26). Federal Register. <https://www.federalregister.gov/documents/2012/01/26/2012-1010/nutrition-standards-in-the-national-school-lunch-and-school-breakfast-programs>

Ollinger, M., & Guthrie, J. (2015). *Economies of Scale, the Lunch-Breakfast Ratio, and the Cost of USDA School Breakfasts and Lunches* (No. 196; p. 51). United States Department of Agriculture. https://www.ers.usda.gov/webdocs/publications/45438/54357_err-196.pdf

Pokorney, P. E., Chandran, A., & Long, M. W. (2019). Impact of the Community Eligibility Provision on meal counts and participation in Pennsylvania and Maryland National School Lunch Programs. *Public Health Nutrition*, 1–7. <https://doi.org/10.1017/S1368980019002246>

Popat, S. (2014). *The 2014 Update of the Rural-Urban Chartbook*. 153.

Powell, L. M., Slater, S., Mirtcheva, D., Bao, Y., & Chaloupka, F. J. (2007). Food store availability and neighborhood characteristics in the United States. *Preventive Medicine*, 44(3), 189–195. <https://doi.org/10.1016/j.ypmed.2006.08.008>

Ratcliffe, M., Burd, C., Holder, K., & Fields, A. (2016). *Defining Rural at the U.S. Census Bureau* (p. 8). U.S. Census Bureau. <https://www.census.gov/content/dam/Census/library/publications/2016/acs/acsgeo-1.pdf>

Rogus, S., Guthrie, J., & Ralston, K. (2018). Characteristics of School Districts Offering Free School Meals to All Students Through the Community Eligibility Provision of the National School Lunch Program. *Economic Research Report Number 255*. <https://www.ers.usda.gov/webdocs/publications/89948/err-255.pdf?v=7184.1>

- Sánchez, V., Hale, R., Andrews, M., Cruz, Y., Bettencourt, V., Wexler, P., & Halasan, C. (2014). School wellness policy implementation: Insights and recommendations from two rural school districts. *Health Promotion Practice, 15*(3), 340–348. <https://doi.org/10.1177/1524839912450878>
- Schneider, L. M., Schermbeck, R. M., Chriqui, J. F., & Chaloupka, F. J. (2012). The Extent to Which School District Competitive Food and Beverage Policies Align with the 2010 Dietary Guidelines for Americans: Implications for Federal Regulations. *Journal of the Academy of Nutrition and Dietetics, 112*(6), 892–896. <https://doi.org/10.1016/j.jand.2012.01.025>
- School Nutrition Environment / Healthy Schools / CDC.* (2019, September 11). <https://www.cdc.gov/healthyschools/nutrition/schoolnutrition.htm>
- Schwartz, M. B., Henderson, K. E., Read, M., Danna, N., & Ickovics, J. R. (2015). New School Meal Regulations Increase Fruit Consumption and Do Not Increase Total Plate Waste. *Childhood Obesity, 11*(3), 242–247. <https://doi.org/10.1089/chi.2015.0019>
- Slack, T., & Jensen, L. (2020). The Changing Demography of Rural and Small-Town America. *Population Research and Policy Review, 39*(5), 775–783. <https://doi.org/10.1007/s11113-020-09608-5>
- Strochlic, R., Au, L., & Ritchie, L. (2017). *Is urban-rural location associated with weight status in school children? An examination of 42 small and rural Californian counties.* *17*(2), 3966. <https://doi.org/10.22605/RRH3966>
- Tovar, A., Chui, K., Hyatt, R. R., Kuder, J., Kraak, V. I., Choumenkovitch, S. F., Hastings, A., Bloom, J., & Economos, C. D. (2012). Healthy-lifestyle behaviors associated with overweight and obesity in US rural children. *BMC Pediatrics, 12*, 102. <https://doi.org/10.1186/1471-2431-12-102>
- Turner, L., & Chaloupka, F. J. (2014). Perceived Reactions of Elementary School Students to Changes in School Lunches after Implementation of the United States Department of Agriculture’s New Meals Standards: Minimal Backlash, but Rural and Socioeconomic Disparities Exist. *Childhood Obesity, 10*(4), 349–356. <https://doi.org/10.1089/chi.2014.0038>
- Turner, L., Guthrie, J. F., & Ralston, K. (2019). Community eligibility and other provisions for universal free meals at school: Impact on student breakfast and lunch participation in California public schools. *Translational Behavioral Medicine, 9*(5), 931–941. <https://doi.org/10.1093/tbm/ibz090>

