PROMOTING SCHOOL BREAKFAST AT THE COUNTY AND STATE LEVEL: AN EVALUATION OF ALTERNATIVE SERVICE MODELS

Sally Lawrence Bullock

A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Nutrition in the Gillings School of Global Public Health.

Chapel Hill
2017

Approved by:

Alice Ammerman

Allison Aiello

Marilyn S. Nanney

Kimberly P. Truesdale

Dianne Ward

ABSTRACT

Sally Lawrence Bullock: Promoting School Breakfast at the County and State Level: An Evaluation of Alternative Service Models
(Under the direction of Alice Ammerman)

Eating breakfast has been associated with improved weight status, nutrient intake, and academic achievement among children. The National School Breakfast Program (SBP) was created by the US Congress to ensure that school-aged children have access to a meal to start the day. However, SBP participation rates have been consistently low nationwide even among students eligible for free or reduced-price (FRP) meals. Policy makers and practitioners have implemented a variety of initiatives to improve breakfast participation, including alternative breakfast service models, such as universal free school breakfast, breakfast in the classroom, second chance breakfast, and grab and go breakfast.

To determine whether alternative breakfast service models are associated with improvements in SBP participation, academic, and health outcomes, we first completed a literature review to examine the associations between these models and SBP participation, student attendance, academic achievement, dietary intake, and weight status. Results indicate that some models may result in an increase in participation, but additional studies are needed.

Using district- and school-level longitudinal data on breakfast participation rates and student demographics for schools across North Carolina, we examined whether changes in statewide policies and practices promoting alternative breakfast are associated with improved

SBP participation. Findings indicate that most of the initiatives implemented in North Carolina were associated with an increase in either school- or district-level SBP participation.

Longitudinal data on students and SBP participation for a large urban school district in the Southeast United States (LUSD) were used to determine whether a district-wide universal free breakfast (UFB) policy implemented in 2013-2014 was associated with changes in school-level SBP participation, attendance, academic achievement, and student weight status. On average across schools there was an increase in participation of 4.1% (SE=0.7, $p<0.001$) immediately following the implementation of the policy. Changes in participation differed among schools by grade level, FRP percent and race/ethnicity. Results provide no evidence of weight gain following the UFB policy or associations between the policy and attendance or test scores. This evaluation of alternative breakfast service models addresses some of the gaps in knowledge about these initiatives and helps build the evidence base to better inform future policy approaches.

ACKNOWLEDGEMENTS

This dissertation and completing a PhD program would not have been possible without the assistance and support of a number of individuals. First, I would like to express my deep-felt appreciation to the members of my dissertation committee: Dr. Alice Ammerman (chair), Dr. Allison Aiello, Dr. Susie Nanney, Dr. Kimberly P. Truesdale, and Dr. Dianne Ward. Thank you all for your time and commitment to my research. It has been an honor to work with you and I am very grateful for your guidance and encouragement throughout this process.

Spring Dawson-McClure and the wonderful women from No Kid Hungry North Carolina provided inspiration for this research and played a critical role in helping me acquire the data and connect to individuals willing to provide me with the information that I needed to complete the project. The work that you all do on behalf of children and families is truly remarkable.

I am also grateful for the assistance that I received from Salomon Ariza and Mary White on the peer-reviewed literature review. Feedback on statistical methods from Chris Wiesen at the Odum Institute was also extremely helpful.

The support and advice that I received throughout the PhD process from colleagues and friends in my cohort and from previous cohorts has been invaluable. I look forward to staying connected with all of you in the future and following your fabulous careers.

To my family and friends, your unwavering support of all of my academic endeavors has been critical to my success. I'm especially thankful to my mom and sister—without all of your assistance, I would never have been able to become "Dr. Sal."

To my son, Jordan, having you in the middle of a PhD program definitely made life more challenging at times, but seeing your smiling face and hearing your wonderful laugh inspired me to keep working to make things better for you and your generation.

Last but definitely not least, I am extremely grateful to my husband, Graham, for his unwavering support throughout the PhD process. Starting a PhD program over 2 hours away from where we were living did not make our lives easier, but throughout the program you have stepped up to the challenge and been one of my biggest cheerleaders. I cannot thank you enough for helping me sort through my research ideas, for reviewing journal articles and proposals, and for helping me work through what seemed to be unsurmountable challenges and continue to progress in the program.

TABLE OF CONTENTS

LIST OF TABLES x

LIST OF FIGURES xi

LIST OF ABBREVIATIONS xii

CHAPTER I: INTRODUCTION 1

I.A. Overview 1

I.B. Specific Aims 2

CHAPTER II: BACKGROUND 4

II.A. Breakfast Consumption Among Children and Adolescents 4

II.B. The School Breakfast Program 5

II.C. Overview of School Breakfast Literature 6

II.D. SBP Participation Rates and Barriers to SBP Participation 11

II.E. Alternative Breakfast Service Models 12

II.F. Alternative Breakfast Service Model Literature 15

CHAPTER III: METHODS 17

III.A. Study Overview 17

III.B. Aim 1. Statewide Policy and Practice Changes 18

III.C. Aim 2. District-wide Universal School Breakfast Policy 27

CHAPTER IV: THE INFLUENCE OF ALTERNATIVE BREAKFAST SERVICE MODELS ON SCHOOL BREAKFAST PARTICIPATION, ATTENDANCE, ACADEMIC ACHIEVEMENT, DIETARY INTAKE AND WEIGHT STATUS: A REVIEW OF THE LITERATURE 33

IV.A. Introduction 33

IV.B. Methods 35

IV.C. Results 38

IV.D. Discussion 51

CHAPTER V: SCHOOL BREAKFAST PROMOTION INITIATIVES AND TRENDS IN SCHOOL BREAKFAST PARTICIPATION: A STATE-WIDE ANALYSIS 57

V.A. Introduction 57

V.B. Methods 59

V.C. Results 66

V.D. Discussion 76

CHAPTER VI: ASSOCIATIONS BETWEEN A UNIVERSAL FREE BREAKFAST POLICY AND SCHOOL BREAKFAST PROGRAM PARTICIPATION, ATTENDANCE, ACADEMIC ACHIEVEMENT, AND WEIGHT STATUS: A DISTRICT-WIDE ANALYSIS 82

VI.A. Introduction 82

VI.B. Methods 84

VI.C. Results 88

VI.D. Discussion 95

CHAPTER VII: SYNTHESIS 102

VII.A. Overview of Findings 102

VII.B. Recommendations 106

VII.C. Future Research 107

VII.D. Summary 108

APPENDIX 1: LITERATURE REVIEW SEARCH TERMS 110

APPENDIX 2: LITERATURE REVIEW DATA TABLE 113

REFERENCES 123

LIST OF TABLES

Table 1. Aim 1 School breakfast timeline of interventions and data availability 19

Table 2. Variable definitions for Aim 1–District-level analyses 21

Table 3. Variable definitions for Aim 1–School-level analyses 22

Table 4. Variable definitions for AIM 2 30

Table 5. Inclusion and exclusion criteria for alternative breakfast service model literature review 36

Table 6. Summary of findings by alternative breakfast service model and study design. 41

Table 7. District-level means and average change for percent of students of color and percent of students eligible for FRP from 2010-11 to 2014-15 and urban/rural classification. 67

Table 8. Demographic information for all study schools and for schools participating in the 2013 and 2014 Breakfast Challenges and 2014-15 Community Eligibility Provision. 68

Table 9. Demographic information for all study schools, for schools with an increase in breakfast participation, and for schools with no increase in breakfast participation. 89

LIST OF FIGURES

Figure 1. Pathways of universal-free school breakfast to school and student outcomes 14

Figure 2. Regression model equation for Aim 1 district-level analyses 24

Figure 3. Regression model equation for Aim 1 school-level analyses 26

Figure 4. Regression model equation for Aim 2 SBP participation analyses 31

Figure 5. Regression model equation for Aim 2 change in test scores, attendance and student weight status 32

Figure 6. Flow diagram of the study selection process. 38

Figure 7. Publication Year of Included Articles by Alternative Breakfast Service Model 39

Figure 8. Timeline of the North Carolina SBP policy and practice changes and district- and school-level data availability. 60

Figure 9. Average National School Breakfast Program participation rate among districts in North Carolina between the 2007-08 and 2014-15 school years. 69

Figure 10. Breakfast participation rates from school year 2007-08 to 2014-15 for North Carolina school districts by percent of free and reduced price eligible students 71

Figure 11. Average School Breakfast Program participation rates among schools in North Carolina between the 2012-13 and 2014-15 school years. 72

Figure 12. Estimated breakfast participation rates for North Carolina schools participating in the 2013 Breakfast Challenge, 2014 Breakfast Challenge, Community Eligibility Provision, all three or none of the interventions by percent of students of color and FRP-eligible students. 75

Figure 13. Estimated average percent School Breakfast Program participation among schools in a large urban school district in the Southeast US between 2006-07 and 2014-15 90

Figure 14. Estimated breakfast participation rates for school years 2006-07 to 2014-15 by FRP eligibility, percent of students of color, percent change in students of color, and percent change in FRP eligible students. 92

LIST OF ABBREVIATIONS

BC2013	2013 Breakfast Challenge
BC2014	2014 Breakfast Challenge
BIC	Breakfast in the Classroom
CBPP	Center on Budget and Policy Priorities
CEP	Community Eligibility Provision
GG	Grab and Go Breakfast
NC DPI	North Carolina Department of Public Instruction
NCES	National Center for Education Statistics
NKH NC	No Kid Hungry North Carolina
NSLP	National School Lunch Program
RUCA	Rural-Urban Commuting Area
RUCC	Rural-Urban Continuum Codes
SBP	The National School Breakfast Program
SC	Second Chance Breakfast
UFB	Universal Free Breakfast
USDA	United States Department of Agriculture

CHAPTER I: INTRODUCTION

I.A. Overview

Eating breakfast has been linked to improved weight status, nutrient intake, and academic achievement among children. The National School Breakfast Program (SBP) was created by the United States Congress to help ensure that school-aged children, and low-income children in particular, have access to a healthy meal to start the day. For children from food insecure households, school meals may serve as the primary source of nutritious foods consumed throughout the day. However, participation rates in the SBP have been consistently low nationwide even among students who are eligible for free or reduced-price meals. Realizing the impact that breakfast can have on improving nutrition and academic performance, policy makers and practitioners have implemented a variety of changes in policies and practices designed to improve breakfast participation. Some of these changes focus on alternative breakfast service models, such as universal free school breakfast, breakfast in the classroom, second chance breakfast, and grab and go breakfast.

In order to determine whether statewide and local efforts are effective in improving participation in the SBP and subsequently improved academic and health outcomes, a rigorous evaluation is needed. To address the need for a rigorous evaluation, we used district- and school-level longitudinal data on breakfast participation rates and student demographics for schools across the state of North Carolina to determine whether new SBP policies and practices implemented in North Carolina are associated with an improvement in district- and school-level

SBP participation. We also used longitudinal data collected annually at the school level for one large urban school district in the Southeast United States (LUSD) to determine whether a universal free school breakfast policy implemented in 2013-14 was associated with changes in school-level breakfast participation, attendance, academic achievement, and student weight status.

I.B. Specific Aims

Aim 1a: Evaluate the accumulated impact of four sequential policy and practice changes – a statewide resolution to promote alternative breakfast service models (2011), the Breakfast is Brain Fuel Toolkit (2011), the No Kid Hungry Campaign (2013 and 2014), and the Community Eligibility Provision (CEP 2014-15) – in North Carolina public schools on school-level breakfast participation rates.

- ***Hypothesis 1:*** Modest increases in breakfast participation rates will be observed after the adoption of each of the policy/practice changes.
- ***Hypothesis 2:*** Schools that have pledged to participate in the No Kid Hungry Breakfast Challenge and/or elected to adopt the CEP will have a greater magnitude of increase in participation than schools that have not yet pledged to participate in the Challenge or adopted CEP.

Aim 1b: Assess the extent to which the impact of participation in SBP varies by demographic characteristics of the student population (e.g., % low-income, % students of color, urban or rural) and type of school (elementary, middle or high).

- ***Hypothesis***: Schools where the population has a larger percentage of students of color and elementary schools will have a have a greater magnitude of increase in participation.

Aim 2: Determine the impact of the district-wide universal school breakfast policy (implemented in 2013-14) in a large urban school district in the Southeast United States (LUSD) on breakfast participation rates, attendance, academic achievement, and student weight status at the school-level as measured by student data collected by the school district on an annual basis (e.g., test scores, height, weight).

- ***Hypothesis:*** Students in schools with increases in breakfast participation will have a greater improvement in or be more likely to maintain their levels of attendance, academic achievement, and weight status in the year following the implementation of the policy relative to the year before.

CHAPTER II: BACKGROUND

II.A. Breakfast Consumption Among Children and Adolescents

Breakfast is often called the most important meal of the day, and the effect of breakfast consumption among children and adolescents has been the focus of numerous studies over the past several decades. Over the years researchers have examined the associations between breakfast consumption and cognition, behavior, nutrient intake, and weight status. While some findings have been mixed, overall studies suggest that consumption of breakfast among children may lead to improved nutrient profiles, better weight status, and improved cognitive function and behavior.[1-5] However, it should be noted that many of the breakfast studies are cross-sectional in design, especially those on weight status and breakfast consumption, and additional longitudinal and experimental studies are needed to determine the relationship between breakfast and various health, cognitive function and behavioral outcomes.

In a literature review published in 1995, Pollitt summarized the biological mechanisms by which breakfast may affect cognition and nutrient status.[6] He stated that in the short-term, skipping breakfast results in a decrease in energy and nutrient availability, which can negatively affect brain function. In the long term, breakfast consumption significantly contributes to children's macro and micronutrient intake and thus can lead to improved nutrient status and health over time.

Despite the reported benefits of breakfast, over the last several decades breakfast consumption among children and adolescents has decreased markedly.[7, 8] In 1965, 5% of children and 12% of adolescents in the United States skipped breakfast regularly compared to 20% of children and 32% of adolescents in the late 1990s and early 2000s.[7, 8] Given the increasing rates of obesity among children and adolescents and the link between breakfast and improved weight status,[1, 3, 9] increasing breakfast consumption may be a worthwhile endeavor.

II.B. The School Breakfast Program

The National School Breakfast Program (SBP) was created to help ensure that school-aged children, and low-income children in particular, have access to a healthy meal to start the day. Initiated as a pilot program in 1966, the SBP became a permanent entitlement program in 1975 and the availability of the program in public and nonprofit private schools has continued to expand ever since.[10] Currently about 13 million students participate in the school breakfast program in more than 88,000 schools.[10] Schools that decide to participate in the program receive cash subsidies from the U.S. Department of Agriculture (USDA) for each meal they serve, and children that participate may be eligible to receive free or reduced price meals depending on their family income.[11] Specifically, for a child to qualify for a free meal, their maximum family income must not exceed 130 percent of the federal poverty level and for a child to qualify for a reduced price meal, their maximum family income must fall within 130 and 185 percent of the federal poverty level.[12] In 2012, the total cost of the SBP was $3.3 billion dollars and over 10.1 million children received their meals free or at a reduced-price.[11]

The meals that schools serve as part of the SBP must meet federal nutrition standards.[10] Under the direction of The Healthy, Hunger-Free Kids Act of 2010, the USDA updated the

nutrition standards for school meals and the new standards for breakfast were implemented starting during the 2013-2014 school year.[11] There are new requirements for whole grains, fruit, trans fat, calories, sodium, menu planning, age/grade group categories, monitoring and offer versus serve.[13] Most of these new requirements were implemented by the 2014-2015 school year, but the sodium requirement was designed to be phased in over several years, and the final target for sodium needs to be reached by the 2022-2023 school year.[13] However, a recent proclamation issued on May 1, 2017 by the Secretary of Agriculture, Sonny Perdue, directs the USDA "to begin the regulatory process to provide schools with additional options in regard to the serving of whole grains."[14] In the proclamation, the Secretary also directs the USDA to begin the regulatory process to relax the sodium requirements and allow flavored, one percent fat milk.

II.C. Overview of School Breakfast Literature

Given the size of the program and the number of dollars spent to support it, several studies have been conducted in an attempt to determine its impact. **Overall, the majority of these studies have found that the SBP is associated with improved diet quality and nutrient intake,[15-20] weight status,[21-25] and academic performance.[26-29]** In addition, the SBP has been found to be beneficial in offsetting food-related concerns experienced by food insecure families.[30] For many low-income students the school meal program may be the only regular source of nutritious foods that they have access to during the day. The sections below provide a brief overview of studies in each of these areas. It should be noted that many of the studies of the SBP have been observational studies, which may provide some evidence of a relationship

between the SBP and the various outcomes below, but do not support a cause and effect conclusion.

II.C.i. SBP and Diet Quality and Nutrient Intake

The contributions of the SBP to diet quality and nutrient intake have been the focus of many studies. Using data from large national studies, **overall researchers have found that the SBP is associated with improved diet quality and nutrient intake**.[15-20] National Health and Nutrition Examination Survey III (NHANES) data were used to determine if there are any associations between the availability of the SBP and children's nutritional intake.[15] With these data researchers were able to compare students' nutritional intake while school was in session to their intake while school was not in session and also compared these students to those who went to schools where the SBP was not available. They found that the program does not affect calorie intake, but improves the quality of the diet. Researchers concluded that children with access to the SBP are more likely to meet the recommended amounts of fiber, iron, and potassium, and less likely to have low serum vitamin C, E, and folate. In addition, they are more likely to consume fewer calories from fat. Hanson and Olson also used NHANES data to examine the relationship between weekday diet quality and energy intake and participation in the school meal program.[16] In order to account for possible differences in food preference and health beliefs between school meal program participants and nonparticipants, Hanson and Olson controlled for weekend dietary intake in their analyses. They found that participation in the school meal program was associated with better diet quality among low-income students, but results were mixed for higher income students.

Using data collected as part of the first School Nutrition Dietary Assessment Study (SNDA I) in 1991-1992, researchers found that SBP participation was associated with higher

intakes of calcium, riboflavin, magnesium, and phosphorus.[17] SBP Participation was also associated with a higher intake of calories over all, but a lower percentage of breakfast calories from carbohydrates and a higher percentage of breakfast calories from fat and saturated fat. With data from the third School Nutrition Dietary Assessment Study (SNDA-III) conducted in 2004 and 2005, researchers found that students that consumed ready-to-eat cereal as part of the SBP consumed more vitamin A, iron, and whole grains, compared with students that skipped breakfast.[19] Analysis of the SNDA-III data by Clark and Fox also indicates that students who participated in the SBP were less likely to have inadequate intakes of Vitamin A and phosphorus and had higher potassium and sodium intakes than non-participants.[18] In addition, Condon et al. found that students who consumed school breakfast were more likely to consume milk and fruit (mostly in the form of 100% juice).[31] However, they also found that participating students were also more likely to consume sweet rolls and doughnuts than non-participants.

School meals can also be an important source of fruits and vegetables, especially for low-income students. Using 24 hour dietary recalls, Robinson-O'Brien et al. examined the proportion of fruits and vegetables the school meal program contributes to the diets of ethnically diverse, low socioeconomic status elementary school aged children in Minnesota.[32] They found that overall the children surveyed consumed about half of their daily fruit and vegetable intake at school. However, 80% of the children surveyed consumed fewer than 5 serving per day. Using telephone surveys about school meal participation and fruit and vegetable consumption, Longacre et al. compared fruit and vegetable consumption for adolescents currently exposed to the school meal program (interviewed when school in session) to those currently unexposed (interviewed when school not in session).[20] They found consuming school food is associated

with higher intake of fruits and vegetables in low income students, but found the opposite among higher income students.

In general, studies indicate that the SBP is associated with improved diet quality, nutrient intake and consumption of fruits and vegetables. While some of the SBP studies did find SBP consumption was associated with higher consumption of sodium, calories, and saturated fat, and lower consumption fruits and vegetables, the new nutrition standards for the SBP that were developed as a result of the passage of The Healthy, Hunger-Free Kids Act of 2010 may address these issues. Additional studies will need to be conducted to determine the impact of the new nutrition standards on students' diet quality and nutrient intake.

II.C.ii. SBP and Weight Status

Studies of participation in the SBP and weight status have generally found some evidence of a protective effect on children's weight or null results.[21-25, 33, 34] Using data from SNDA III, Gleason and Dodd found that usual participation in the SBP (consuming school breakfast most days of the week) was associated with lower BMI among students and the association was strongest among non-Hispanic white students.[21] Kimbro and Rigby also found that receiving school meals is negatively associated with children's BMI using longitudinal data from the Fragile Families and Child Wellbeing Survey (waves III and IV).[22] Millimet et al. examined the relationship between school meal programs and child weight and looked at selection into the meal program using data from the Early Childhood Longitudinal Study, Kindergarten cohort (ECLS-K).[23] They found that children who gained more weight prior to starting kindergarten were more likely to participate in school breakfast, which indicates that there is non-random selection into the SBP. The researchers also found that the SBP appears to mitigate childhood obesity when taking selection into the program into account. Other studies

that have examined differences in weight change over the summer versus during the school year also suggest that school meals may have a protective effect on children's weight. Von Hippel et al. compared weight gain while school was in session to weight gain when school was not in session using data from the ECLS-K and found children gain weight at a faster rate during summer than during school.[24] Downey and Boughton found that children's BMI increases roughly twice as fast during the summer as during it does during the school year.[25] However, many other factors may contribute to the rate of BMI change in the summer versus the school year. For example, von Hippel et al. speculate that unstructured environments that children may be exposed to during the summer months may promote more sedentary activity and snacking that could contribute to weight gain.[24]

Baxter et al. and Paxton et al. found that BMI was not significantly associated with regular participation in the SBP.[33, 34] Hofferth and Curtin used data from the 1997 Panel Study of Income Dynamics Child Development Supplement and found that participation in the school meal program may be associated with a higher chance of being overweight.[35] However, this relationship disappeared when researchers corrected for selection bias through an instrumental variables procedure.

II.C.iii. SBP and Academic Achievement

Similar to studies of the SBP and nutrient intake and weight status, studies of the SBP and academic achievement also indicate that **participation in the SBP may have a positive impact on test scores and other measures of academic achievement.**[26-29] A review of 36 articles published between 1950 and 2013 suggests that habitual breakfast and participation in the SBP are positively associated with academic performance.[26] The authors of the review conclude that there is a positive association between breakfast and mathematic and arithmetic

grades, especially among undernourished children. They also found that breakfast is positively associated with on-task behavior in the classroom. A study of state mandates to increase the availability of the SBP in schools found that increasing the availability of the SBP in schools increases student academic achievement.[27] The author of this study used data from the National Assessment of Educational Progress (NAEP) to compare student achievement in schools above the threshold for providing breakfast to achievement in schools below the threshold. He also used data from the Early Childhood Longitudinal Study, Kindergarten Cohort of 1998–99 (ECLS-K) to study achievement and the availability of the SBP in schools. With both sets of data he found that the availability of the SBP increases math and reading achievement. A study evaluating the effect of the "Feed Me Better" campaign in Greenwich, England used a difference-in-difference approach to determine whether changes in school meals were associated with educational outcomes, meal participation, and absenteeism.[28] Results indicate that there were improvements in English, Math and Science test scores and that authorized absences decreased. Meyers et al. found that participation in the SBP was associated with improved scores on standardized tests when compared to scores from students who qualified for FRP SBP but did not participate.[29]

II.D. SBP Participation Rates and Barriers to SBP Participation

Despite high levels of availability in schools across the country and high levels of eligibility for free and reduced price breakfast, **participation in the SBP is much lower than participation in the school lunch program** (NSLP). At the national level, 52 low-income children participated in school breakfast for every 100 that participated in school lunch.[36] Students eligible for free breakfast and lunch have participation rates of 39%, compared to

participation rates of 20% for students eligible for reduced-price meals and participation rates of 8% for students who pay full price.[37]

A number of factors have been found that may influence participation in the SBP. Quality, variety, taste and appearance of food have all been cited by students as important factors in their decision to participate in school meals.[38-40] The price of meals may also be a deterrent for some students.[41-43] Barnes estimated that for every 1 percent increase in meal price for school breakfast there is a 1.5 percent decrease in participation among students paying full price.[43] School schedules and the time and convenience of accessing school meals may also be a factor in students' decision to participate.[41, 44]

Several studies have also found that participation is associated with certain demographic characteristics—African American students, males, younger students, and students living in rural areas are more likely to participate.[39, 42, 45-47] Stigma has been identified as a particularly important influence on participation rates and may explain some of the differences in participation by race/ethnicity, sex and age.[48] The stigma associated with school breakfast consumption may stem from the perception that only "poor kids" eat school meals.[48]

II.E. Alternative Breakfast Service Models

Realizing the impact that breakfast can have on improving nutrition and academic performance, policymakers and practitioners have implemented a variety of policies and interventions promoting ***alternative breakfast service models*** (universal free breakfast, breakfast in the classroom, grab and go, second chance breakfast, etc.) in order to increase school breakfast participation rates. Universal free breakfast (UFB) programs and policies allow all students regardless of their family income to receive breakfast at school for free. At the national level,

the Healthy Hunger-Free Kids Act of 2010, which sets policy and authorizes funding for the school meals programs, contains a provision -- the Community Eligibility Provision (CEP) -- designed to expand enrollment in the school meal program by allowing high poverty schools to provide free meals to all students (i.e. "universal free breakfasts").[49] High-poverty schools are schools with ≥40 percent students who directly certify for FRP meals through participation in the Supplemental Nutrition Assistance Program (SNAP) or other assistance program.[50] Implementing a universal breakfast strategy may help to reduce the stigma associated with breakfast participation.[51] A conceptual model created for a 3-year pilot study of the effects of a universal free breakfast program depicts the pathways by which a universal breakfast program might affect school and student outcomes (see Figure 1).[52]

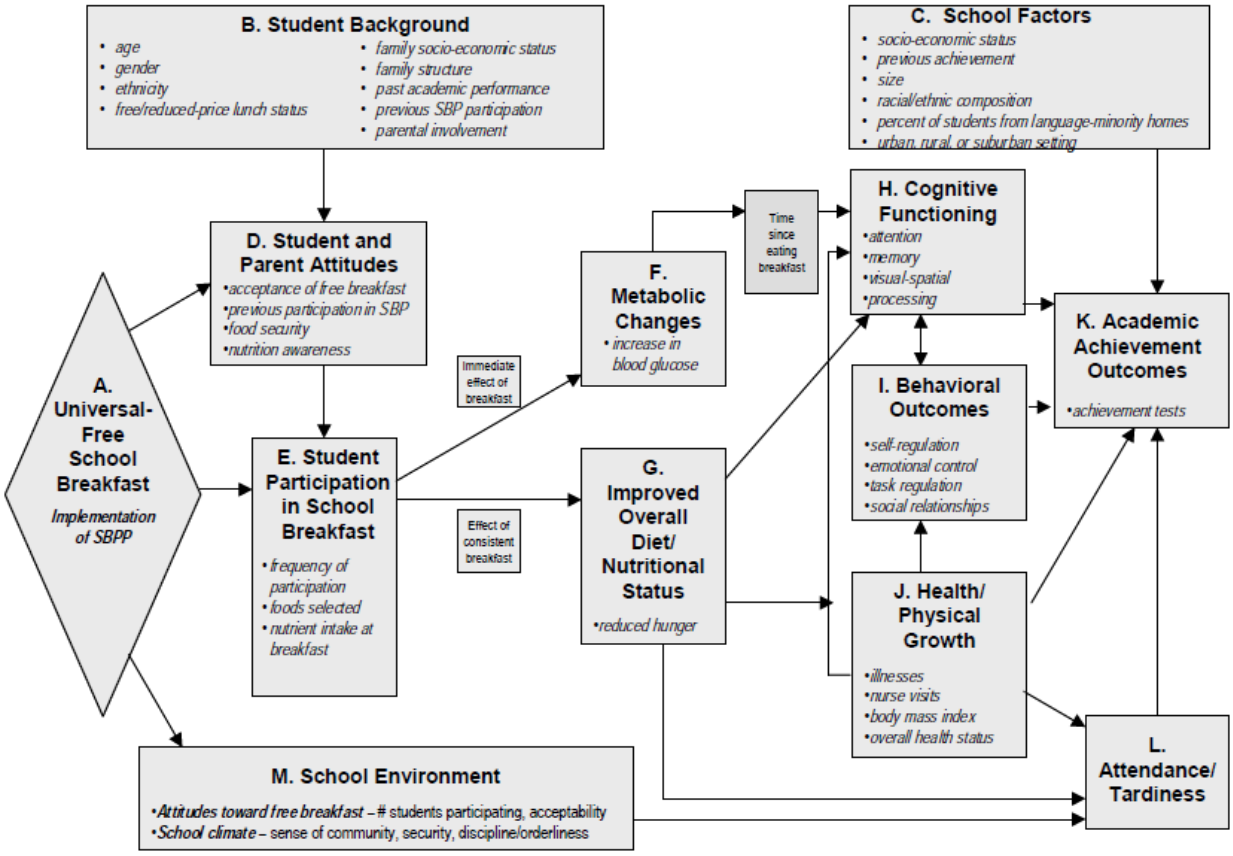

Figure 1. Pathways of universal-free school breakfast to school and student outcomes
Source: Bernstein et al., 2004

Breakfast in the Classroom (BIC) usually involves breakfast being delivered to each classroom at a school and students eating the meal during the first few minutes of class.[53] BIC eliminates the need for students to arrive before the school day begins and go to the cafeteria, where breakfast is traditionally served, to eat their meal. "Grab and go" breakfast also can eliminate the need for to students to arrive early and eat their breakfast in the cafeteria.[53] With grab and go, students pick up pre-packaged meals from kiosks around school or in the cafeteria and can eat their meals on the way to class or at their desks during the first few minutes of school. With second chance breakfast (also known as breakfast after the bell), students can eat breakfast after first period or during a nutrition break either in class or on the way to class, which

also eliminates the need to arrive early to school to eat school breakfast.[53] Some school districts have also offered breakfast on school buses and other innovative alternative models that reduce some of the barriers around breakfast participation.

In addition to CEP at the national level, a number of programs and policies promoting alternative breakfast service models are being implemented on the state and local level. In North Carolina, a series of policy and practice changes were implemented from 2011-2014. These initiatives were designed to improve breakfast participation, in part via alternative breakfast service models to reduce the stigma associated with consuming school meals. In August 2011, the North Carolina State Board of Education passed a *Resolution to Promote School Breakfast* encouraging all school districts to "consider providing breakfast in the classroom during appropriate instructional and educational activities as one of the multiple options for removing barriers."[36] In October 2011, the NC Department of Public Instruction (DPI) introduced the Breakfast is Brain Fuel Toolkit, which included guidance for schools of all grade levels on Breakfast in the Classroom and other alternative service models.[54] Finally, in 2013, No Kid Hungry North Carolina, a public-private partnership working to end childhood hunger, initiated a Breakfast Challenge to incentivize schools to increase breakfast participation. Over 800 schools pledged to participation in the 2013 Challenge (550 elementary, 178 middle, 137 high, and 13 "other" schools). The Challenge was offered again in 2014 and almost 1500 schools pledged to participate (891 elementary, 319 middle, 274 high, and 14 "other" schools).

II.F. Alternative Breakfast Service Model Literature

While there have been a number of studies of the SBP conducted to date, most of them have not focused on the impact of alternative breakfast service models that are currently being

implemented in schools across the country. A review of the alternative breakfast service model peer-reviewed literature is provided in Chapter IV.

CHAPTER III: METHODS

III.A. Study Overview

In order to determine whether alternative breakfast service models are associated with improvements in SBP participation and academic and health outcomes, a review of peer-reviewed research articles was conducted to examine the associations between alternative breakfast service models and student attendance, academic achievement, dietary intake, and weight status. The methods used for this review are presented in Chapter IV.

In addition to the literature review, several analyses were conducted to address the need for a rigorous evaluation of alternative service model school breakfast programs. To evaluate associations between statewide policy and practice changes that encourage implementation of alternative breakfast service models (AIM 1), district-level longitudinal data on breakfast participation rates and student demographics for schools across the state of North Carolina were used. To evaluate the impact of a universal free breakfast policy on breakfast participation, attendance, academic achievement, and student weight status (AIM 2) data collected annually in a large urban school district in the Southeast US (LUSD) at the school and student level were used. Methods used to address AIM 1 are presented below and in Chapter V and methods to address AIM 2 are presented below and in Chapter VI.

III.B. Aim 1. Statewide Policy and Practice Changes

A series of policy and practice changes aimed at improving school breakfast participation through alternative breakfast service models have been adopted in North Carolina in recent years (see Table 1). Beginning in August 2011, the North Carolina State Board of Education passed a *Resolution to Promote School Breakfast* encouraging schools to "consider providing breakfast in the classroom during appropriate instructional and educational activities as one of the multiple options for removing barriers."[36] In October 2011, the NC Department of Public Instruction (NC DPI) introduced the *Breakfast is Brain Fuel Toolkit*, which included guidance for Breakfast in the Classroom and other alternative service models. In 2013, No Kid Hungry North Carolina, a public-private partnership working to end childhood hunger, initiated a Challenge to incentivize schools to increase breakfast participation. The Challenge was offered again in 2014 and several additional schools pledged to participate. Finally, starting in 2014, several schools in North Carolina elected to adopt the Community Eligibility Provision (CEP) from the Healthy Hunger-Free Kids Act of 2010. This provision was designed to expand enrollment in the school meal program by allowing schools in high-poverty areas to provide free meals to all students.[55] However, the extent to which these policy and practice changes have impacted participation in the school breakfast program is not clear.

Table 1. Aim 1 School breakfast timeline of interventions and data availability

	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Breakfast-Related Interventions								
Statewide Resolution Adopted								
Breakfast is Brain Fuel Toolkit Released								
No Kid Hungry Breakfast Challenge (First Round)								
No Kid Hungry Breakfast Challenge (Second Round)								
National Healthy, Hunger-Free Kids Act Community Eligibility Provision Implemented								
Available Data								
District-Level Breakfast Participation Rates (Total, By Year)								
School-Level Breakfast Participation Rates (Total, By Year)								
School and District Student Populations and their Race/Ethnicity (Total)								
District-Level Number of Students Eligible for Free and Reduced Meals								
School-Level Number of Students Eligible for Free and Reduced Meals								
Names of Schools that Participated in 2013 Challenge								
Names of Schools that Participated in 2014 Challenge								
Names of Schools that Adopted CEP								

For this Aim, we used both school-level and district-level longitudinal data to determine whether these policy and practice changes were associated with changes in SBP participation in

districts and schools across the state of North Carolina. These data included student demographic information, which allowed us to explore differences in characteristics in the schools that pledged to participate in the Breakfast Challenges and/or elected to adopt CEP.

III.B.i. Research Questions

1. Is there an increase in breakfast participation at the district level after each policy/practice change is introduced/implemented?
2. If an increase in participation is observed, what district demographic characteristics are associated with this increase?
3. What are the demographic characteristics of schools that pledged to participate in the Breakfast Challenge?
4. Do schools that pledged to participate in the Breakfast Challenge have a greater magnitude of increase in participation rates than schools that do not pledge?
5. Do schools that are eligible for CEP and elect to adopt the provision have a greater magnitude of increase in participation rates than schools that are eligible but have not adopted CEP?

III.B.ii. Hypotheses

1) Modest increases in breakfast participation rates will be observed after the adoption of each of the policy/practice changes.
2) Schools that have pledged to participate in the No Kid Hungry Breakfast Challenge and/or elected to adopt the CEP will have a greater magnitude of increase in participation than schools that have not yet pledged to participate in the Challenge or adopted CEP.

3) Schools where the population has a larger percentage of students of color and elementary schools will have a have a greater magnitude of increase in participation.

III.B.iii. Data Sources and Variables

The data for this aim was provided by NKH NC, NC DPI School Nutrition Services Division, and drawn from publicly available datasets from NC DPI,[56, 57] the National Center for Education Statistics (NCES),[58] United States Department of Agriculture (USDA) (the Rural-Urban Commuting Area (RUCA)[59] codes and Rural-Urban Continuum Codes (RUCC)[60]), and the Center on Budget and Policy Priorities (CBPP) website.[61] Table 2 includes a list of variables that were used for the district-level analyses for this aim, together with the type, sources and definitions of each variable. Table 3 includes a list of variables that were used for the school-level analyses for this aim.

Table 2. Variable definitions for Aim 1–District-level analyses

Variables for District-Level Analyses	Type	Source	Variable Definition
Time-Varying Outcome Variable			
SBP participation	Continuous	NC DPI	Participation= Meals served per year/ (Average Daily Membership for the year x number of days that year that breakfasts were served)
Covariates			
Urbanicity	Categorical	NCES[58] and USDA[60]	Four-levels based on a combination of the urban-centric locale codes from NCES and the county-level RUCC codes from the USDA: town/rural, suburban/town, suburban, or urban
Average percent of students of color	Continuous	NC DPI website[57]	The mean of the percentage of students in the district who were not classified as "white" from school years 2010-11 to 2014-15
Change in percent of students of color	Continuous	NC DPI website[57]	The percent of students of color for 2014-15 minus the percent of students of color for 2010-11
Average percent FRP eligible students	Continuous	NC DPI website[56]	The mean of the percentage of students in the district who were FRP eligible from school years 2010-11 to 2014-15
Change in percent FRP eligible students	Continuous	NC DPI[56]	The percent FRP eligible students for 2014-15 minus the percent FRP eligible students for 2010-11

Table 3. Variable definitions for Aim 1–School-level analyses

Variables for School-Level Analyses	Type		Variable Definition
Time-Varying Outcome Variable			
SBP participation	Continuous	NC DPI	Participation= Meals served per year/ (Average Daily Membership for the year x number of days that year that breakfasts were served)
School Level Variables			
Breakfast Challenge 2013	Binary	NKH NC	Equal to 1 if the school pledged to participate in the Breakfast Challenge in 2013 and equal to 0 otherwise.
Breakfast Challenge 2014	Binary	NKH NC	Equal to 1 if the school pledged to participate in the Breakfast Challenge in 2014 and equal to 0 otherwise.
Community Eligibility Provision (CEP)	Binary	NC DPI[56]	Equal to 1 if the school elected to adopt the CEP in 2014-15 and equal to 0 otherwise.
Eligibility for CEP	Binary	CBPP[61]	Equal to 1 if the school was eligible to participation in CEP in 2014-15 and equal to 0 otherwise.
School grade level	Categorical	NCES[58]	Elementary, middle, high, or other school
Charter school status	Binary	NCES[58]	Equal to 1 if the school is a charter school equal to 0 otherwise.
Urbanicity	Categorical	NCES[58] and USDA[59]	Three-levels based on a combination of the urban-centric locale codes from NCES and the RUCA codes: town/rural, suburban, or urban
Percent of students of color	Continuous	NC DPI website[57]	The percentage of students in the school who were not classified as "white"
Percent of FRP eligible students	Continuous	NC DPI website[56]	The percentage of students in the school who were eligible for free or reduced priced meals.
District Level Variables			
District mean 2013 Breakfast Challenge	Continuous	NKH NC	The percent of schools in a district that pledged to participate in the 2013 Breakfast Challenge.
District mean 2014 Breakfast Challenge	Continuous	NKH NC	The percent of schools in a district that pledged to participate in the 2014 Breakfast Challenge.
District mean CEP	Continuous	NC DPI website[56]	The percent of schools in a district that participated in CEP during the 2014-2015 school-year.
District mean percent students of color	Continuous	NC DPI website[57]	The mean of percent of students of color in schools across a district.
District mean percent FRP	Continuous	NC DPI website[56]	The mean of percent FRP students in schools across a district.

III.B.iv. Statistical Methods to Address Aim 1

For both the district- and school-level analyses, descriptive information was generated for variables of interest and general linear mixed models were estimated using the maximum likelihood method. For the district-level analyses, an empty means model was estimated first to partition the variance in breakfast participation across the two levels. Unconditional growth models (including time only) were then examined. A piecewise or spline model was estimated with four pieces/slopes. For this model, the intercept was at time 0 (the 2007-08 school year) and there were breakpoints after each policy intervention—at time=3 (2011/2012), time=6

(2013/14) and time=7 (2014/15). The piecewise model with four random linear slopes allowed for comparison of slopes before and after the implementation of each of the policy interventions. Conditional growth models including covariates were then examined using the piecewise model as a baseline. The covariates were added one at a time and pseudo-R^2 was calculated to determine the proportion reduction of each variance component accounted for by each predictor. The pseudo- R^2 or proportion reduction in variance was calculated by subtracting the estimated variance from a model with more parameters from the estimated variance from a model with fewer parameters and dividing the result by the estimated variance from the model with fewer parameters. The proportion of explained total outcome variance (total R^2) was also calculated by correlating the outcome predicted based on the fixed effects included in the model with the actual outcome and squaring the result. Figure 2 contains the final conditional regression model equation for the district-level analyses.