- Turner, L., Ohri-Vachaspati, P., Powell, L., & Chaloupka, F. J. (2016). Improvements and Disparities in Types of Foods and Milk Beverages Offered in Elementary School Lunches, 2006-2007 to 2013-2014. *Preventing Chronic Disease, 13*, E39. <https://doi.org/10.5888/pcd13.150395>
- USDA ERS – Rural Poverty & Well-Being.* (2021) United States Department of Agriculture. <https://www.ers.usda.gov/topics/rural-economy-population/rural-poverty-well-being/>
- Vericker, T. C., Gearing, M. E., & Kim, S. D. (2019). Updated Nutrition Standards for School Meals Associated With Improved Weight Outcomes for Boys in Elementary School. *Journal of School Health, 89*(11), 907–915. <https://doi.org/10.1111/josh.12828>
- Vital Signs: Fruit and Vegetable Intake Among Children—United States, 2003–2010.* (2014). Retrieved October 19, 2019, from <https://www.cdc.gov/Mmwr/preview/mmwrhtml/mm6331a3.htm>
- Wang, Y., Cai, L., Wu, Y., Wilson, R. F., Weston, C., Fawole, O., Bleich, S. N., Cheskin, L. J., Showell, N. N., Lau, B. D., Chiu, D. T., Zhang, A., & Segal, J. (2015). What childhood obesity prevention programmes work? A systematic review and meta-analysis. *Obesity Reviews, 16*(7), 547–565. <https://doi.org/10.1111/obr.12277>

APPENDIX A
PRINCIPAL LOCO PARENTIS FORM

Drs. Marc Adams and Meg Bruening

School of Nutrition and Health Promotion

College of Health Solutions, Arizona State University

500 North 3rd Street | Phoenix, AZ 85004 | MC3020

Office: 602-827-2470 | Fax: 602-827-2253

Re: School Lunch Study

Dear Drs. Meg Bruening and Marc Adams,

As principal of school (_____), I am excited to collaborate with you on your research study. For this project, I will be acting in loco parentis. Due to this partnership, you will not need to obtain signed parental permission forms.

Sincerely,

Principal's Name (signed and printed)

APPENDIX B

IRB-APPROVED ENGLISH ELEMENTARY STUDENT ASSENT STATEMENT

English Elementary Student Assent

Hi! My name is _____ and I'm from Arizona State University in Phoenix. Can you tell me what grade you are in? I'm visiting your school cafeteria today to see what kids eat for lunch. I'm asking students like you to let me weigh and take a picture of their lunch tray. If you're ok with this then you will need to go to have your lunch tray weighed and photographed (point to weigh station) before you eat anything! After we weigh your tray then you can sit down and eat your lunch. Nothing will happen to your lunch – your lunch will be the same after we weigh and take a picture of it.

When you are finished eating, you will need to give your tray to (point to tray depot) and then we will give you a small gift. Please do not throw your tray away!

You do not have to do this if you don't want to and you can stop doing it at any time.

Would it be ok with you for us to weigh and take a picture of your lunch tray?

APPENDIX C

IRB-APPROVED SPANISH ELEMENTARY STUDENT ASSENT STATEMENT

Spanish Elementary Student Assent

Hola mi nombre es _____ y soy de Arizona State University (ASU) en Phoenix. ¿Me puedes decir en cuál grado estas? Estoy visitando la cafetería de su escuela hoy para mirar qué comen los niños para lonche. Estoy preguntando a niños como tu que me dejen pesar y tomar una foto de su comida. ¡Si estás bien con esto tienes que ir para que te pesen tu plato de comida y le tomen una foto (punta a la estación de pesaje) antes que cualquier cosa! Después que te pesemos tu comida te puedes ir a sentar y comer tu comida. Nada le ha pasar a tu comida -- tu lonche va estar igual despues que lo pesemos y le tomamos una foto.

Cuando termines de comer, vas a llevar tu plato ha (punta al depósito de platos) y después te vamos a dar un pequeño regalo. ¡Por favor no tires tu plato!

No tienes que hacer esto si no quieres y puedes dejar de hacerlo en cualquier momento.

¿Sería aceptable con usted para que pesemos y tomemos una imagen de su plato de comida?

APPENDIX D

IRB-APPROVAL FOR HUMAN SUBJECT TESTING



APPROVAL: EXPEDITED REVIEW

Meredith Bruening
 SNHP: Nutrition
 602/827-2266
 Meg.Bruening@asu.edu

Dear Meredith Bruening:

On 4/3/2017 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Salad bars and students' fruit and vegetable consumption: A group-randomized trial with objective assessments
Investigator:	Meredith Bruening
IRB ID:	STUDY00005882
Category of review:	(7)(b) Social science methods, (7)(a) Behavioral research
Funding:	Name: HHS-NIH: National Heart, Lung, & Blood Institute (NHLBI)
Grant Title:	
Grant ID:	
Documents Reviewed:	<ul style="list-style-type: none"> • StudentAssent.pdf, Category: Consent Form; • _SaladBar_Grant_102816-LATEST-SUBMITTED v2.pdf, Category: Grant application; • Principal loco parentis form.pdf, Category: Consent Form; • Salad Bar Study IRB_032717.docx, Category: IRB Protocol; • Email Newsletter Blurb Phone - School Salad Bar Study Recruitment Scripts - Updated 03.27.17_marc.pdf, Category: Recruitment Materials;

The IRB approved the protocol from 4/3/2017 to 4/2/2018 inclusive. Three weeks before 4/2/2018 you are to submit a completed Continuing Review application and required attachments to request continuing approval or closure.

If continuing review approval is not granted before the expiration date of 4/2/2018 approval of this protocol expires on that date. When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

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

Sincerely,

IRB Administrator

cc:

Timothy Richards
Marc Adams
Punam Ohri-Vachaspati
Michael Todd