Figure 2. Regression model equation for Aim 1 district-level analyses

Final District-Level Conditional Model:

Level 1: $y_{td} = \beta_{0d} + \beta_{1d}$ (Slope03) + β_{2d} (Slope35) + β_{3d} (Slope56) + β_{4d} (Slope67) + e_{td}
Level 2: Intercept: $\beta_{0d} = \gamma_{00} + \gamma_{01}$(Covariate1) +…+ γ_{0X}(CovariateX) + U_{0d}
Slope03: $\beta_{1d} = \gamma_{10} + \gamma_{11}$(Covariate1) +…+ γ_{1X}(CovariateX) + U_{1d}
Slope35: $\beta_{2d} = \gamma_{20} + \gamma_{21}$(Covariate1) +…+ γ_{2X}(CovariateX) + U_{2d}
Slope56: $\beta_{3d} = \gamma_{30} + \gamma_{31}$(Covariate1) +…+ γ_{3X}(CovariateX) + U_{3d}
Slope67: $\beta_{4d} = \gamma_{40} + \gamma_{41}$(Covariate1) +…+ γ_{4X}(CovariateX) + U_{4d}
Covariates= urbanicity, average percent students of color, change in percent students of color, average percent FRP, change in percent FRP

y_{td}= SBP at time t for district d
e_{td}= residual that represents time specific deviation from district's predicted SBP
β_{0d} =intercept for district d
γ_{00}= fixed intercept/predicted mean SBP at time 0 and when covariates=0
γ_{0X} = change in intercept per unit change in CovariateX
U_{0d}= random intercept that represents between district variance in mean breakfast participation at time 0 after controlling for covariates
β_{1d} =slope03 for district d
γ_{10}=fixed linear time slope for time 0 to time 3 when covariates=0/predicted mean rate of change per school year between 2007-08 and 2010-11
γ_{1X}= change in linear time slope03 per unit change in CovariateX (=covariateX*slope03)
U_{1d} =random linear time slope03 after controlling for covariates/district-specific deviation from fixed linear time slope03
β_{2d} =slope35 for district d
γ_{20}= fixed linear time slope for time 3 to time 5 when covariates=0/predicted mean rate of change in SBP per school year between 2010-11 and 2012-13
γ_{2X}= change in linear time slope35 per unit change in CovariateX
U_{2d} = random linear time slope35 after controlling for covariates/district-specific deviation from fixed linear time slope35
B_{3d} =slope56 for district d
γ_{30}= fixed linear time slope for time 5 to time 6 when covariates=0/predicted mean rate of change in SBP per school year between 2012-13 and 2013-14
γ_{3X}= change in linear time slope56 per unit change in CovariateX
U_{3d} = random linear time slope56 after controlling for covariates/district-specific deviation from fixed linear time slope56
B_{4d} =slope67 for district d
γ_{40}= fixed linear time slope for time 6 to time 7 when covariates=0/predicted mean rate of change in SBP per school year between 2013-14 and 2014-15
γ_{4X}= change in linear time slope67 per unit change in CovariateX
U_{4d}= random linear time slope67 after controlling for covariates/district-specific deviation from fixed linear time slope67

For the school-level analyses, given the clustered longitudinal design, three-level general linear mixed models were estimated using maximum likelihood. For these models, level-1 occasions were nested within level-2 schools with in level-3 districts. First empty means models were estimated to partition the variance in breakfast participation across levels. Intraclass

correlation coefficients (ICC) were calculated to determine the proportion of total variance due to schools and districts. Unconditional growth models (including time only) were then examined. A piecewise model with two fixed linear slopes was used to allow for comparison of slopes before and after the implementation of the policy and practice changes. Conditional growth models including predictors were then examined using the piecewise model as a baseline. Predictor and control variables were added one at a time and pseudo-R^2 was calculated to determine the proportion reduction of each variance component accounted for by each predictor. The proportion of explained total outcome variance (total R^2) was also calculated. Conditional growth models were also estimated that included only schools that participated in CEP and schools that were eligible for CEP for the 2014-2015 school year. Figure 3 contains the final conditional regression model equation for the school-level analyses.

Figure 3. Regression model equation for Aim 1 school-level analyses

Final School-Level Conditional Model:

Level 1 Occasions: $y_{tsd} = \beta_{0sd} + \beta_{1sd}(\text{Slope01}) + \beta_{2sd}(\text{Slope12}) + e_{tsd}$

Level 2 Schools:

Intercept: $\beta_{0sd} = \zeta_{00d} + \zeta_{01d}(\text{school-level covariate1}_{sd}) + \ldots + \zeta_{0Xd}(\text{school-level covariateX}_{sd}) + U_{0sd}$

Slope01: $\beta_{1sd} = \zeta_{10d} + \zeta_{11d}(\text{school-level covariate1}_{sd}) + \ldots + \zeta_{1Xd}(\text{school-level covariateX}_{sd})$

Slope12: $\beta_{2sd} = \zeta_{20d} + \zeta_{21d}(\text{school-level covariate1}_{sd}) + \ldots + \zeta_{2Xd}(\text{school-level covariateX}_{sd})$

Level 3 Districts:

Intercept: $\zeta_{00d} = \gamma_{000} + \gamma_{001}(\text{district-level covariate1}_{d}) + \ldots + \gamma_{00X}(\text{district-level covariateX}_{d}) + V_{00d}$

Slope01: $\zeta_{10d} = \gamma_{100} + \gamma_{101}(\text{district-level covariate1}_{d}) + \ldots + \gamma_{10X}(\text{district-level covariateX}_{d})$

Slope12: $\zeta_{20d} = \gamma_{200} + \gamma_{102}(\text{district-level covariate1}_{d}) + \ldots + \gamma_{10X}(\text{district-level covariateX}_{d})$

school-level covariate1: $\zeta_{01d} = \gamma_{010}$

school-level covariate1*Slope01: $\zeta_{11d} = \gamma_{110}$

school-level covariate1 *Slope12: $\zeta_{21d} = \gamma_{210}$

school-level covariateX: $\zeta_{0Xd} = \gamma_{0X0}$

school-level covariateX*Slope01: $\zeta_{1Xd} = \gamma_{1X0}$

school-level covariateX *Slope12: $\zeta_{2Xd} = \gamma_{2X0}$

School-Level Covariates: BC2013, BC2014, CEP, grade level, charter, urbanicity, school percent students of color, and school percent FRP

District-Level Covariates: percent of BC2013 schools in the district, percent of BC2014 schools in the district, percent of CEP schools in the district, district percent students of color, and district percent FRP

y_{tsd}= SBP at time t for school s in district d

e_{tsd}= residual that represents time specific deviation from school's predicted SBP

β_{0sd} =intercept for school s in district d

ζ_{00d}= school fixed intercept/predicted mean SBP for school s at time 0 and when covariates=0

ζ_{0Xd}= change in school intercept per unit change in school covariateX

U_{0sd}= School random intercept/school -specific deviation from district's predicted outcome after controlling for covariates

β_{1sd}=slope01 for school s in district d

ζ_{10d}=school fixed linear time slope for time 0 to time 1 when covariates=0/predicted mean rate of change per school year between 2012-13 and 2013-14

ζ_{1Xd}= change in school linear time slope01 per unit change in school-level covariateX (=school-level covariateX*slope01)

β_{2sd}=slope12 for school s in district d

ζ_{20d}=school fixed linear time slope for time 1 to time 2 when covariates=0/predicted mean rate of change per school year between 2013-14 and 2014-15

ζ_{2Xd}= change in school linear time slope12 per unit change in school-level covariateX (=school-level covariateX*slope12)

γ_{000}= district fixed intercept/predicted mean SBP for districts at time 0 and when covariates=0

γ_{00X}= change in district intercept per unit change in district-level covariateX

V_{00d} = district random intercept/district-specific deviation from fixed intercept after controlling for covariates

γ_{100}= district fixed linear time slope for time 0 to time 1 when covariates=0/predicted mean rate of change per school year between 2012-13 and 2013-14

γ_{101}= change in district linear time slope01 per unit change in district-level covariateX (=district-level covariateX*slope01)

γ_{200}= district fixed linear time slope for time 1 to time 2 when covariates=0/predicted mean rate of change per school year between 2013-14 and 2014-15

γ_{201}= change in district linear time slope12 per unit change in district-level covariateX (=district-level covariateX*slope12)

III.C. Aim 2. District-wide Universal School Breakfast Policy

The LUSD universal free breakfast (UFB) policy was implemented in all schools across the district during the 2013-14 school year. Under this policy, all students in all schools throughout the district could receive free school breakfast. The extent to which the UFB policy increased participation in the breakfast program and lead to improvements in test scores, attendance, and weight status is not clear.

For this Aim, we used school-level longitudinal data to determine whether this policy change was associated with changes in SBP participation, attendance, academic achievement, and student weight status.

III.C.i. Research Questions

1. Is implementation of the policy associated with an increase in breakfast participation at the school level?
2. What school or student characteristics are associated with a greater increase in breakfast participation?
3. Do schools that have a greater increase in participation have a greater improvement in attendance, test scores, and/or student weight status?

III.C.ii. Hypothesis

Students in schools with increases in breakfast participation will have a greater improvement in or be more likely to maintain their levels of attendance, academic achievement, and weight status in the year following the implementation of the policy relative to the year before.

III.C.iii. Data Sources and Variables

III.C.iv. The data for this aim was provided by the LUSD Department of Nutrition Services, LUSD Office of Accountability, the Institute for Social Capital (ISC) at the University of North Carolina at Charlotte, and drawn from publicly available datasets from NC DPI[56, 57] and NCES.[58]

Statistical Methods to Address Aim 2

For the SBP participation analysis, general linear mixed models were estimated using the maximum likelihood method. For this analysis, level-1 occasions were nested within level-2 schools. An empty means model was estimated first to partition the variance in breakfast participation across the two levels. Unconditional growth models (including time only) were then examined. A piecewise/spline model was estimated with two pieces/slopes. The intercept was at time 0 (the 2006-07 school year) and there was a breakpoint and a jump/shift in intercept when the policy was implemented after time 6 (2012/13). The piecewise model with a random intercept, two random linear slopes, and a random jump allowed for comparison of slopes before and after the implementation of the policy and the immediate shift in the intercept after the policy. Conditional growth models including covariates were then examined using the piecewise model as a baseline. Covariates were added one at a time and pseudo-R^2 was calculated to determine the proportion reduction of each variance component accounted for by each predictor. The proportion of explained total outcome variance (total R^2) was also calculated. Figure 4 contains the final conditional regression model equation for the SBP participation analysis.

Table 4 includes a list of variables that were used for this aim and definitions for each of these variables.

III.C.v. Statistical Methods to Address Aim 2

For the SBP participation analysis, general linear mixed models were estimated using the maximum likelihood method. For this analysis, level-1 occasions were nested within level-2 schools. An empty means model was estimated first to partition the variance in breakfast participation across the two levels. Unconditional growth models (including time only) were then examined. A piecewise/spline model was estimated with two pieces/slopes. The intercept was at time 0 (the 2006-07 school year) and there was a breakpoint and a jump/shift in intercept when the policy was implemented after time 6 (2012/13). The piecewise model with a random intercept, two random linear slopes, and a random jump allowed for comparison of slopes before and after the implementation of the policy and the immediate shift in the intercept after the policy. Conditional growth models including covariates were then examined using the piecewise model as a baseline. Covariates were added one at a time and pseudo-R^2 was calculated to determine the proportion reduction of each variance component accounted for by each predictor. The proportion of explained total outcome variance (total R^2) was also calculated. Figure 4 contains the final conditional regression model equation for the SBP participation analysis.

Table 4. Variable definitions for AIM 2

Variable	Type	Source	Definition
Outcome Variables			
SBP participation	Continuous	LUSD	Meals served per year/ (Average Daily Membership for the year x number of days that year that breakfasts were served)
Change in attendance	Continuous	ISC	Change in Attendance= Attendance 2014-Attendance 2013 Attendance= (1-(total number of student absences/total number of days in membership) *100
Change in unexcused absences	Continuous	ISC	Change in Unexcused Absences= Unexcused 2014- Unexcused 2013 Unexcused Absences= (total number of unexcused absences/total number of absences) *100
Change in days tardy	Continuous	ISC	Change in Days Tardy= Days Tardy 2014- Days Tardy 2013 Days Tardy= (total number of days tardy/ total number of days in membership) *100
Change in test scores (EOG/EOC)—All subjects	Continuous	NC DPI	Change in All Test Scores=All Test Scores 2014- All Test Scores 2013 All Subjects Test Scores= percent of students who scored at or above grade-level proficiency (an achievement level of 3 or above)
Change in test scores (EOG/EOC)—Math	Continuous	NC DPI	Change in Math Test Scores=Math Test Scores 2014- Math Test Scores 2013 Math Test Scores= percent of students who scored at or above grade-level proficiency (an achievement level of 3 or above)
Change in Test Scores (EOG/EOC)—Reading	Continuous	NC DPI	Change in Reading Test Scores=Reading Test Scores 2014- Reading Test Scores 2013 Reading Test Scores= percent of students who scored at or above grade-level proficiency (an achievement level of 3 or above)
Change in student weight status	Continuous	LUSD	Change in Student Weight Status= Percent of Overweight and Obese Students 2014- Percent of Overweight and Obese Students 2013 Percent of Overweight and Obese Students= (Number of Students with BMI-for-age greater than or equal to the 85th percentile/total number of students) *100
Covariates			
School grade level	Categorical	NCES[58]	Elementary, middle, high, or other school (K-8, K-12, 6-12, 9)
Percent of students of color	Categorical	NC DPI website[57]	The percentage of students in the school who were not classified as "white" was categorized into three-levels: low is equal to or less than 30%, medium is equal to or greater than 30% and less than 70%, and high is equal to 70% or greater
Change in percent of students of color	Continuous	NC DPI website[57]	The percent of students of color for 2013-14 minus the percent of students of color for 2012-13
Percent of FRP eligible students	Categorical	NC DPI website[56]	The percentage of students in the school who were eligible for free or reduced priced meals was categorized into three-levels: low is equal to or less than 30%, medium is equal to or greater than 30% and less than 70%, and high is equal to 70% or greater
Change in percent FRP eligible students	Continuous	NC DPI[56]	The percent FRP eligible students for 2013-14 minus the percent FRP eligible students for 2012-13
Change in breakfast participation	Continuous	LUSD	The percent SBP participation for 2013-14 minus the percent SBP participation for 2012-13

Figure 4. Regression model equation for Aim 2 SBP participation analyses

Final Conditional Model:

Level 1: $y_{ts} = \beta_{0s} + \beta_{1s}$ (Slope06) + β_{2s} (Jump) + β_{3s} (Slope68) + e_{ts}
Level 2: Intercept: $\beta_{0s} = \gamma_{00} + \gamma_{01}$(Covariate1) +…+ γ_{0X}(CovariateX) + U_{0s}
Slope06: $\beta_{1s} = \gamma_{10} + \gamma_{11}$(Covariate1) +…+ γ_{1X}(CovariateX) + U_{1s}
Jump: $\beta_{2s} = \gamma_{20} + \gamma_{21}$(Covariate1) +…+ γ_{2X}(CovariateX) + U_{2s}
Slope68: $\beta_{3s} = \gamma_{30} + \gamma_{31}$(Covariate1) +…+ γ_{3X}(CovariateX) + U_{3s}
Covariates= school level, percent students of color, change in percent students of color, percent FRP, change in percent FRP

y_{ts}= SBP at time t for school s
e_{ts}= residual that represents time specific deviation from school's predicted SBP
β_{0s} =intercept for school s
γ_{00}= fixed intercept/predicted mean SBP at time 0 and when covariates=0
γ_{0X} = change in intercept per unit change in CovariateX
U_{0s}= random intercept that represents between school variance in mean breakfast participation at time 0 after controlling for covariates
β_{1s} =slope06 for school s
γ_{10}=fixed linear time slope for time 0 to time 6 when covariates=0/predicted mean rate of change per school year between 2006-07 and 2012-13
γ_{1X}= change in linear time slope06 per unit change in CovariateX (=covariateX*slope06)
U_{1s} =random linear time slope06 after controlling for covariates/school-specific deviation from fixed linear time slope06
β_{2s} =jump for school s
γ_{20}= fixed shift in intercept/jump after time 6 when covariates=0/predicted mean shift in intercept/jump after policy implementation
γ_{2X}= change in jump per unit change in CovariateX
U_{2s} = random shift in intercept/jump after time 6 after controlling for covariates/school-specific deviation from jump
B_{3s} =slope68 for school s
γ_{30}= fixed linear time slope for time 6 to time 8 when covariates=0/predicted mean rate of change in SBP per school year between 2012-13 and 2014-15
γ_{3X}= change in linear time slope68 per unit change in CovariateX
U_{3s} = random linear time slope68 after controlling for covariates/school-specific deviation from fixed linear time slope68

General linear models were estimated to determine associations between changes in breakfast participation and changes in school-level attendance, test scores, and percent overweight and obese students. Figure 5 contains the final conditional regression model equation for the change in test scores, attendance and student weight status analyses.

Figure 5. Regression model equation for Aim 2 change in test scores, attendance and student weight status

Final Conditional Model:

$\Delta Test_s = \beta_0 + \beta_1 \Delta BR + \ldots + \beta_x CovariateX + \varepsilon_s$
Covariates= school level, percent students of color, change in percent students of color, percent FRP, change in percent FRP, and school breakfast participation for 2012-13

$\Delta Test_s$= change in test scores between 2012-13 and 2013-14 (the percent of students who scored at or above grade-level proficiency in 2013-14 minus the percent of students who scored at or above grade-level proficiency average test scores in 2012-13) in school s
β_0= value of the outcome when all covariates=0
β_1= change in the outcome per unit change in breakfast participation between 2012-13 and 2013-14
β_x= change in the outcome per unit change in CovariateX
ε = the error term

*Similar models were used for other outcomes, such as attendance, and student weight status

CHAPTER IV: THE INFLUENCE OF ALTERNATIVE BREAKFAST SERVICE MODELS ON SCHOOL BREAKFAST PARTICIPATION, ATTENDANCE, ACADEMIC ACHIEVEMENT, DIETARY INTAKE AND WEIGHT STATUS: A REVIEW OF THE LITERATURE

IV.A. Introduction

Breakfast has been identified as the most important meal of the day, and the effect of breakfast consumption among children and adolescents has been the focus of numerous studies over the past several decades. Researchers have examined the associations between breakfast consumption and cognition, behavior, nutrient intake, and weight status. While some findings have been mixed, studies overall suggest that consumption of breakfast among children may lead to improved nutrient profiles, better weight status, and improved cognitive function and behavior.[1-5] Despite the reported benefits of breakfast, there has been a striking decrease in breakfast consumption among children and adolescents over the last several decades.[7, 8] In 1965, 5% of children and 12% of adolescents in the United States skipped breakfast regularly compared to 20% of children and 32% of adolescents in the late 1990s and early 2000s.[7, 8] Given the benefits associated with breakfast, increasing breakfast consumption may be a worthwhile endeavor.

The National School Breakfast Program (SBP) was created in the late 1960s to help ensure that school-aged children, and low-income children in particular, have access to a meal to start the school day.[10] While participation has increased since its inception, use of the program is still low in comparison to the National School Lunch Program (NSLP).[36] At the national level,

52 low-income children participated in school breakfast for every 100 that participated in school lunch.[36] As a result, there have been calls by non-profits and government entities for schools to implement alternative breakfast service models in an effort to increase participation in the SBP and perhaps improve student health and academic outcomes. In contrast to the traditional breakfast service model, which involves serving breakfast in the school cafeteria prior to the start of the school day, alternative breakfast service models are designed to promote breakfast participation by reducing barriers that are associated with traditional service breakfast. These barriers include, but are not limited to, the price of breakfast for students who do not qualify for free meals,[41-43] school schedules and the time and convenience of accessing school meals,[41, 44] and stigma associated with school breakfast consumption, which may stem from perception that only "poor kids" eat school meals.[48]

Among the alternative breakfast service models that have been implemented in the past are universal free breakfast (UFB) programs, breakfast in the classroom (BIC), "grab and go" breakfast, and second chance breakfast or breakfast after the bell. UFB programs allow all students regardless of their family income to receive breakfast at school for free and may help to reduce the stigma associated with breakfast participation.[51] BIC programs usually involve breakfast being delivered to each classroom at a school and students eating the meal during the first few minutes of class.[53] BIC eliminates the need for students to arrive before the school day begins and go to the cafeteria, to eat their meal. Grab and go breakfast also can eliminate the need for students to arrive early and eat their meal in the cafeteria.[53] With grab and go, students pick up pre-packaged meals from kiosks around school or in the cafeteria and can eat their meals on the way to class or at their desks during the first few minutes of school. With second chance breakfast (also known as breakfast after the bell), students can eat breakfast after first period or

during a nutrition break either in class or on the way to class, which also eliminates the need to arrive early to school to eat school breakfast.[53]

Alternative breakfast service models have been implemented in schools and districts across the United States and in other countries. Some of these programs have been either informally or formally evaluated and in some cases more rigorous studies of these models have been conducted. However, there can be financial costs and administrative burdens associated with the implementation of these models, and questions remain about whether these service models do indeed result in improvements in breakfast program participation and improvements in student attendance, academic achievement, nutrient intake, and weight status. To our knowledge there has not been a review of the alternative breakfast service model peer-reviewed literature to summarize the evidence to date and identify gaps in knowledge. Murphy summarized findings from several universal free breakfast programs conducted prior to 2004 in a section of a larger review of breakfast and learning,[62] but this review did not include other alternative breakfast service models and does not include more recent studies. Thus, this review seeks to examine the associations between alternative breakfast service model programs and breakfast program participation, student attendance, academic achievement, nutrient or dietary intake, and weight status. Information gathered from this review may inform the development and implementation of these programs and policies and future research needs.

IV.B. Methods

IV.B.i. Search strategy and search terms

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[63] Several databases were

searched including PubMed, Embase, EBSCO, ProQuest, Web of Science and Scopus. Exact search terms used for each of the databases are provided in Appendix 1. Reference lists of existing articles were also reviewed to supplement the database searches. All search results were imported into Covidence Online Software (Vertitas Health Innovation Ltd, Melbourne, Australia) for review and analysis.

IV.B.ii. Inclusion and exclusion criteria

This review was limited to peer-reviewed journal articles published in English prior to May of 2017. Only studies that are quantitative and focused on alternative breakfast service models in elementary, middle, and/or high schools were included. Alternative breakfast service models included the provision of free breakfast to all students regardless of family income (i.e., universal free breakfast), breakfast in the classroom, grab and go breakfast, and second chance breakfast or breakfast after the bell. Included studies must focus on the relationship between alternative breakfast service models and one or more of the following outcomes: 1) participation in the school breakfast program, 2) attendance (days present at school and/or days tardy), 3) academic achievement (test scores, grades, or other student measures of academic performance), 4) nutrient intake (macro and/or micro nutrient intake and/or calorie consumption), or 5) weight status. Table 5 presents the inclusion and exclusion criteria for this review.

Table 5. Inclusion and exclusion criteria for alternative breakfast service model literature review

Inclusion Criteria	**Exclusion Criteria**
Published in English	Not published in English
Peer-reviewed article published in scientific literature	Publications that were not peer reviewed and published in scientific literature. Reviews of previous studies or conference abstracts
Quantitative study	Qualitative or nonscientific study

Age range of interest is K-12	Preschool, daycare or college breakfast program
Focuses on alternative breakfast service model in a school setting (universal free breakfast/free breakfast for all, breakfast in the classroom, second chance breakfast/ breakfast after the bell, grab and go)	Laboratory study or only focuses traditional service breakfast (free, reduced price, and full price breakfast in the cafeteria before school starts)
Outcome of interest is academic achievement, attendance, BMI/weight status, nutrient/dietary intake, or school breakfast program participation	Outcome of interest is not academic achievement, attendance, BMI/weight status, nutrient/dietary intake, or school breakfast program participation

IV.B.iii. Study Selection Process and Data Extraction

Figure 6 presents a flow diagram of the study selection process. The titles and abstracts of articles found through the search process were reviewed independently by two reviewers and included or excluded based on the criteria presented in Table 5. If any uncertainty existed, the article was included and the full text examined. The full text of all the articles that were selected for inclusion during the title and abstract review were then reviewed by the two reviewers for their relevance to the topic. For articles that met the inclusion criteria, the reviewers then independently extracted the following data: study design, type(s) of alternative breakfast service models studied, study sample or participants, the type of intervention or the procedure used in the study, and study outcome(s). A summary of each study included is presented in Appendix 2. Any discrepancies were discussed and most differences were due to simple oversight or differences in interpretation of the study design or outcomes.

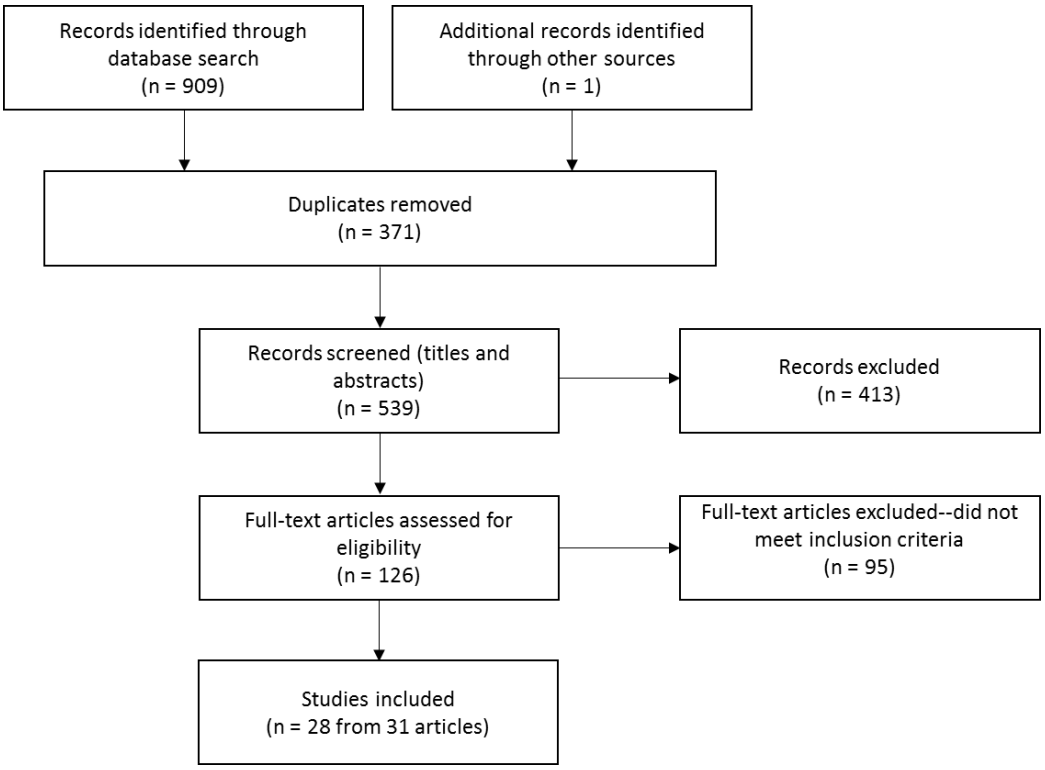

Figure 6. Flow diagram of the study selection process.

IV.C. Results

IV.C.i. Summary of Studies

Thirty-one journal articles met the inclusion criteria for the study. All articles were published between February of 1976 and May of 2017 (Figure 7), with the majority of articles published between 2010 and 2016. Three articles[64-66] presented different outcomes from one cluster randomized study and two articles[33, 67] presented different outcomes from one cross-sectional study. Thus, there were a total of 28 unique studies identified that met the inclusion criteria.

Some of the studies examined more than one type of alternative breakfast service model,[41, 68, 69] but most examined only one type of model. Nineteen articles analyzed universal free breakfast programs or policies,[64-66, 70-85] nine articles analyzed breakfast in the classroom,[33,

[44, 69, 86-90] three articles analyzed grab and go breakfast,[41, 68, 91] and three articles analyzed second chance breakfast or breakfast after the bell.[41, 68, 69] Of the 28 unique studies, eighteen focused elementary or primary schools or students,[33, 44, 64-67, 69, 71, 72, 74-77, 80, 81, 83-86, 89, 90] three on middle schools,[68, 73, 91] four on high schools or secondary schools,[41, 70, 78, 87] and three had mixed grade/school samples (all grades[88] or third to eighth grade[79, 92]). Overall, the majority of the studies (22) were conducted in the United States and six were conducted in other countries, including Canada,[78] Jamaica,[83] New Zealand,[81] Norway,[70] Peru,[72] and the United Kingdom.[64-66] Of the studies conducted in the US, seven were in the Northeast,[74, 76, 77, 79, 82, 88, 90] two in the Southeast,[33, 67, 84] four in the Midwest,[41, 68, 75, 85] two in the Southwest,[73, 89] three in the West,[69, 80, 87] two included schools from across the US,[44, 71] and two[86, 91] did not disclose the location of the study within the US.

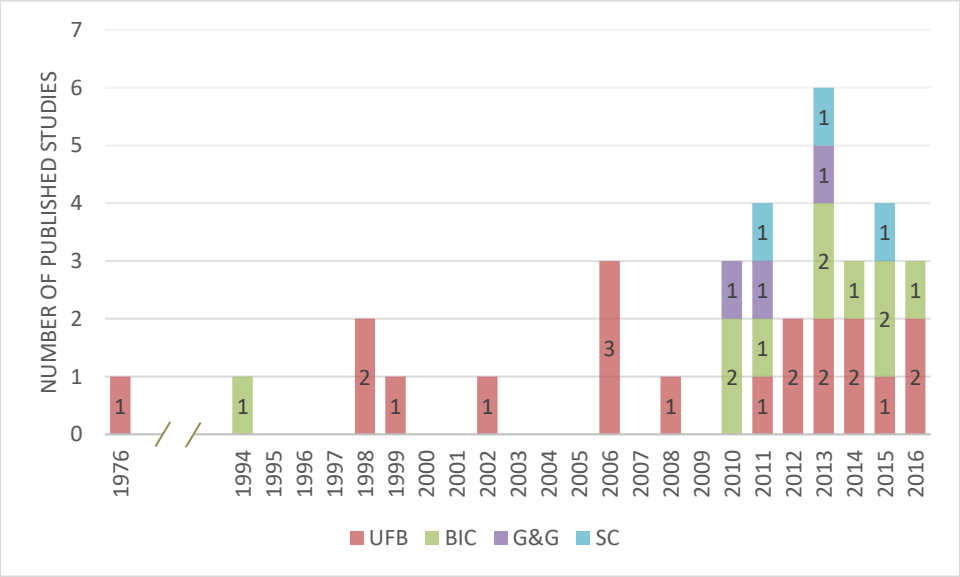

Figure 7. Publication Year of Included Articles by Alternative Breakfast Service Model
Note: Some articles included more than one alternative service breakfast model and some articles reported on different outcomes for the same study.
UFB=universal free breakfast, BIC=breakfast in the classroom, G&G=grab and go, and SC=second chance breakfast

IV.C.ii. Study Designs

Of the 28 studies, 12 were intervention studies and 16 were observational studies. For all of the intervention studies, the researchers were involved in the allocation of the alternative breakfast service model intervention. Four of these intervention studies included cluster randomized control studies,[64-66, 70, 71, 81] where researchers randomized schools or classes to serve as either intervention groups or comparison groups. The sample size for these studies ranged from two classes to 153 schools and one of the studies was a step-wedge randomized study, where all schools eventually received the intervention.[81] Another intervention study was a randomized control study where students were randomized to receive free breakfast or a placebo.[83] There were four quasi-experimental studies that included non-randomized intervention and comparison schools.[72, 73, 80, 85] Three studies were pre-post intervention studies where all schools in the study received the intervention and comparisons were made before and after the study.[41, 68, 91] Finally, one intervention study had a crossover design where one class of students received the intervention twice and served as their own controls.[87]

Of the 16 studies that were observational studies, eight studies were natural experiments where researchers studied the implementation of an alternative breakfast service model programs or policies by comparing schools that had implemented the model to schools that had not over time.[75, 78, 79, 84-86, 88, 89] Several of these studies used difference-in-difference regression models for their statistical analyses in an attempt to simulate an experimental research study and draw casual inferences. Two observational studies were natural experiments where researchers compared outcomes before and after implementation of a new alternative breakfast service model in the same schools and did not have comparison schools.[76, 92] Lastly, six studies were

cross-sectional studies that examined associations between alternative breakfast service models and certain outcomes at a single point in time.[33, 44, 67, 69, 74, 77, 90]

IV.C.iii. Outcomes of Interest

Table 6 provides a summary of findings for each outcome by alternative breakfast service model and study design. The sections below further describe each of the studies by outcome.

Table 6. Summary of findings by alternative breakfast service model and study design.

Alternative Breakfast Service Model Focus	**Number of Studies Reporting Positive (P), Negative (N), Mixed (M), and Neutral or Non-Significant (NS) results**				
	BP Participation (n = 21)	Attendance (n = 14)	Academic Achievement (n = 15)	Nutrient or Dietary Intake (n = 13)	BMI or Weight Status (n = 6)
Randomized intervention					
UFB	P: 3[65, 71, 81]	P: 1[83] M: 1[81] NS: 1[70]	M: 1[83] NS: 3[65, 70, 81]	P: 2[70, 83] M: 2[65, 71] NS: 1[81]	P: 1[83] M: 1[70] NS: 1[71]
Quasi-experimental					
UFB	P: 3[72, 73, 80]	P: 1[72] NS: 1[80]	M: 1[72] NS: 1[80]	NS: 1[80]	NS: 1[80]
Pre-post					
GG & SC	P: 2[41, 68]	NA	NA	NA	NA
GG	P: 1[91]	NA	NA	NA	NA
Crossover					
BIC	NA	NS: 1[87]	NA	NA	NA
Natural experiment with comparison					
UFB	P: 4[75, 79, 84, 85] M: 1[78]	P: 1[75] N: 1[84] M: 1[79]	P: 1[85] M: 1[84] NS: 2[75, 79]	M: 1[78]	NA
BIC	P: 3[86, 88, 89]	P: 1[86] NS:2[88, 89]	M: 1[89] NS: 2[86, 88]	NA	NS: 1[88]
Natural experiment without comparison					
UFB	P: 1[92]	P: 2[76, 92]	P: 1[76] M: 1[92]	M: 1[76]	NA
Cross-Sectional					
UFB	NS: 1[74]	NA	NA	NS: 2[74, 77]	NA
BIC	P: 2[44, 67]	NA	NA	P: 1[69] N: 1[33] M: 1[90]	N: 1[33]

Abbreviations: BP, Breakfast Program; BMI, body mass index; UFB, Universal Free Breakfast; BIC, Breakfast in the Classroom; SC, Second Chance Breakfast; GG, Grab and Go Breakfast; NA, not applicable.

School Breakfast Program Participation

Of the 21 studies that included breakfast program participation as an outcome, 19 found either an increase in breakfast program participation resulting from an alternative breakfast service model intervention or a positive association between alternative breakfast service models and participation (see Table 6).

A stepped-wedge, cluster randomized controlled study in New Zealand[81] and a cluster randomized study in the UK[65] that both examined the effect of a UFB intervention on breakfast program participation found an increase in students consuming breakfast at school. However, in both studies, the increase in breakfast participation in school resulted at least in part from a shift in eating breakfast at home to eating breakfast at school.

Quasi-experimental studies and natural experiments that have examined relationships between UFB programs and participation have also found increases in school breakfast participation. A study of a UFB program in five middle schools located in a school district in the Houston, TX found that the average SBP participation rate increased from approximately 17% to 59% among three intervention schools and from approximately 28% to 35% for comparison schools.[73] When three elementary schools located in a district in the Midwest implemented a UFB program, the SBP participation rate increased approximately 20 to 50 percentage points while SBP participation rates remain relatively stable among three comparison schools.[75] In a study of a UFB program among third to eighth grade students in New York City schools, SBP participation increased among students of all income levels (those eligible for free, reduced, and full price meals) at UFB schools in the year after implementation.[79] A study of the implementation of a UFB program in one public school in Philadelphia, PA (grades K-6) and

two public schools in Baltimore, MD (grades K-8) found breakfast participation nearly doubled.[92] A study of the switch from a UFB program to a traditional program in elementary schools in Guilford County School District in North Carolina found UFB was associated with a 12% to16% increase in SBP participation.[84] Prior to a UFB program implemented in four elementary schools in Minnesota, the average SBP participation rate was approximately 13%.[85] After UFB implementation, the average participation rate for UFB schools was between approximately 75% and 98% in year one, 75% and 92% in year two, and 69% to 94% in year three.[85]

One natural experiment conducted in secondary schools Ontario, Canada found mixed results.[78] In this study, two schools increased the number of days of UFB availability from four to five and one school increased the days available from three to five. Another school switched from traditional breakfast to UFB five days a week and a fifth school changed from UFB two days a week to no UFB. The school that switched from three days of UFB to five had an increase of 16.5% in the prevalence of students participating in breakfast on one or more days a week. Participation for the other schools did not change relative to comparison schools.

The one cross-sectional study of a UFB program in a school district in the Northeast US found that fourth and sixth grade students participated in the SBP on approximately 31% of the days they attended school, but researchers did not compare participation rates to schools that did not have UFB.[74]

Three natural experiments that examined associations between BIC and SBP participation all found positive assoications.[86, 88, 89] The average participation rate among 257 elementary schools in a large urban district in the US with a BIC program was approximately 74% compared to an average participation rate of roughly 43% in among 189 schools in the district that served

traditional breakfast.[86] Participation at 33 elementary schools in a large urban school district in the Southwest US that implemented BIC increased between 40 and 50 percentage points.[89] Participation also increased an average of approximately 30 percentage points in New York City elementary and middle schools that had implemented schoolwide BIC.[88] Two cross-sectional BIC studies also found positive associations between BIC and SBP participation.[44, 67] A study that included a nationally representative sample of 6,680 third grade public school students found the probability of participating in the SBP was positively associated with BIC (odds ratio=2.35, $p<0.01$).[44] A study including 18 elementary schools from one district in South Carolina found SBP participation was lower for schools with traditional breakfast (38%) vs. those with BIC (71%).[67]

Finally, there were a few pre-post intervention studies that examined associations between grab and go breakfast and second chance breakfast or breakfast after the bell and SBP participation. In one study in a Midwestern middle school and another in a Midwestern high school researchers implemented combined grab and go and second chance breakfast interventions.[41, 68] The middle school study found that among sixth graders, SBP participation increased from an average of 0.74 days per week to 1.21 days per week at the end of the six-week intervention.[68] At the high school, the number of breakfasts served tripled after implementation of the intervention.[41] After a two-week grab and go pilot program was implemented in one US middle school, almost two-thirds of surveyed students reported participating in grab and go and nearly half of surveyed students who reported rarely eating breakfast prior to the intervention had participated in grab and go.[91]

Attendance

Six of the fourteen studies that included attendance as an outcome found positive effects of or positive associations with alternative breakfast service models and school attendance. One study found negative results, two studies found increases in attendance for some subgroups and not others, and five studies found non-significant or neutral results. All of these studies focused on either UFB or BIC.

One randomized control trial of undernourished and nourished second through fifth grade students from 16 rural Jamaican schools found small but significant improvements in attendance among students who received free breakfast relative to those who did not.[83] A small cluster randomized controlled study among high school classes in Norway found no significant effect of UFB on attendance during the four month intervention.[70] A stepped-wedge, cluster randomized controlled trial of a UFB intervention in New Zealand found no significant effect of the UFB intervention on attendance overall, but students who participated in the UFB more frequently were significantly more likely to achieve an attendance rate greater that 95%.[81]

Results of quasi-experimental and natural experiments that included attendance were also mixed. A quasi-experimental study in Peru found an increase in monthly attendance from 90% to 95% for UFB schools compared to 80% to 87% in non-UFB schools.[72] Another quasi-experimental study in Los Angeles found no significant difference in attendance between an intervention school and a comparison school. Attendance at three intervention schools in the St. Joseph School District in Missouri increased significantly from approximately 91% prior to the implementation of a UFB program to 94% after implementation.[75] Students who improved their nutritional intake after the start of a UFB program in three Boston elementary schools decreased the number of days they were absent.[76] After the implementation of UFB program in two

Philadelphia elementary schools and one Baltimore elementary school, students who participated rarely in the SBP were absent and tardy more often than students who participated sometimes or often.[92] In addition, students who increased their SBP participation were significantly less likely to be absent or tardy than those who maintained or decreased their participation. Leos-Urbel et al. found an increase in attendance in New York City schools among only a few student populations after the implementation of a UFB program.[79] These researchers found there were small, significant increases in attendance for black students eligible for free meals and Asian students not eligible for free meals. In contrast, among schools in the Guilford School District in North Carolina that changed from UFB back to a traditional breakfast program, there was actually a small increase in attendance equivalent to about 1 day more present per year.[84]

Only four studies that focused on BIC programs included attendance as an outcome. After the implementation of a BIC program in a large urban school district in the US, researchers found a small but significant main effect for attendance.[86] Grade-level attendance rates for BIC schools (95.5%) were slightly higher than non-BIC schools (95.3%). The other three studies found no significant associations between BIC and attendance.[87-89]

Academic Achievement

Only two of the fifteen studies that included academic achievement as an outcome show positive associations between alternative breakfast service models and achievement. Five studies found mixed results, and eight studies found non-significant or neutral results. Measures of academic performance included self-reported time spend on homework, reading, writing and numeracy tests, episodic memory tests, standardized math and reading tests, and course grades. The majority of these studies focused on UFB programs and only three focused on BIC.

Among the randomized control studies, Powell et al. found a significant benefit of the UFB intervention on math scores, but not in spelling or reading scores among second through fifth grade children from 16 rural Jamaican schools.[83] Norwegian secondary school students did not report any significant increase in school performance as measured by time spent doing homework following the implementation of a UFB cluster randomized study.[70] There was no significant effects of a UFB intervention on academic achievement as measured by reading, writing and numeracy tests among primary school students that participated in a cluster randomized study in New Zealand.[81] There were also no significant differences in cognitive performance as measured by episodic memory tests among students from intervention and comparison schools in a cluster randomized study in the UK.[65]

Among natural experiments focused on UFB programs, Ribar et al. found no evidence that UFB is associated with math or reading test scores, but did find a positive association between UFB and science test proficiency among economically disadvantaged children only.[84] Wahlstrom et al. found an increase in test scores between when students were in third grade (prior to UFB implementation) and when the same students were in sixth grade (year three of UFB).[85]

Among BIC studies that included academic achievement as an outcome, there were three natural experiments. On average there was an increase of 0.09 standard deviations in math scores and 0.06 standard deviations in reading scores associated with BIC among students from a large urban school district in the Southwest US.[89] However researchers did not find a significant impact of BIC on grades. A study of BIC schools in New York City found no significant improvements in academic achievement as measured by reading and math scores on state tests.[88] Similarly, no significant differences were found on the percentages of students who achieved

state benchmarks on standardized tests for math and reading among BIC and non-BIC schools in a large urban district in the US.[86]

Dietary or Nutrient Intake

Of the thirteen studies that included nutrient or dietary intake as an outcome, three found positive results, five found mixed results, one found negative results, and four found non-significant results. Only three of these studies focused on BIC and the rest focused on UFB.

Among the randomized control studies that focus on UFB, students from intervention schools in a UK study consumed significantly more healthy items at breakfast than students from control schools, but there were no differences in healthy or unhealthy items consumed during the rest of the day.[64-66] Researchers also found that deprivation among students was associated with higher levels of breakfast skipping, consumption of unhealth items, and fewer fruits and vegetables, but as a result of the UFB program breakfast skipping was reduced among children from more deprived schools and students from deprived households.[66] Crepinsek et al. found no significant difference in breakfast consumption between intervention and comparison students (four percent skipped) in a study in the US.[71] In addition, students eating two breakfasts had higher daily energy intakes than students eating one. However, intervention students were significantly more likely to eat a substantive breakfast than students at comparison schools and calcium, magnesium, and phosphorus intakes at breakfast were higher among intervention students. Cholesterol intake was lower for intervention students at breakfast and over a 24-hour period. Before a UFB intervention in Norway, 54% of intervention students and 43% of comparison students had breakfast each day.[70] During the UFB intervention, most intervention students had breakfast, but after the intervention students went back to their pre-intervention

habits. However, intervention males increased their healthy eating index significantly during the intervention. In another study, intervention students receiving free breakfast in schools in Jamaica consumed fewer calories at lunchtime, but had an overall net increase in calories consumed over the day.[83] In the case of this study, some of the Jamaican students were undernourished, so the increase in calories represented an improvement in nutrient intake.

A natural experiment in three schools in Boston found that prior to the UFB program, 29% of students had two or more nutrient intakes ≤50% of the recommended dietary allowance (RDA).[76] In addition, students who rarely ate school breakfast were more likely to be nutritionally at risk than students who ate school breakfast sometimes or often. After the implementation of the UFB program, 19% of students improved their nutrition, 64% did not change, and 18% got worse. Among five intervention schools in a natural experiment in Ontario Canada, only one school had a significant decrease in breakfast skipping relative to the comparison schools.[78] This school had started a new UFB program, and the prevalence of students skipping breakfast at least once per week decrease by approximately 15% after program implementation. A study of a UFB intervention in Los Angeles was not able to demonstrate that the breakfast program provided improved daily nutrient intake.[80]

A cross-sectional study in Philadelphia found that after UFB implementation, approximately 50% of students ate one breakfast, 40% consumed multiple breakfasts, and 12% skipped breakfast the morning of the survey.[77] Additionally, sixth graders had lower odds of eating breakfast than fourth and fifth graders. Obese students consumed fewer breakfasts than healthy weight students and were more likely to report not eating breakfast than overweight and health weight students.

There were three cross-sectional studies of BIC that had nutrient or dietary intake as an outcome. Van Wye et al. found that students in BIC classrooms in New York City were less likely to skip breakfast than comparison classes (8.7% vs 15.0%, P< .001).[90] However, approximately 45% of BIC students consumed breakfast in the classroom and at least one other location. Students in BIC classrooms also consumed an estimated average of 95 calories more than student in comparison classrooms and students actually consuming BIC consumed 151 more calories than students eating in other locations. Similarly, based observations, Baxter et al. estimated that fourth grade students in a district in South Carolina consumed significantly more calories in BIC (276 calories) than in the cafeteria (250 calories; p = 0.017). Conversely, a cross-sectional study conducted in San Diego schools found no significant differences in mean daily calorie intake between BIC students and students at schools with a traditional breakfast program.[69] In addition, BIC students had higher diet quality, as quantified using the Healthy Eating Index-2010. BIC students also consumed more total fruit, whole fruit and fewer empty calories than other students.

Weight Status

Only six studies included student weight status or BMI as an outcome. Of these six studies, one found positive results, one found mixed results, one found negative results, and three found non-significant or neutral results. Two of the studies focused on BIC and the rest focused on UFB.

Three randomized control studies of UFB interventions included weight or BMI as an outcome. Heights and weights increased more among intervention than comparison students in a UFB study in Jamaica.[83] As previously mentioned, some of the Jamaican students were

undernourished, so increases for these students indicated an improvement in nutrient intake and weight status. Prior to a UFB intervention among Norwegian secondary students, there were no significant differences in weight and BMI.[70] After the four-month intervention, weight and BMI increased significantly in males and females in the comparison class. There was also a significant increase in weight among intervention males, but not among intervention females. There was not significant change in BMI in the intervention group. There were no significant differences in BMI or the percentage of students who were overweight in intervention and comparison schools in a national study of a UFB intervention.[71] Lastly, a quasi-experimental study of UFB in Los Angeles found no significant change in heights and weights among intervention students after five months of the intervention.[80]

A natural experiment focused on BIC in New York City schools found no evidence that offering BIC resulted in an increase in BMI or the prevalence of obesity.[88] Conversely, a cross-sectional study in a school district in South Carolina found that the average BMI was larger for fourth grade students at BIC schools (21.9) than student at schools with breakfast in the cafeteria (20.5).[33]

IV.D. Discussion

IV.D.i. Summary of Findings

Among the studies included in this review, UFB programs have been the most widely studied. The UFB programs in these studies have been implemented with students in countries around the world and have ranged from small cluster randomized control studies to large cross-sectional studies. Overall, when school breakfast participation was included as an outcome, results indicate that there may be an increase in participation following the implementation of the

UFB program. However, questions remain about whether UFB programs and other alternative breakfast service models are increasing participation among students who previously skipped breakfast or if students are just shifting from eating breakfast at home to eating breakfast at school after implementation of new service programs.

There have been fewer studies of UFB programs with attendance, academic achievement, nutrient intake and student weight status or BMI as outcomes. Studies that have included these outcomes have had mixed findings, and thus it is premature to conclude what the effects of UFB programs may be on these outcomes.

Studies of BIC are more limited than studies of UFB, but similar to UFB studies, BIC studies that have included breakfast participation as an outcome have found positive associations between the implementation of BIC and participation in school breakfast programs. The were no randomized control studies of BIC programs included in this review, so a causal relationship between BIC and participation cannot be established. The relationship between BIC and the other outcomes of interest in this review also cannot be established due to the lack of strong study designs (mostly observational studies have been conducted to date) and mixed findings. Studies of BIC that examine dietary intake have raised questions about whether BIC and possibly other alternative breakfast service models may lead children to consume more than one breakfast, which could lead to increase calorie consumption and weight gain. More studies with stronger study designs are needed to answer these questions.

As far as we are aware, with the exception of a few small pilot studies, results of grab and go breakfast and second chance breakfast programs have not been published in the scientific literature. The studies that have been published included breakfast program participation as an outcome and some explored student and school staff perceptions of the program. However, they

did not include the other outcomes relevant to this study. The positive associations between these programs and breakfast program participation are promising, but additional studies are needed.

IV.D.ii. Methodologic Considerations and Strength of Evidence

Overall, studies of alternative breakfast service models published in the scientific literature are limited, which makes drawing conclusions about relationships between these models and outcomes challenging. In addition, the number of experimental studies where either student or schools were randomized to alternative breakfast service model interventions are also extremely limited making causal relationships impossible to establish. As mentioned previously, several of the natural experiments included in this review made use of difference-in-difference regression models for their statistical analyses. Given the challenges involved in conducting large randomized studies in school environments, statistical methods like difference-in-difference should be used more in future studies to try and simulate experimental research studies and draw casual inferences.

Another consideration when assessing the strength of the evidence is the generalizability of the studies included in this review. With the exception of one cluster randomized study, all the randomized studies were conducted outside of the United States. The extent to which these randomized studies are applicable to students in other countries is not known. In addition, while the studies that were conducted in the United States did occur in a wide range of locations, it is possible that alternative service models have differential effects among students from different socioeconomic backgrounds and who attend schools in various locations. Student age may also be a key factor in the effectiveness of alternative breakfast service models. Most of the studies

included in this review were conducted in elementary or primary schools and the extent to which the findings hold for older students is not known.

There is also the possibility of publication bias. Researchers who have found negative or null results in studies of alternative school breakfast models may not have attempted to published results or they may not have had studies accepted for publication in the peer-reviewed literature.

IV.D.iii. Research Recommendations

This review points to several areas for future research. In order to determine the relationships between alternative breakfast service models and the outcomes of interest for this review, more studies with stronger studies designs need to be conducted. These studies, when possible, should include randomization of students or schools to alternative breakfast service model interventions. However, there is also a need to rigorously evaluate the alternative breakfast service models that are being implemented as a result of policy and practice changes across the country. Using statistical methods that attempt to reduce confounding and mimic conditions in randomized studies may help provided stronger evidence.

Future studies should also examine the longer-term effects of alternative breakfast service models on outcomes. In some cases, follow-up times for studies included in this review were limited to the school year immediately after implementation of the program and only a few studies examined longer-term trends. More studies in middle and high schools are also needed, as well as studies with students from a variety of backgrounds.

In addition, studies in this review primarily examined test scores as measures of academic achievement, but a few studies examined changes in grades or time spent doing homework. It may be beneficial for future studies to measure academic achievement in more than one way or if

possible use a common measure that can serve as the most appropriate measure of academic achievement across studies.

IV.D.iv. Limitations

In order to ensure the scientific rigor of the studies included in this review, only peer-reviewed journal articles met the inclusion criteria. However, there are a number of government, school and non-profit organization reports and non-refereed articles that may include information relevant to alternative breakfast and to the outcomes of interest for this review. As a result, this review may not capture all of the alternative breakfast programs that have been evaluated but not published in the peer-reviewed literature. Nevertheless, in many cases, both reports and peer-reviewed articles do exist for the same studies and thus some of those studies were included in this review.

A few studies of alternative breakfast service models also included child or student behavior as an outcome. Given the complexities of measuring behavior and the lack of standardization across behavioral measures,[93] we did not include behavior in this study. Qualitative studies and qualitative components of the studies included in this review were also not included. Qualitative studies can provide valuable information about implementation of alternative service breakfast models and discuss ways in which barriers to breakfast participation may be overcome. However, these studies were beyond the scope of this review.

IV.D.v. Conclusion

Overall the results of this study indicate that some alternative breakfast service models may result in an increase in participation in school breakfast programs. However, the extent to

which the increase in participation in the breakfast program leads to improvements in attendance, academic achievement, nutrient intake/diet quality, and weight status is not clear. Since there is some evidence that alternative breakfast service models may have a positive impact on these outcomes, further studies are warranted.

CHAPTER V: SCHOOL BREAKFAST PROMOTION INITIATIVES AND TRENDS IN SCHOOL BREAKFAST PARTICIPATION: A STATE-WIDE ANALYSIS

V.A. Introduction

Eating breakfast has been associated with improved weight status, nutrient intake, and academic achievement among children.[1-5] The National School Breakfast Program (SBP) was created by the United States Congress to help ensure that school-aged children, and low-income children in particular, have access to a healthy meal to start the day.[10] Despite high levels of availability of the SBP in schools across the country (approximately 92% of schools that serve lunch also serve breakfast)[94] and high levels of eligibility for free and reduced price breakfast, participation in the SBP is much lower than participation in the school lunch program (SLP). At the national level, 52 low-income children participated in school breakfast for every 100 that participated in school lunch.[36] Overall, students eligible for free breakfast have participation rates of just 40%, compared to participation rates of 28% for all students.[95]

Realizing the impact that breakfast may have on improving nutrition and academic performance, policy makers and practitioners have implemented a variety of changes in policies and practices designed to improve breakfast participation. Some of these changes focus on alternative breakfast service models, such as universal free school breakfast, breakfast in the classroom, second chance breakfast, and grab and go breakfast.[1] At the national level, the Healthy Hunger-Free Kids Act of 2010, which sets policy and authorizes funding for the school

[1] Grab and go breakfast programs allow students to pick up a bagged or boxed breakfast when they enter the school rather than having to go to the cafeteria to eat breakfast.

meals programs, contains a provision -- the Community Eligibility Provision (CEP) -- designed to expand enrollment in the school breakfast and lunch programs by allowing high poverty schools (schools with ≥40 percent students who directly certify for FRP meals) to provide free lunch and breakfast to all students (i.e., "universal free breakfasts").[49] Implementing such a universal breakfast strategy and other alternative breakfast service models may make participation in the SBP more convenient and help to reduce the stigma associated with breakfast participation.[51]

While there have been a number of studies of the SBP conducted to date, most have not focused on the impact of alternative breakfast service models that are currently being implemented in schools across the country. There have been a few studies that have used longitudinal data to determine the effect of the implementation of an alternative breakfast program on SBP participation.[79, 92, 96, 97] These studies have found policies promoting alternative breakfast service models are associated with an increase in breakfast participation. However, the majority of these studies have focused on primary schools in a single school district or a few primary schools in a small number of school districts. There is a need to examine the impact of alternative breakfast policies on breakfast participation in middle and high schools and across a larger number of school districts.

The purpose of this study is to determine whether changes in statewide policies and practices promoting alternative breakfast and SBP participation are associated with an improvement in school breakfast participation. In North Carolina, a series of policy and practice changes designed to improve breakfast participation, in part via alternative service models, were implemented between the 2011-12 and 2014-15 school years. Beginning in August 2011, the North Carolina State Board of Education passed a *Resolution to Promote School Breakfast*

encouraging schools to "consider providing breakfast in the classroom during appropriate instructional and educational activities as one of the multiple options for removing barriers."[36] In October 2011, the NC Department of Public Instruction (DPI) introduced the *Breakfast is Brain Fuel Toolkit*, which included guidance for Breakfast in the Classroom and other alternative service models.[54] In 2013, No Kid Hungry North Carolina, a public-private partnership working to end childhood hunger, initiated a Breakfast Challenge to incentivize schools to increase breakfast participation. Over 800 schools pledged to participation in the 2013 Challenge. The Challenge was offered again in 2014 and almost 1500 schools pledged to participate. Finally, starting in 2014, nearly 600 schools in North Carolina elected to adopt the Community Eligibility Provision (CEP) from the Healthy Hunger-Free Kids Act of 2010 as mentioned above.
Using district-level and school-level longitudinal data on breakfast participation rates and student demographics for schools across the state of North Carolina, this study examines whether statewide policy and practice changes are associated with changes in participation in the school breakfast program.

V.B. Methods

This longitudinal study examines both district-level participation in the National School Breakfast Program (SBP) among school districts in North Carolina for eight school years—the 2007-08 school year to the 2014-15 school year—and school-level participation in the SBP from three school years—2012-13 to 2014-15. On the district-level, three combined policy and practice changes (i.e., "policy interventions") were examined. Figure 8 provides a timeline of the policy and practice changes and data availability. The *Resolution to Promote School Breakfast* and the *Breakfast is Brain Fuel Toolkit* served as the first policy intervention (PI1).

Since the resolution was passed within months of the release of toolkit during the 2011-12 school year, the possible impact of these policies/practice changes on participation at the district level is not distinguishable and thus they are considered a combined intervention. The second policy intervention (PI2) was the 2013 Breakfast Challenge occurring during the 2013-14 school-year, and the third policy intervention (PI3) was the 2014 Breakfast Challenge and CEP, both occurring during the 2014-15 school-year and also considered a combined intervention. Due to the lack of availability of school-level data prior to the 2012-13 school year, only the 2013 and 2014 Breakfast Challenges and CEP were examined on the school level, but all policies were examined on the district level. Due to the fact that this study does not use any student-level data it was deemed exempt by the University of North Carolina at Chapel Hill Institutional Review Board.

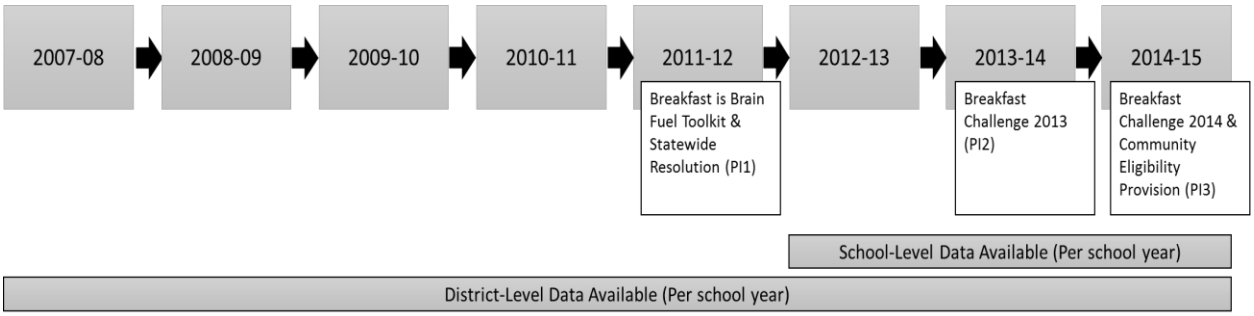

Figure 8. Timeline of the North Carolina SBP policy and practice changes and district- and school-level data availability.

V.B.i. Setting

The state of North Carolina has over 1.4 million students enrolled in over 2,400 public schools in 115 school districts or local educational agencies (LEAs).[98] The majority of the school districts are organized at the county-level, but 15 school districts are municipal school districts. All 115 school districts were included in the district-level analyses. Charter and

private schools that operate independently from the school districts in North Carolina were not included in the district-level analyses.

For the school-level analyses, public schools of all grade levels in all school districts across the state and charter schools of all grade levels were included. Schools were excluded from the school-level analyses if they were residential schools, part of the Bureau of Indian Education, alternative schools, schools that serve only students with special needs, Pre-K or Head Start only schools, military schools, hospital schools, and schools that did not have breakfast as part of the National School Meal Program for at least one year during the study period. Schools that had missing data for one or more of the independent variables and/or were missing data needed to calculate the outcome variable for at least one year were also removed from the dataset.

V.B.ii. Variables and Data Sources

Outcome Variables

Breakfast participation rates were calculated for each school year/measurement occasion by dividing the total number of school breakfasts served during that school year by the product of the average daily membership (ADM) and the number of days that year that breakfasts were served. ADM for each year is calculated by adding the number of days of membership (or number of days enrolled in a district or school) for all students in each district or school and dividing by the number of days in the school year.[99] The exact number of days that breakfast was served in each district was not available, so 180 days was used for the district-level analyses, as it was the minimum number of instruction days that schools were required to have in North Carolina. Time-varying breakfast participation rates were calculated at the district level and at

the school level. Data needed to calculate the breakfast participation rate for both districts and schools were provided by the North Carolina Department of Public Instruction (NC DPI) School Nutrition Services Division.

Covariates for District-Level Analyses

All covariates for the analyses were chosen *a priori*, and for the district-level analyses included urbanicity, percent of students of color, and percent of students eligible for free or reduced price (FRP) meals through the National School Lunch and School Breakfast Programs. Data needed to calculate district urbanicity were available on the National Center for Education Statistics (NCES) website and the United States Department of Agriculture (USDA) website. Schools were coded as town/rural, suburban/town, suburban, or urban based on a classification scheme similar to those used in previous studies.[100, 101] This scheme combines the urban-centric locale codes from NCES[102] with the county-level Rural-Urban Continuum Codes (RUCC) from the USDA.[60]

The percent of students of color in each district for each year was calculated by dividing the number of students enrolled in a district who were not classified as "white" by the total number of students enrolled in the district. Enrollment numbers for districts by race/ethnicity were available on the NC DPI website.[57] The percent of students of color for school years 2010-11 to 2014-15 was then used to create two variables: average percent students of color and change in percent students of color. For each district, average percent students of color was the mean of the percent of students of color between 2010-11 and 2014-15. To enable interpretation of the intercept and main effects, average percent students of color was centered by subtracting the mean. Change in percent students of color for each district was calculated by subtracting the percent of students of color for 2010-11 from the percent of students of color for 2014-15. The

five school years used for these variables are the years during which the policy interventions occurred.

The percent of students eligible for FRP meals was calculated by dividing the number of FRP-eligible students in each district by the average daily membership for each district. Enrollment numbers by FRP eligibility were available on the NC DPI website.[56] Similar to percent students of color, the percent of FRP-eligible students for school years 2010-11 to 2014-15 were used to create the average percent FRP-eligible students and the change in percent FRP-eligible students. Average percent FRP was centered by subtracting the mean.

Covariates for School-Level Analyses

The three policy/practice intervention predictor variables included in the school-level analyses were school participation in: 1) the 2013 Breakfast Challenge (BC13) (yes/no), 2) the 2014 Breakfast Challenge (BC14) (yes/no), and 3) the Community Eligibility Provision (CEP) for the 2014-2015 school year (yes/no). District-level variables were also created for BC13, BC14 and CEP using school-level data. The percent of schools in a district that participated in BC13 was calculated by dividing the number BC13 schools in a district by the total number of schools in that district. The percent of schools in a district that participated in BC14 and CEP were also calculated this way. The mean percentages across districts were calculated for these variables and each variable was centered by subtracting its mean. No Kid Hungry North Carolina provided the names of the schools and school districts that participated in the 2013 and 2014 North Carolina Breakfast Challenges. A list of schools that participated in CEP was publicly available on the NC DPI website.[56] A list of schools that were eligible to participate in CEP during the 2014-15 school year was publicly available on The Center on Budget and Policy Priorities website.[61]

Other covariates included in the school-level analyses were school grade-level, charter school status, urbanicity, percent of students of color, and percent of students eligible for FRP meals. School grade-level information was gathered from the NCES website.[58] Schools were coded as elementary, middle, high, or other school. "Other schools" had grade level configurations that did not fall within in NCES grade spans for elementary, middle or high schools (i.e., K-12, 6-12, or single grade schools). Charter school status was also available on the NCES website and coded as a 1 for charter and 0 for non-charter. Data needed to calculate school urbanicity were available on the NCES website and the USDA website. Schools were coded as town/rural, suburban, or urban based on a classification scheme that combines the urban-centric locale codes from NCES[102] with the Rural-Urban Commuting Area (RUCA) codes from the USDA.[59] The percent of students of color was calculated by dividing the number of students enrolled in a school who were not classified as "white" by the total number of students enrolled in the school. The percent of students eligible for FRP meals was calculated by dividing the number of FRP-eligible students in each school by the average daily membership for each school. Enrollment numbers by race/ethnicity and FRP eligibility were available on the NC DPI website.[56, 57] In addition, district-level variables were calculated from school-level percent students of color and percent FRP by averaging the percentages across schools in each district. All continuous variables were centered at their respective means. Due to missing and unavailable data for some school years, the data for the 2013-2014 school year were used for all control variables.

V.B.iii. Statistical Methods

For both the district- and school-level analyses, descriptive information was generated for variables of interest and general linear mixed models were estimated using the maximum likelihood method. For the district-level baseline unconditional model, level-1measurement occasions were nested within level-2 districts and a piecewise/spline model was estimated with four pieces/slopes. For this model, the intercept was at time 0 (the 2007-08 school year) and there were breakpoints after each policy intervention—at time=3 (2011/2012), time=6 (2013/14) and time=7 (2014/15). The piecewise model with four random linear slopes allowed for comparison of slopes before and after the implementation of each of the three policy interventions. Conditional models including covariates were then examined using the piecewise unconditional model as a baseline.

For the school-level analyses, level-1 measurement occasions were nested within level-2 schools within level-3 districts. A piecewise unconditional model with two fixed linear slopes was used to allow for comparison of slopes before and after the implementation of the policy and practice changes. Conditional models including covariates were then examined using the piecewise model as a baseline. The models were estimated with and without charter schools included. Some parameter estimates were slightly different between the models, but these differences did not change the results in any meaningful way, so charter schools were left in the final model. In addition, conditional growth models were also estimated that included only schools that participated in CEP and schools that were eligible for CEP for the 2014-2015 school year. Models were also estimated that included only schools that had participated in the 2013 Breakfast Challenge, 2014 Breakfast Challenge and CEP and school that did not participate in any of these initiatives.

Likelihood ratio tests, Bayesian Information Criterion (BIC), and Akiake Information Criterion (AIC) were used to select the best model for the analyses. The proportion of explained total outcome variance (total R^2) was also calculated by correlating the outcome predicted based on the fixed effects included in each of the models with the actual outcome and squaring the result. For each outcome variable, residual normality, linearity, homogeneity of variance, and influential outliers were assessed and no gross violations were observed. All analyses were conducted using SAS version 9.4 (SAS Institutes, Cary, NC).

V.C. Results

For the district-level analyses, there were 920 occasions of data (115 districts x eight years). For the school-level analyses, 2309 schools were nested within 146 districts across three school years, where each charter school (n=31) was considered to be in its own district. There were a total of 6904 occasions of data—2309 schools (2278 public, 31 charter) in 146 districts.

V.C.i. Descriptive Statistics

District-Level

Table 7 contains the district means and average change for percent of students of color and percent of students eligible for free or reduced priced meals during the years in which the policy and practice changes were occurring (2010-11 to 2014-15) and the percent of districts classified as Town/Rural, Suburban/Town, Suburban, and Urban.

Table 7. District-level means and average change for percent of students of color and percent of students eligible for FRP from 2010-11 to 2014-15 and urban/rural classification.

North Carolina School Districts	**n=115**
Mean percent of students of color (SD, Range)	43.3% (22.1, 5.5-96.8%)
Average change in percent of students of color (SD, Range)	2.2% (2.1, -5.1-7.0%)
Mean percent of students eligible for FRP (SD, Range)	63.3% (14.0, 26.6-93.3%)
Average change in percent FRP students (SD, Range)	3.68% (4.1, -6.9-21.0%)
Percent Town/Rural Districts	33.9%
Percent Suburban/Town	18.3%
Percent Suburban Districts	37.4%
Percent Urban Districts	10.4%

School Level

Demographic characteristics of schools that elected to join the 2013 or 2014 Breakfast Challenges or CEP were different in the year prior to the implementation of those initiatives than demographic characteristics of schools that did not join those initiatives. Demographic information for all schools included in the study and for schools participating in the 2013 and 2014 Breakfast Challenges and 2014-15 CEP are included in Table 8. During the 2013-14 school year, 878 (38.3%) schools included in the study participated in the 2013 Breakfast Challenge. During the 2014-15 school year, 1498 (64.9%) schools included in the study participated in the 2014 Breakfast Challenge. Overall, 1562 schools participated in the 2013 and/or 2014 Breakfast Challenges, of which 814 schools joined the Challenges both years. For the 2014-2015 school year, there were a total of 1,145 schools in the study that met the eligibility criteria for CEP. Of those eligible schools, 597 (52%) schools elected to adopt CEP. Of the 597 CEP schools, 545 (91.9%) had also joined the 2014 Breakfast Challenge.

Table 8. Demographic information for all study schools and for schools participating in the 2013 and 2014 Breakfast Challenges and 2014-15 Community Eligibility Provision.

	All Study Schools (n=2309)	2013 Breakfast Challenge[a]		2014 Breakfast Challenge[b]		Community Eligibility Provision[b]		
		Participants (n=878)	Non-Participants (n=1415)	Participants (n=1498)	Non-Participants (n=811)	Participants (n=597)	Eligible Non-Participants (n=548)	Non-eligible Non-Participants (n=1164)
Mean Percent Breakfast Participation (SD)	31.9 (20.9)	34.4 (20.4)	29.6 (19.5)	34.8 (21.6)	26.7 (18.4)	48.1 (20.7)	41.9 (18.1)	18.9 (11.9)
Mean Percent Students of Color (SD)	49.1 (27.3)	57.3 (28.9)	42.9 (24.6)	51.9 (28.2)	43.8 (24.7)	67.8 (28.2)	54.5 (25.0)	36.9 (20.8)
Mean Percent FRP-eligible (SD)	62.8 (23.3)	67.4 (22.7)	58.5 (22.8)	66.1 (22.7)	56.7 (23.2)	84.7 (14.1)	76.5 (11.6)	45.1 (16.2)
Percent Urban Schools	24.4	37.4	16.0	27.2	19.2	30.3	20.1	25.4
Percent Suburban Schools	19.6	15.3	22.4	18.3	21.9	7.2	17.9	12.3
Percent Town/Rural Schools	56.0	47.4	61.6	54.5	58.8	62.5	62.0	62.3
Percent Elementary Schools	58.7	62.5	56.4	59.5	57.3	69.8	69.0	48.2
Percent Middle Schools	21.3	20.2	21.8	21.3	21.3	17.6	22.3	22.8
Percent High Schools	18.5	15.6	20.4	18.3	18.9	11.2	7.3	27.5
Percent Other Schools	1.5	1.7	1.3	1.0	2.5	1.3	1.5	1.5

[a] Data for the 2013 Breakfast Challenge are for the year prior to implementation (2012-13).
[b] Data for the 2014 Breakfast Challenge and CEP are for the year prior to implementation (2013-14)

V.C.ii. District-Level Regression Models

Baseline Unconditional Model

Figure 9 displays the trajectory of breakfast participation from 2007-08 to 2014-15, as estimated by the unconditional model. The estimated average participation rate at time 0 (school year 2007-08) was 28.5% (SE=1.4, $p<0.001$) across all districts. The average initial rate of change (slope 1) before the first policy intervention (PI1) was significantly different than zero and estimated to be 0.7% per year (SE=0.2, $p<0.001$). The slope after PI1 (slope 2) was estimated to be 1.9% (SE=0.3, $p<0.001$), which was significantly more positive than slope 1 by

1.1% (SE=0.4, p=0.002). The slope after the second policy intervention (PI2), slope 3, was not significantly different from zero (0.01% SE=0.4, p=0.9), indicating that on average there was not an increase in participation across districts. There was a significant increase (2.1% SE=0.5, p<0.001) in the rate of change in participation (slope 4) after policy intervention 3 (PI3). The difference between slopes 3 and 4 was significant (2.1% SE=0.7, p=0.002).

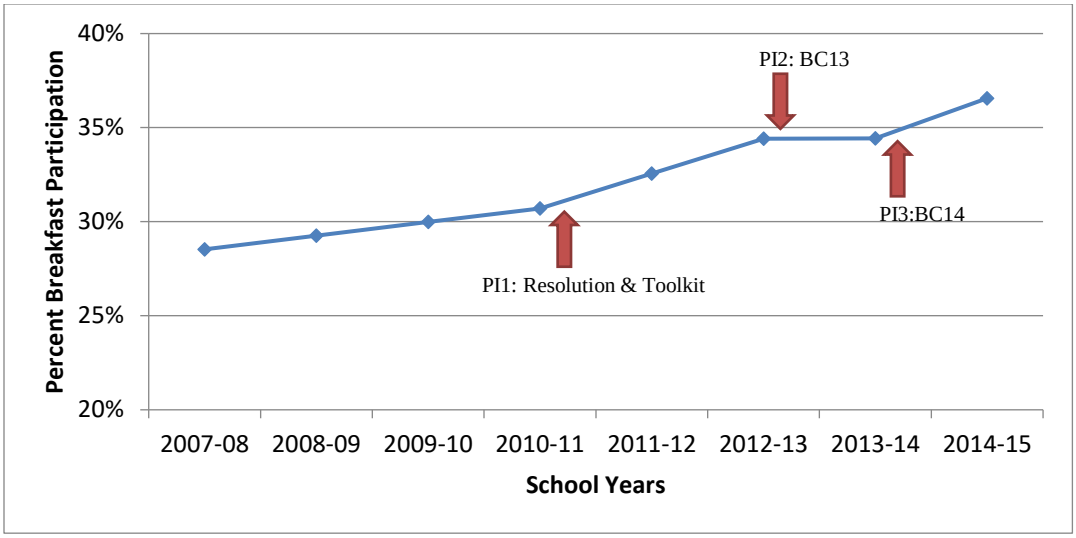

Figure 9. Average National School Breakfast Program participation rate among districts in North Carolina between the 2007-08 and 2014-15 school years.
Note: Each arrow represents a policy intervention.

Final Conditional Model

The final conditional model includes the following district-level covariates: urbanicity (rural/town, suburban/town, suburban, urban), mean percent students of color student (centered at mean of 40%), percent change in students of color, mean percent of FRP-eligible students (centered at mean of 60%), and percent change in FRP-eligible students. The model also contained interaction terms for each of these covariates and the four slopes. Approximately 72% of the total variance in district-level breakfast participation was explained by including the covariates in the model.

In the conditional final model the only significant effect of urbanicity was a less positive participation rate at time 0 for districts in Suburban/Town areas relative to districts in Rural/Town areas (-5.0% SE=2.4, p=0.04). There were no significant effects of percent of students of color in the final model. Adding the continuous variable for average percent of FRP-eligible students to the model resulted in a significant increase in participation of 0.9% (SE=0.09, $p<0.001$) at time 0 for each 1% increase in students eligible for FRP. The effects of the average percent FRP on the slopes, however, were all non-significant. Adding the continuous variable for percent change in FRP-eligible students to the model did not result in a significant change in the intercept. However, there was a significant increase in the rate of participation of 0.5% (SE=0.1, $p<0.001$) in slope 3 for every 1% increase in FRP-eligible students. Figure 10 displays the estimated trajectory of breakfast participation from 2007-08 to 2014-15 for school districts with different levels of FRP-eligible students and urbanicity.

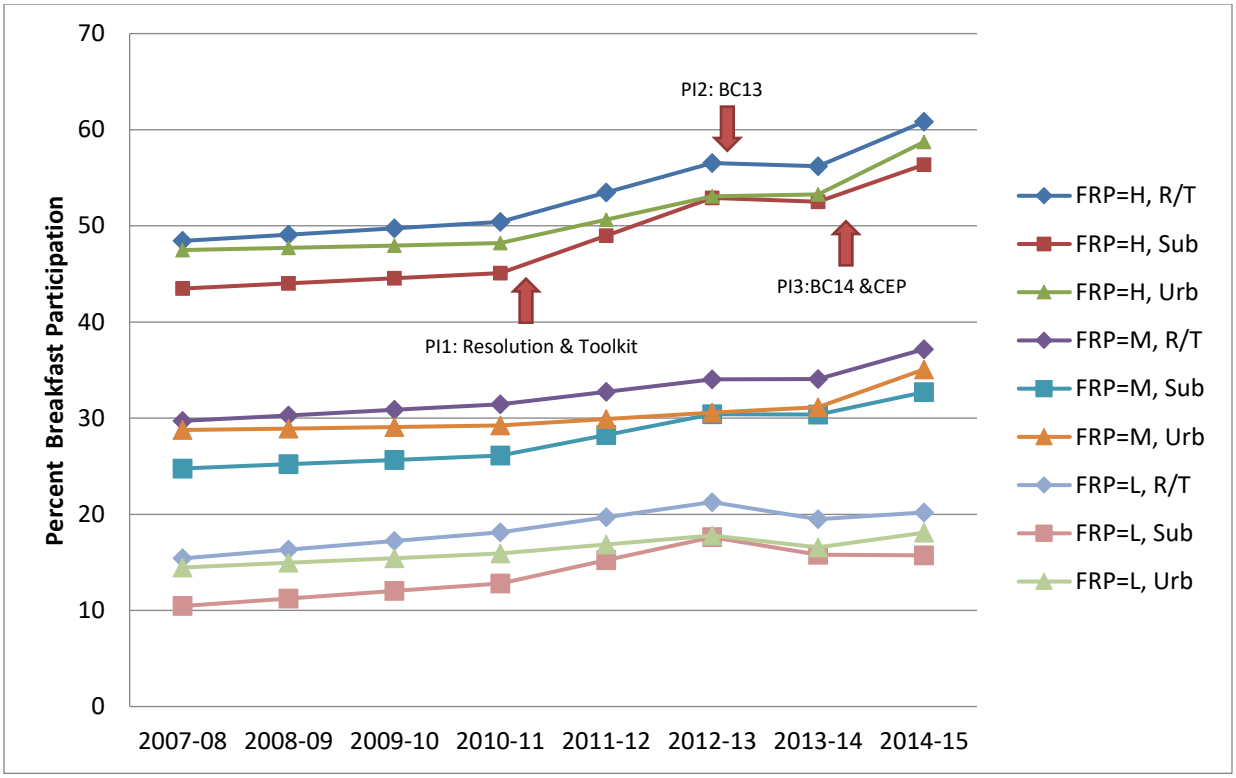

Figure 10. Breakfast participation rates from school year 2007-08 to 2014-15 for North Carolina school districts by percent of free and reduced price eligible students

Note: FRP=Low≤50%, 50%>Medium≤75%, or High>75% and urbanicity=rural/town, suburban, or urban.

V.C.iii. School-Level Regression Models

Baseline Unconditional Model

The overall estimated breakfast participation rate among schools in 2012-13, was predicted to be 35.1%. Between the 2012-13 and 2013-14 school year the rate of change in breakfast participation was significantly different than zero and estimated to be by 0.6% (SE=0.2, p= 0.004). The rate of change in breakfast participation was also significantly different than zero between 2013-14 and 2014-15 and was estimated to be 2.2% (SE=0.2, p<.0001). Figure 11 illustrates the estimated average percent breakfast participation among schools in North Carolina from the 2012-13 school year to the 2014-15 school year.

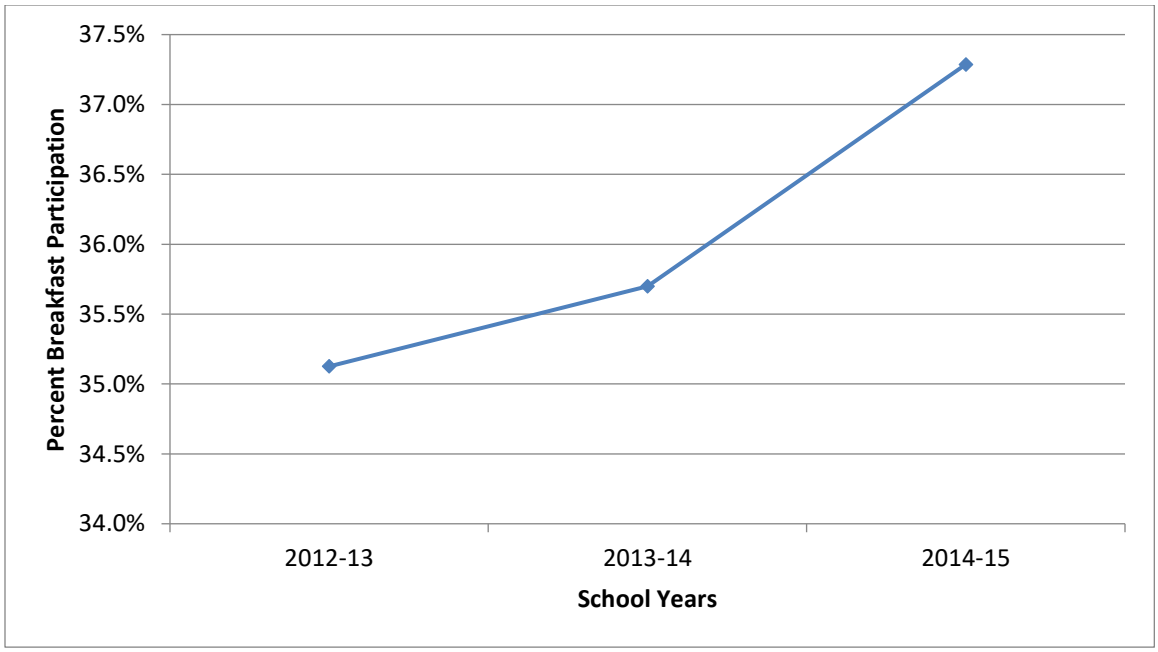

Figure 11. Average School Breakfast Program participation rates among schools in North Carolina between the 2012-13 and 2014-15 school years.

Final Conditional Model

Approximately 67% of the total variance in breakfast participation was explained by including the policy interventions and covariates in the model. Results from the final model are summarized below, and Figure 12 contains estimated SBP participation rates for school years 2012-13 to 2014-15 for schools participating in the 2013 Breakfast Challenge, 2014 Breakfast Challenge, CEP, all three or none of the policy/practice interventions by percent of students of color (SC=Low≤50% or High>50%) and FRP-eligible students (FRP=Low≤50% or High>50%).

Breakfast Challenges: Schools that participated in the 2013 Breakfast Challenge had a significantly greater increase in participation from 2012-13 to 2013-14 (5.0% SE=0.9, $p<0.001$), but a significantly greater decrease in participation from 2013-14 to 2014-15 (-3.0% SE=0.9, $p<0.001$). However, the decrease from 2013-14 to 2014-15 was significantly less negative by 0.03% for every 1% increase in the number of schools in a district participating in the BC13

challenge. While there was a slight increase in participation from 2013-14 to 2014-15 for schools that participated in the 2014 Challenge relative to those that did not, none of the effects of the 2014 Breakfast Challenge were significant.

CEP: Schools that participated in CEP had significantly higher breakfast participation by 4.6% (SE=0.9, $p<0.001$) in 2012-13 and a significantly greater increase in participation by 5.7% (SE=0.8, $p<0.001$) from 2013-14 to 2014-15. There was also an effect of having a higher percent of CEP schools in a district—after controlling for school participation in CEP, there was a significantly less positive school-level participation rate in 2012-13 of -0.1% (SE=0.03, $p=0.008$) per 1% increase in number of CEP schools in a school district. For every 1% increase in CEP schools in a district, there was also a significantly more positive increase in participation of 0.05 (SE=0.01, $p<0.001$) from 2012-13 to 2013-14. When the model included only schools participating in CEP (n=597) and schools that were eligible, but did not participate in CEP (n=548), the increase in participation from 2013-14 to 2014-15 of CEP schools relative to CEP eligible schools was significantly greater by 7.0% (SE=1.3, $p<0.001$).

Breakfast Challenges and CEP: A separate model was run to examine the joint effect of participating in both of the Breakfast Challenges and CEP. Compared to schools that did not participate in any of these initiatives (n=703), schools that participated in all three (n=312) had a significantly greater increase in participation rate by 6.7% (SE=0.8, $p<0.001$) from 2012-13 to 2013-14 and by 6.8% (SE=0.8, $p<0.001$) from 2013-14 to 2014-15.

School Level and Charter Schools: Relative to elementary schools, middle schools had significantly lower breakfast participation in 2012-13 (-9.0% SE=0.6, $p<0.001$), and a significantly less positive change in participation rate from 2012-13 to 2013-14 (-1.4% SE=0.5, $p=0.004$) and from 2013-14 to 2014-15 (-1.6 SE=0.5, $p<0.001$). Similarly, relative to elementary

schools, high schools had significantly less positive breakfast participation in 2012-13 (-13.3% SE=0.7, $p<0.001$) and significantly less positive change in participation rate from 2012-13 to 2013-14 (-2.1% SE=0.6, $p<0.001$) and from 2013-14 to 2014-15 (-1.3 SE=0.6, p=0.02). Other schools also had significantly lower breakfast participation in 2012-13 (-5.9% SE=2.0, p=0.004) than elementary schools. Charter schools had a significantly greater increase in participation from 2013-14 to 2014-15 (4.2% SE=1.7, p=0.01) than non-charter schools.

Other Covariates: In the final model there were no significant effects of urbanicity. There were two significant effects of the percent of students of color in a school. In 2012-13, a school with a higher percentage of students of color had a higher participation rate of 0.1% for every 1% increase in students of color (SE=0.02, p=0.001). However, after controlling for school-level percent students of color, a school's participation rate was significantly less positive by -0.2% in 2012-13 for every 1% increase (SE=0.047, p=0.001) in the percent of students of color in its district overall. There were also two significant effects of percent FRP-eligible students in the final model. For every 1% increase in FRP-eligible students there was a 0.4% increase in participation in 2012-13 (SE=0.02, $p<0.001$). After controlling for school-level percent FRP-eligible, this effect was significantly more positive if a school was in a district with a higher percent FRP—0.4% increase for every 1% increase in district FRP eligibility (SE=0.1, $p<0.001$).

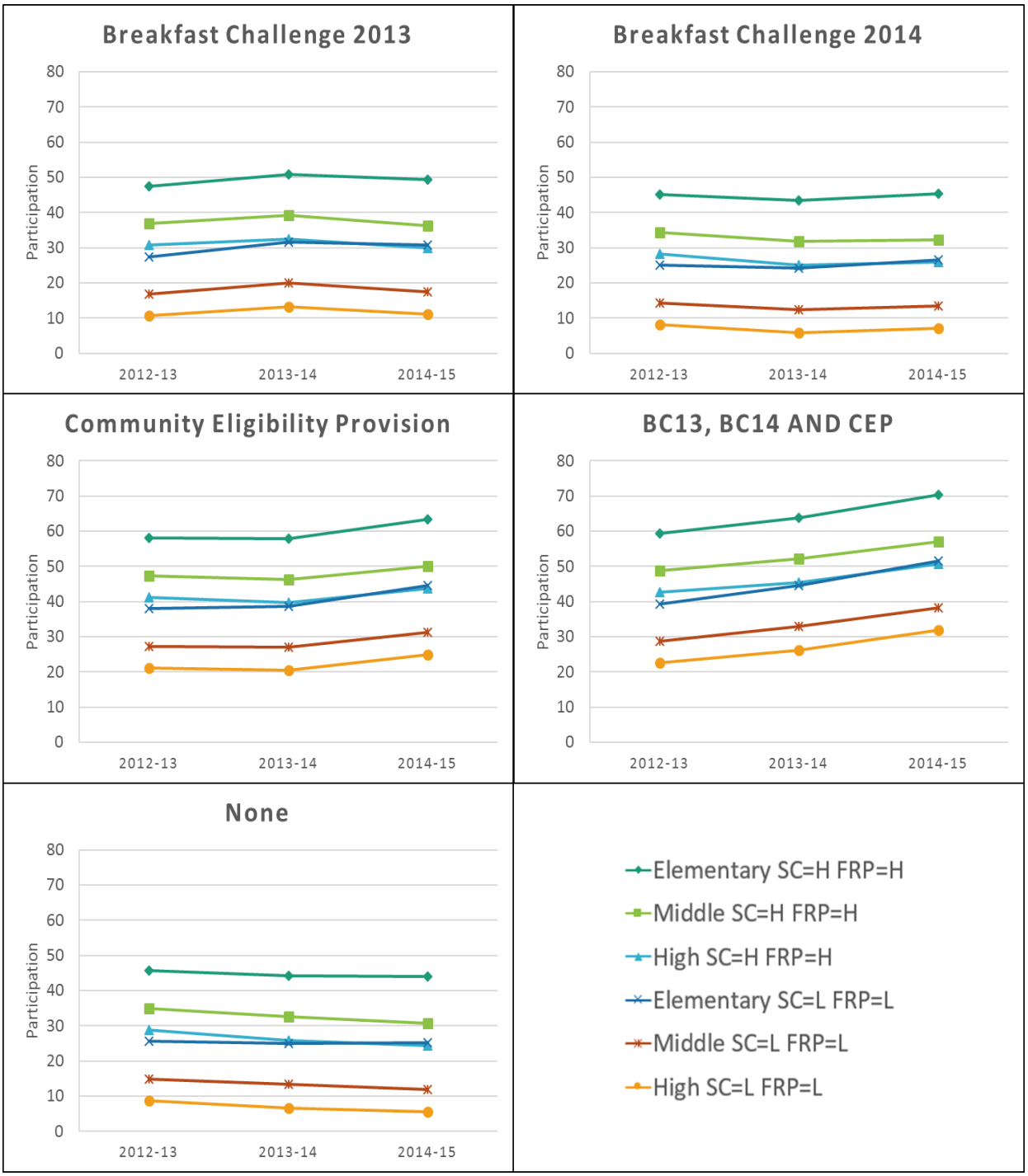

Figure 12. Estimated breakfast participation rates for North Carolina schools participating in the 2013 Breakfast Challenge, 2014 Breakfast Challenge, Community Eligibility Provision, all three or none of the interventions by percent of students of color and FRP-eligible students.

Note: Percent students of color (SC=Low≤50% or High>50%) and percent free and reduced price eligible students (FRP=Low≤50% or High>50%).

BC13= Breakfast Challenge 2013, BC14=Breakfast Challenge 2014, CEP=Community Eligibility Provision.

V.D. Discussion

This longitudinal study examined changes in district- and school-level participation in the SBP in North Carolina and whether statewide policies and practice changes promoting alternative breakfast and SBP participation are associated with changes in school breakfast participation. On average, on the district level, there was a significant increase in the rate of change in breakfast participation of 1.1% after the *Resolution to Promote School Breakfast* was passed and the *Breakfast is Brain Fuel Toolkit* was released (policy intervention 1) relative to the breakfast participation rate before the resolution and toolkit (school years 2007-08 to 2010-11). In 2011-12, there were more than 1.4 million public school students in North Carolina,[103] so a 1.1% increase in the rate of change in breakfast participation would be roughly equivalent to 16,243 more students participating in school breakfast per year (rate of increase prior to PI1 was 10,383 students per year and rate of increase after PI1 was 26,626 students per year). Data on individual schools and their use of the toolkit or uptake of the resolution were not available, so it is not clear which specific initiative (or the combination of the two) was associated with the uptick in participation rates that was observed between the 2010-2011 and 2011-2012 school years.

On average, the breakfast participation rate at the district level did not increase after the 2013 Breakfast Challenge. The percent of students in the district eligible for FRP meals, however, was associated with a greater increase in the rate of participation after the 2013 Challenge. Schools that participated in the 2013 Challenge had a higher percent FRP-eligible students than non-participating schools prior to the implementation of the Challenge, and the school-level analyses indicated that schools that participated in the 2013 Challenge did have a significantly greater increase in participation rate of 5.0% between the 2012-2013 and 2013-14

school years relative to schools that did not participate. It is possible that not enough schools participated in the 2013 Challenge to see a corresponding change in participation rates on the district level or that decreasing rates of participation among non-participating schools may have masked the effect of the 2013 Challenge on the district level.

The stagnant and in some cases decreasing participation rates that were observed on the district level between the 2012-13 and 2013-14 school-years may also have been affected by new stricter dietary standards for the SBP that were implemented nationwide during the 2013-2014 school year as required by the Healthy Hunger-Free Kids Act of 2010.[11, 49] These new standards may have made school breakfasts healthier but perhaps less attractive to students, and could have caused a decrease in participation. The extent to which these new requirements may have affected participation, however, is not clear. Groups like the School Nutrition Association and School Superintendents Association have reported that the new requirements have resulted in increased costs for school nutrition programs and decreases in participation among students.[104] However, a study conducted in Washington State showed that participation in the lunch program remained relatively the same before and after the new requirements[105] and a study by the Government Accountability Office showed that on the national-level breakfast participation increased between the 2010-11 and 2013-14 school years.[106]

On the district level, there was a significant increase in the rate of participation after the implementation of CEP and the 2014 Breakfast Challenge. On the school level, schools that participated in CEP did have a significantly greater increase in participation than schools that did not participate in CEP during the 2014-15 school year, but there was not a significant increase in participation among schools that participated in the 2014 Breakfast Challenge relative to those who did not participate in this Challenge. Since there was not a significant change in

participation due to the 2014 Challenge on the school level, it is possible that the change observed on the district level was driven primarily by CEP. In 2014, more districts pledged to participate in the Challenge rather than individual schools and it is possible that the commitment to increase breakfast participation did not filter down to the individual schools. Whereas in 2013, several individual schools joined the Challenge, and these schools could have been highly motivated to increase participation and may have driven the increase in participation observed on the school level after the 2013 Challenge.

Schools that participated in both the 2013 and 2014 Breakfast Challenges and CEP had a greater increase in participation rates between the 2012-13 and 2014-15 school years than schools that did not participate in any of these initiatives. It is possible that the joint effect of participating in multiple initiatives may lead to an even greater increase in SBP participation than participating in any single initiative. Schools that decide to participate in multiple initiatives may also be different than schools that do not participate in any initiative in ways that may be difficult to quantify or were beyond the scope of this study. For example, support of school staff for breakfast, grants or other financial support to promote breakfast, or the availability of equipment needed to conduct breakfast in the classroom may be different across these two groups of schools. Future studies could examine these and other factors that facilitate breakfast participation.

When comparing only CEP schools to schools that were eligible to participate in CEP but did not, the increase in participation rates between the 2013-14 and 2014-15 school years was even greater relative to comparing CEP schools to all non-participating schools. The 2014-15 school year was the first year that schools could adopt CEP, and schools or school districts that decided to implement CEP could have been motivated earlier adopters for whom CEP made

clear financial sense. On average, schools in the study that adopted CEP in the first year had higher SBP participation rates and higher percentages of FRP-eligible students prior to the 2014-15 school year, indicating that these were schools that could most likely maximize the federal reimbursement under CEP. Additional research is needed to examine the number of schools that have adopted CEP since the initial year and the longer-term impact of CEP on SBP participation rates.

Most of the policy and practice changes implemented in North Carolina were associated with an increase in school breakfast participation either at the school or district level. These findings are similar to previous studies that examined associations between alternative breakfast service model policies and participation. A study of the impact of the implementation of a universal free school breakfast policy in New York City schools found that among 3rd to 8th graders there was a small increase in breakfast participation.[79] A study of the switch from a universal free breakfast program to a standard eligibility-based program in elementary schools in Guilford County School District in North Carolina found a reduction in breakfast participation.[96] A study of the implementation of a universally free breakfast program in one public school in Philadelphia, PA (grades K-6) and two public schools in Baltimore, MD (grades K-8) found breakfast participation nearly doubled.[92] Schanzenbach and Zaki analyzed data collected as part of a 3-year pilot study of the effects of a universal free breakfast program conducted in elementary schools in 6 school districts across the US to determine whether there was a difference in the impact of universal free breakfast and breakfast in the classroom (BIC).[52, 97] They found that both policies increased participation in school breakfast, but BIC increased participation more than universal free breakfast in the cafeteria. In addition, researchers found a significant increase in breakfast participation, especially among low-income students, after

implementing a six-week pilot study of a grab and go and BIC program among 6th grade students.[68] All of these other examples, however, are studies of specific initiatives, such as universal free breakfast or breakfast in the classroom. This study has shown that broader resolutions, toolkits, challenges, and policies encouraging a range of different policy interventions may also result in higher school breakfast participation rates.

V.D.i. Limitations

While findings from this study were comparable to other similar studies, the observational study design does not allow us to determine whether the policy interventions actually caused the observed increases in participation. It is possible that other factors and events not included in this study could have influenced or caused changes in participation rates in North Carolina. Future research could include comparisons of trends in breakfast participation rates in North Carolina to trends in neighboring states. Another limitation of the study is that it was not possible to examine the individual effects of some of the policy interventions. Data are also not available on the efforts that schools that participated in the 2013 and/or 2014 Breakfast Challenges took to try to increase breakfast participation. Although, anecdotally, some of the schools and school districts that participated in one or both of the Challenges did report to NKH NC that they had adopted alternative breakfast service models (H. Roberts, personal communication, May 3, 2016). A survey for tracking the implementation of alternative breakfast service models in schools in North Carolina was not implemented on the state-level until recently and may provide an opportunity for future research. Additional research is also needed to assess the longer-term impact of these policies (beyond the 2014-2015 school year) on participation and other relevant outcomes like academic achievement, behavior, attendance and student BMI, and to determine whether there are any unintended consequences.

V.D.ii. Conclusion

The implementation of new SBP policies and practices provides a unique opportunity to address some of the gaps in knowledge about alternative school breakfast service models and helps build the evidence base to better inform future policy approaches. Broad-based programs, national- and state-level initiatives, and combinations of formal state resolutions with public/private partnerships may be effective ways to increase participation in the SBP. Although the focus of this study was schools in North Carolina, the results of the study may be applicable to schools around the country. North Carolina has over 2,400 public schools, which include some of the largest urban school districts in the country (including the 15th and 16th largest) and many rural districts.[98] Therefore, results from this study have the potential to inform and influence policy and practices at the national level and in a range of different state and local contexts.

CHAPTER VI: ASSOCIATIONS BETWEEN A UNIVERSAL FREE BREAKFAST POLICY AND SCHOOL BREAKFAST PROGRAM PARTICIPATION, ATTENDANCE, ACADEMIC ACHIEVEMENT, AND WEIGHT STATUS: A DISTRICT-WIDE ANALYSIS

VI.A. Introduction

Over the last several decades breakfast consumption among children and adolescents has decreased markedly.[7, 8] Participation in the National School Breakfast Program (SBP) is also much lower than participation in the school lunch program.[36] These trends in breakfast consumption are potentially problematic as eating breakfast may lead to improved nutrient profiles, better weight status, and improved cognitive function and behavior among children.[1-5] The SBP, which was initiated as a pilot program in 1966 and then became a permanent entitlement program in 1975, was created to ensure that school-aged children have access to a meal to start the school day.[10] Across the country, the SBP is available in approximately 92% of schools that serve lunch.[94]

There are many factors that may influence participation in the SBP. Quality, variety, taste and appearance of the food have all been cited by students as key factors in their decision to participate in school meals.[38-40] The price of meals may also be a deterrent for some students.[41-43] Barnes estimated that for every 1 percent increase in meal price for school breakfast there is a 1.5 percent decrease in participation among students paying full price.[43] School schedules and the time and convenience of accessing school meals may also be a factor in students' decision to participate.[41, 44] Several studies have also found that participation is associated with certain demographic characteristics—African American students, males, younger students, and students

living in rural areas are more likely to participate.[39, 42, 45-47] Stigma has also been identified as a particularly important influence on participation rates and may explain some of the differences in participation by race/ethnicity, gender and age.[48] The stigma associated with school breakfast consumption may stem from the perception that only "poor kids" eat school meals.[48]

Alternative breakfast service models, like universal free breakfast, breakfast in the classroom, grab and go, and second chance breakfast, have been proposed and implemented by policymakers and practitioners in an effort to overcome barriers and increase participation in the SBP. In particular, implementing a universal free breakfast policy, where all students in a school receive free school breakfast, may help to reduce barriers around cost and the stigma associated with breakfast participation.[51] Studies of universal free breakfast programs and policies indicate that there is an increase in SBP participation following their introduction.[52, 79, 92, 96, 97, 107] However, the extent to which the increase in participation in the breakfast program leads to improvements in academic and health-related indicators such as test scores, attendance, and weight status is not clear. In addition, the majority of studies of universal free breakfast programs have focused on primary schools and have not included middle and high schools.

The purpose of this observational study is to determine whether a district-wide universal free school breakfast policy implemented in a large urban school district in the Southeast United States (LUSD) is associated with changes in school-level breakfast participation, school attendance, academic achievement, and student weight status. The LUSD universal free breakfast (UFB) policy was implemented in all schools across the district during the 2013-14 school year.

VI.B. Methods

VI.B.i. Setting

As of the 2015-16 school year, LUSD had over 146,000 students enrolled in 168 schools, including 91 elementary schools, 30 middle schools, 31 high schools, and 16 "other" schools (Pre-K-8, K-8, K-12, 6-12, and alternative schools) .[108] Across the district there are approximately 30,000 breakfasts and 94,000 lunches served daily.[109] Since the UFB policy is a districtwide policy, students across all different school levels were included the analyses. However, alternative schools, Pre-K only schools, and schools that serve only students with special needs were excluded from the analyses given their specialized nature and unique student population. Schools that did not have complete data for the 2012-13 and/or 2013-14 school years were also excluded. As a result, a total of 150 schools were included in the analyses.

VI.B.ii. Variables and Data Sources

Outcome Variables

The outcome variables for the analyses included school-level participation in the SBP, change in attendance, change in test scores, and change in student weight status. School-level participation in the SBP was calculated by dividing the total number of school breakfasts served during a school year by the product of the average daily membership (ADM) and the number of days that year that breakfasts were served. ADM is the number of school days that a child is enrolled in a school during a certain timeframe (usually a school year) and the official ADM for each school for each year was available on the NC Department of Public Instruction website.[99] Other data needed to calculate SBP participation was provided by LUSD.

The school-level change in attendance before and after the UFB policy was calculated using student-level attendance data provided by the UNC Charlotte Institute for Social Capital.[110] Data for students in grades other than kindergarten through 12th grade were excluded. Days in membership for each student was calculated using a combination of student entry dates and withdrawal dates, as well as holidays and teacher work days from the official LUSD calendar for each school year. The maximum days in membership for each school year was 180 and students were excluded if they had less than or equal to 30 days in membership during a school year or the number of absences for the year were equal to or exceeded the number of days in membership. Total absences and days in membership were summed for students enrolled in each school. School-level attendance for each year was calculated by dividing total number of student absences by the total number of days in membership, subtracting the quotient from one and multiplying the difference by 100. Change in attendance between the 2012-13 and 2013-14 school years was calculated by subtracting attendance for 2012-13 from attendance for 2013-14. Change in unexcused absences and days tardy were also calculated using this method.

School-level change in test scores was calculated using data from the North Carolina Public Schools website.[111] During the 2012-13 and 2013-14 school years, end-of-grade assessments were conducted in reading and mathematics in grades 3-8 and in science for grades 5 and 8. In addition, end-of-course assessments in English II, Biology and Math I were also conducted in high schools and in some middle schools. School-level change in test scores for all subjects combined (reading, math, and science) was calculated by subtracting the percent of students in each school in 2012-13 who scored at or above grade-level (an achievement level of 3 or above) for all of the end-of-grade and end-of-course tests administered from the percent of

students who scored at or above grade-level in 2013-14. Change in test scores for single subjects (math and reading) were also calculated using this method.

School-level changes in the percent overweight and obese students were calculated using student height and weight data provided by LUSD. Student height and weight data are collected annually, and in some cases biannually, by LUSD physical education teachers and entered into the WELNET® software program (Focused Fitness, Spokane, WA). Students' BMI-for-age and sex percentiles were calculated using a SAS Program based on the 2000 Centers for Disease Control and Prevention (CDC) Growth Charts.[112] Students were classified as underweight, healthy weight, overweight or obese based on the CDC recommended BMI-for-age cutoffs.[113] The number of students in each school in each category was determined and the percent of students in each category was calculated by dividing the number of students in each category at each school by the total number of students with usable data from each school. If schools did not have data or data for only a small percent of their total student population in either the 2012-13 or 2013-14 school years, those schools were excluded from the analysis.

Covariates

All covariates for the analyses were chosen *a priori.* For the school breakfast participation analysis, variables for school-grade level, percent of students of color, and percent of students eligible for free or reduced price (FRP) meals through the National School Lunch and School Breakfast Programs were included in the model. School grade-level information was gathered from the National Center for Education Statistics (NCES) website[58] and enrollment numbers by race and FRP eligibility were available on the NC DPI website.[56, 57] Schools were coded as elementary, middle, high, or other school. "Other schools" had grade level configurations that did not fall within NCES grade spans for elementary, middle or high schools

(K-8, K-12, 6-12, and 9th grade only). The percent of students of color was calculated by dividing the number of students enrolled in a school who were not classified as "white" by the total number of students enrolled in the school. Percent of students of color was categorized into three-levels: low is equal to less than 30%, medium is equal to or greater than 30% and less than 70%, and high is equal to 70% or greater. The percent of students of color for 2012-13 was subtracted from the percent of students of color for 2013-14 to create another variable, change in percent students of color. The percent of students eligible for FRP meals was calculated by dividing the number of FRP eligible students in each school by the average daily membership for each school. Percent FRP was also categorized into three-levels with the same cutoffs as percent students of color. Similarly, the percent of FRP students for 2012-13 was subtracted from the percent of FRP students for 2013-14 to create a change in percent FRP value for each school.

For the change in attendance, test scores and percent overweight and obese students analyses, school-grade level, 2012-13 breakfast participation rate, percent of students of color, change in percent of students of color, percent FRP, and change percent of students eligible for FRP were included in the models. In addition, change in breakfast participation between 2012-13 and 2013-14 was also included in the models. Change in breakfast participation was calculated by subtracting school-level breakfast participation for 2012-13 from breakfast participation for 2013-14.

VI.B.iii. Statistical Methods

Descriptive information was generated for variables of interest. General linear mixed models were estimated using the maximum likelihood for the breakfast participation analysis. For this analysis, level-1 occasions were nested within level-2 schools and a piecewise/spline model was estimated with two pieces/slopes. The intercept was at time 0 (the 2006-07 school

year) and there was a breakpoint and a jump/shift in intercept when the policy was implemented after time 6 (2012/13). The piecewise model with a random intercept, two random linear slopes, and a random jump allowed for comparison of slopes before and after the implementation of the policy and the immediate shift in the intercept after the policy. Conditional growth models including covariates were then examined using the piecewise model as a baseline. Likelihood ratio tests, Bayesian Information Criterion (BIC), and Akiake Information Criterion (AIC) were used to select the best model for this analysis.

General linear models were estimated to determine associations between changes in breakfast participation and changes in school-level attendance, test scores, and percent overweight and obese students. For each outcome variable, residual normality, linearity, homogeneity of variance, and influential outliers were assessed. Models were run with and without outliers and no meaningful differences in parameter estimates were observed. All analyses were conducted using SAS version 9.4 (SAS Institutes, Cary, NC).

VI.C. Results

For the breakfast participation analysis, between 133 to 150 schools were included in the dataset per year over 9 years for a total of 1,306 observations. Demographic data for the schools during the school year before the policy (2012-13) and the year after the policy was implemented (2013-14) are provided in Table 9.

Table 9. Demographic information for all study schools, for schools with an increase in breakfast participation, and for schools with no increase in breakfast participation.

	All Study Schools (n=150)		Schools with increase in participation (n=122)		Schools with no increase in participation (n=28)	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Mean Percent Breakfast Participation (SD)	24.1 (17.6)	28.9 (16.7)	20.9 (15.4)	27.6 (16.3)	38.1 (19.8)	34.5 (17.9)
Mean Percent Attendance (SD)	95.0 (1.4)	95.3 (1.5)	95.2 (1.3)	95.5 (1.5)	94.2 (1.5)	94.7 (1.4)
Mean Percent Unexcused Absences (SD)	52.7 (13.5)	58.2 (12.2)	51.4 (13.9)	57.3 (12.6)	58.0 (10.3)	61.8 (9.8)
Mean Percent Days Tardy (SD)	3.7 (1.6)	3.7 (2.1)	3.7 (1.6)	3.5 (2.1)	4.1 (1.8)	4.3 (2.0)
Mean Percent Grade Level Proficient (GLP) All EOG/EOC Subjects (SD)	44.9 (19.9)	57.6 (18.7)	47.6 (19.9)	60.2 (18.4)	33.0 (15.2)	46.5 (15.6)
Mean Percent GLP Math EOG/EOC (n, SD)	45.9 (129, 20.5)	56.3 (129, 20.5)	48.8 (105, 20.4)	59.0 (105, 19.3)	33.3 (24, 15.8)	44.6 (24, 17.0)
Mean Percent GLP Reading EOG/EOC (n, SD)	43.1 (129, 20.5)	55.3 (129, 19.5)	46.3 (105, 20.3)	58.6 (105, 19.0)	29.1 (24, 15.1)	40.8 (24, 14.6)
Mean Percent Overweight and Obese Students (n, SD)	31.8 (86, 9.7)	32.0 (86, 9.4)	30.5 (68, 9.7)	30.7 (68, 9.4)	36.8 (18, 7.9)	36.8 (18, 8.1)
Mean Percent Students of Color (SD)	70.7 (26.3)	71.3 (26.1)	67.4 (26.5)	68.1 (26.3)	85.1 (20.1)	85.0 (20.8)
Mean Percent FRP Eligible (SD)	59.8 (28.4)	60.3 (29.6)	54.4 (27.0)	55.5 (28.8)	83.4 (21.8)	81.1 (23.5)
Percent Elementary Schools	59.3	59.3	61.5	61.5	50.0	50.0
Percent Middle Schools	18.0	18.0	17.2	17.2	21.4	21.4
Percent High Schools	14.0	14.0	13.9	13.9	14.3	14.3
Percent Other Schools	8.7	8.7	7.4	7.4	14.3	14.3

VI.C.i. School Breakfast Participation

Baseline Unconditional Model

Figure 13 displays the trajectory of breakfast participation from 2006-07 to 2014-15, as estimated by this unconditional model. The intercept estimates an average participation rate of 22.6% (SE=1.4, $p<0.001$) among schools at time 0 (school year 2006-07). The average initial rate of change (slope 1) before the policy was implemented was estimated to be 0.3% per year (SE=0.1, $p=0.005$). The slope after the policy was implemented (slope 2) was estimated to be 0.2% (SE=0.4, $p=0.6$). There is a shift or jump in the intercept of 4.1% (SE=0.7, $p<0.001$) after time 6.

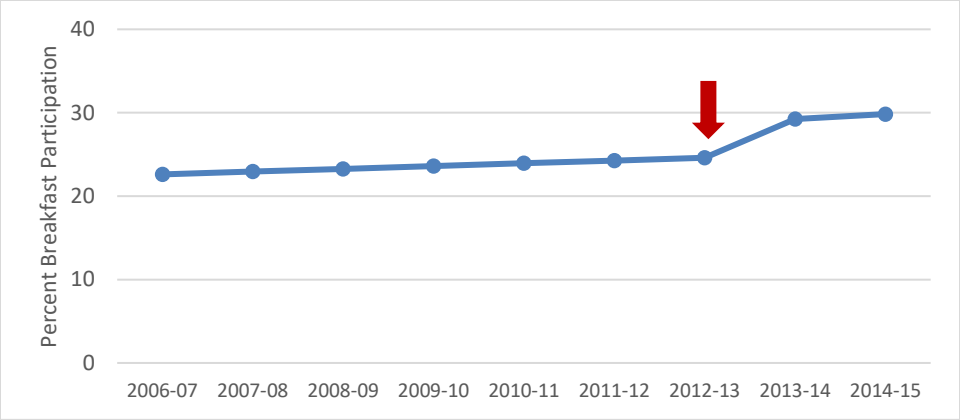

Figure 13. Estimated average percent School Breakfast Program participation among schools in a large urban school district in the Southeast US between 2006-07 and 2014-15
Note: The arrow represents the implementation of the 2013 Universal Free Breakfast Policy.

Final Conditional Model

The final conditional model includes the following school-level covariates: school grade-level (elementary, middle, high, or other school), percent students of color student (Low<30%, 30%≥Medium<70%, or High≥70%), percent change in students of color, percent of FRP eligible students (Low<30%, 30%≥Medium<70%, or High≥70%), and percent change in FRP eligible students. The model also contained interaction terms for each of these covariates and the two slopes and jump. Results from the final model are summarized below. Figure 14 contains estimated SBP participation rates for school years 2006-07 to 2014-15 by FRP eligibility, percent students of color, percent change in students of color, and percent change in FRP eligible students.

School Level: Relative to elementary schools, middle schools had significantly lower breakfast participation in 2006-07 (-7.8% SE=1.9, p<0.001) and a significantly less positive change in participation rate from 2012-13 to 2014-15 (-3.0 SE=1.1, p<0.01). Similarly, relative to elementary schools, high schools had significantly less positive breakfast participation in

2006-07 (-17.2% SE=2.2, p<0.001) and significantly less positive change in participation rate from 2012-13 to 2014-15 (-3.1% SE=1.2, p=0.01). "Other" schools (schools with grade level configurations that did not fall within NCES grade spans for elementary, middle or high schools) had significantly higher breakfast participation in 2006-07 (10.3% SE=2.6, p<0.001) than elementary schools and significantly less positive change in participation rate from 2012-13 to 2014-15 (-4.0% SE=1.5, p<0.001).

Percent Students of Color: Relative to schools with a high percentage of students of color (≥70%), schools with a medium percentage of students of color (30%≥Medium<70%) had significantly lower breakfast participation in 2006-07 (-7.0% SE=2.4, p<0.01). Relative to schools with a high percentage of students of color (≥70%), schools with a low percentage of students of color (<30%) had a non-significantly lower breakfast participation in 2006-07 (-6.7% SE=3.6, p=0.07). There were no significant effects of the change in percent of students of color between 2012-13 and 2013-14.

Percent FRP Students: Relative to schools with a high percentage of FRP eligible students (≥70%), schools with a medium percentage of FRP eligible students (30%≥Medium<70%) had significantly lower breakfast participation in 2006-07 (-10.7% SE=2.0, p<0.001) and a significantly greater increase or jump in participation after 2012-13 (8.7% SE=2.1, p<0.001). Similarly, relative to schools with a high percentage of FRP eligible students, schools with a low percentage of FRP eligible students (<30%) had significantly lower breakfast participation in 2006-07 (-22.4% SE=3.2, p<0.001) and a significantly greater increase or jump in participation after 2012-13 (9.0% SE=3.2, p<0.01). In addition, for every 1% increase in FRP eligible students between the 2012-13 and 2013-14 there was a 0.5% increase in the jump (SE=0.01, p<0.001).

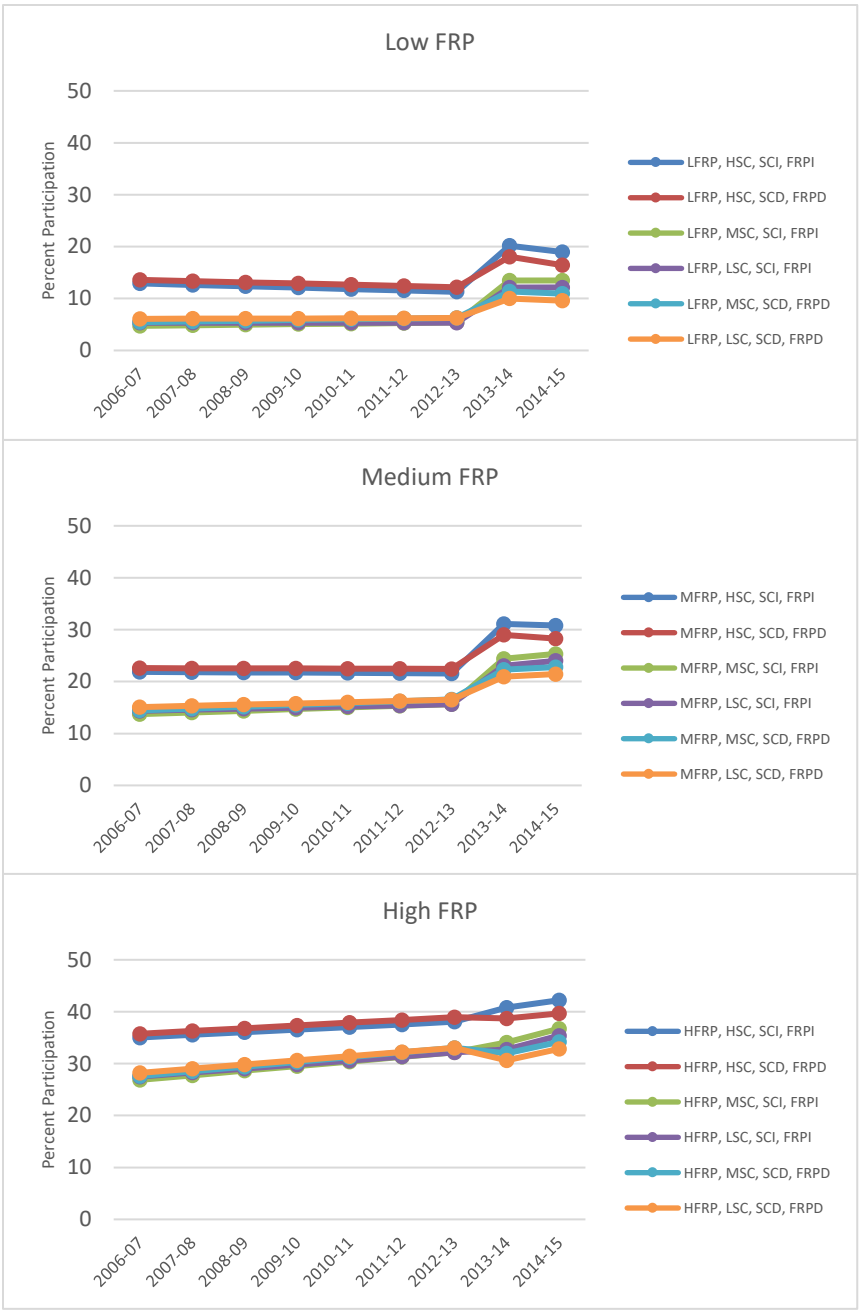

Figure 14. Estimated breakfast participation rates for school years 2006-07 to 2014-15 by FRP eligibility, percent of students of color, percent change in students of color, and percent change in FRP eligible students.

Note: Low percent FRP eligibility =LFRP<30%, 30%≥medium percent FRP eligibility =MFRP<70%, high percent FRP eligibility =HFRP≥70%),
Low percent of students of color=LSC<30%, 30%≥medium percent of students of color=MSC<70%, or high percent of students of color HSC≥70%)
Percent change in students of color (SC decrease (SCD)=-2%, SC Increase (SCI)=2%),
Percent change in FRP eligible students (FRP decrease (FRPD)=-2%, FRP Increase (FRPI)=2%)

VI.C.ii. School Attendance

Overall there was an average observed increase in school-level attendance of 0.3% between the 2012-13 and 2013-14 school years (n=150, SD=0.7). The observed mean increase in attendance for schools that had an increase in SBP participation was 0.3% (n=122, SD=0.7) and was 0.5% (n=28, SD=0.7) for schools that did not have an increase in participation. Results from a linear regression model controlling for school-grade level, 2012-13 breakfast participation rate, percent of students of color, and percent of students eligible for FRP indicate that for every 1% increase in breakfast participation between 2012-13 and 2013-14, the change in attendance was expected to be non-significantly lower by 0.003% in (SE= 0.01, p=0.7).

Overall between the 2012-13 and 2013-14 school years, there was an observed increase of 5.5% in the percent of absences that were unexcused absences (n=150, SD=8.6). The mean observed increase in unexcused absences for schools that had an increase in SBP participation was 5.9% (n=122, SD=9.2) and was 3.8% (n=28, SD=5.6) for schools that did not have an increase in participation. After controlling for school-grade level, 2013 breakfast participation rate, percent of students of color, and percent of students eligible for FRP there was no significant association between change in breakfast participation and the change in unexcused absences (0.003% SE=0.1, p=0.9).

The overall percent of days that students were tardy decreased by 0.06% (n=150, SD=1.3) between the 2012-13 and 2013-14 school years. For schools that increased participation in the SBP, the percent of days that students were tardy decreased by 0.13% (n=122, SD=1.3) and at schools were SBP participation did not increase, the percent of days that students were tardy increased by 0.24% (n=28, SD=1.4). Results from a linear regression model controlling for covariates mentioned above indicate that for every 1% increase in breakfast

participation between 2012-13 and 2013-14, the percent of days that students were tardy was expected to be non-significantly lower by 0.03% (SE= 0.02, p=0.06).

VI.C.iii. Test Scores

Across all study schools, the mean observed percent change in test scores for all EOG/EOC subjects combined increased by 12.8% (n=150, SD=4.9) between the 2012-13 and 2013-14 school years. The mean observed percent change in test scores for all EOG math assessments increased by 10.4% (n=129, SD=5.8) and the mean observed percent change in test scores for all EOG reading assessments increased by 12.2% (n=129, SD=4.3). In schools that increased participation in the SBP the mean percent change in test scores for all EOG/EOC subjects combined increased by 12.6% (n=122, SD=4.7), increased by 10.2% (n=105, SD=5.5) for all EOG math assessments, and increased by 12.3% (n=105, SD=4.2) for all EOG reading assessments. In schools that did not increase participation the mean percent change in test scores for all EOG/EOC subjects combined increased by 13.4% (n=28, SD=5.5), increased by 11.3% (n=24, SD=7.3) for all EOG math assessments, and increased by 11.7% (n=24, SD=4.7) for all EOG reading assessments.

Controlling for covariates mentioned above, for every 1% increase in breakfast participation between 2012-13 and 2013-14, the percent change in test scores for all EOG/EOC subjects was significantly lower by 0.13% (SE= 0.06, p=0.02). For every 1% increase in breakfast participation, the percent change in test scores for all EOG math assessments was non-significantly lower by 0.12% (SE=0.08, p= 0.2). For every 1% increase in breakfast participation, the percent change in test scores for all EOG reading assessments was non-significantly lower by 0.04% (SE= 0.06, p= 0.5).

VI.C.iv. Percent Overweight and Obese Students

Between 2012-13 and 2013-14 there was an observed increase of 0.2% (n=86, SD=6.4) in the mean percent of overweight and obese students across all schools included in the study. Among schools that had an increase in SBP participation there was an observed increase of 0.2% (n=68, SD=6.6) in the mean percent of overweight and obese students and among schools that did not have an increase in participation there was an increase of 0.01% (n=18, SD=6.1). Results from a linear regression model controlling for covariates mentioned above indicate that for every 1% increase in breakfast participation between 2012-13 and 2013-14 there was a non-significant increase of 0.03% in the percent of overweight and obese students (SE= 0.1, p=0.4).

VI.D. Discussion

On average, across all schools included in the study, there was an immediate uptick in participation following the implementation of the UFB policy, but the rate of increase in participation (the slope) after the policy was not as great as the rate of increase prior to the policy. However, these changes appear to differ among schools with different levels of FRP eligible students and students of color and among schools of different grade-levels. Schools with lower percentages of FRP eligible students and students of color had lower breakfast participation than schools with higher percentages before the policy. Conversely, the immediate jump in participation following the policy appeared to be greater for schools with lower percentages of FRP eligible students than schools with higher percentages. Middle and high schools also had significantly lower participation rates than elementary schools prior to the policy and a significantly lower rate of increase in participation following the policy.

The lower rates of increased participation in schools on average and in middle and high schools that followed the implementation of the policy, were based on only a few years of data, and thus it may be too early to determine the association between the policy and the longer-term rate of change in breakfast participation. The reason for the greater increase in participation immediately following policy implementation in schools with lower FRP eligibility relative to higher eligibility may be due to a variety of factors. It is possible that the increase in participation came from students who did not previously qualify for free and reduced meals. Students who normally might not be incentivized to eat breakfast at school due to cost and perhaps other barriers may have found that option more appealing since breakfast was free. It is also possible that if more students who were not eligible for free or reduced-price meals were participating at the schools with lower FRP eligibility due to the policy, there may have been less perceived stigma around eating school breakfast and more FRP eligible students may have participated as well. Unfortunately, changes to the way that free and reduced eligibility is determined that occurred after the policy and inconsistencies in the numbers of students in each eligibility category at each school did not allow for direct comparisons of changes in participation among free, reduced, and full price students. Barriers to breakfast participation at schools with higher FRP eligibility may also be different than those with lower FRP eligibility, and a UFB policy alone may not be able to address those barriers.

As for associations between the UFB policy and attendance, there was very little change in total attendance (excused and unexcused absences combined) and percent of days tardy in schools overall before and after the policy was implemented. The small changes that were observed did not differ significantly for schools that had an increase in SBP participation following the policy relative to those that did not. There was an increase in unexcused absences

on average across schools and the percent increase in unexcused absences was slightly higher for schools that increased participation in breakfast, but this difference was not statistically significant. Individual students in schools across the district may have been on time and present more often due to the availability of free breakfast, but these changes were not large enough to detect on the school level. Some studies of UFB policies that were able to analyze breakfast participation on the student-level did observe increases in attendance.[79, 92] For example, a study of a UFB policy in New York City schools found that among 3rd to 8th graders there was a small increase in breakfast participation and a small increase in attendance for black students eligible for free meals.[79] A study of the implementation of a UFB program in one public school in Philadelphia, PA (grades K-6) and two public schools in Baltimore, MD (grades K-8) found breakfast participation nearly doubled and students who increased their participation had greater decreases in absences and tardiness than students whose participation remained the same or decreased.[92] However, a study of a UFB program in San Diego elementary schools found no significant change in attendance.[107]

Observed test scores increased dramatically between the 2012-13 and 2013-14 school years across all schools and appeared to increase more for schools that did not have an increase in SBP participation following the implementation of the UFB policy. One of the reasons that there was such a large change in test scores might be due to the fact that end-of-year testing across the state of North Carolina changed during the 2012-13 school year. As of the 2012-13 school year the NC State Board of Education implemented the READY Accountability Model, which aligned the Standard Course of Study in NC schools with the Common Core State Standards in Mathematics and English Language Arts/Reading and the NC Essential Standards in Science.[111, 114] End-of-grade assessments in reading and mathematics in grades 3-8 and

science assessments in grades 5 and 8 and end-of-course assessments in English II, Biology and Math I were changed in 2012-13 to correspond to the new Standard Course of Study.[114] After the change in testing, the percent of students meeting grade level proficiency in LUSD and across the state decreased markedly,[115] but across the state there was an increase of 11.6% in the percent of students meeting grade level proficiency for all EOG/EOC subjects between the 2012-13 and 2013-14 school years.[111, 116] The increases in percent of students meeting grade level proficiency for all EOG/EOC subjects in LUSD was slightly higher than the increase at the state-level (12.8% vs 11.6%), so it is possible that the UFB policy may have contributed to the increase in test scores. However, adjustments by teachers and students to the more rigorous testing standards may have been the primary reason for the observed increase in scores.

Results of studies of other UFB programs and policies that included academic performance have been mixed.[79, 92, 96, 97, 107, 117, 118] A study of the switch from a UFB program back to an eligibility-based program in elementary schools in Guilford County School District in North Carolina found a reduction in breakfast participation and no significant change in math and reading test scores.[96] A study of the impact of the implementation of a UFB policy in New York City schools found little evidence of changes in test scores.[79] A 3-year pilot study of the effects of a UFB program that was conducted in elementary schools in 6 school districts across the US did not find any significant association between the program and test scores except in among a few "highly disadvantaged" student populations.[97, 118] Dotter (2013) found an increase in math and reading test scores among elementary schools in San Diego that adopted a UFB program.[107] Imberman and Kugler (2012) studied the impact of a breakfast in the classroom program in elementary and middle schools in a large urban school district in the Southwest United States on academic performance.[117] Similar to Dotter, they found improvements in both

math and reading scores at schools that implemented the program, but did not find significant improvements in grades. A study of UFB programs in a public school in Philadelphia, PA and two public schools in Baltimore, MD found greater increases math grades among students who increased their participation in breakfast.[92]

Finally, on average, there was very little change in the percent of overweight and obese students in LUSD schools included in the study between the 2012-13 and 2013-14 school years. Similarly, at the national and state-level the percent overweight and obese children and adolescents has also remained relatively stable over the last several years.[119, 120] Nationally, the percent of obese children and adolescents aged 2-19 years between 2011-2014 was approximately 17%,[119] and the percent overweight and obese students in grades 9-12 has fluctuated between roughly 27% to 30% from 2003 to 2013.[120] There has been some concern that UFB programs and other alternative breakfast service models may result in excess calorie consumption by students eating more than one breakfast.[121] While it is premature to draw conclusions about the longer-term impact of the UFB policy in LUSD on student weight status, these early results do not provide evidence of excess calorie consumption and subsequent weight gain. Other studies of UFB programs and alternative breakfast service models have found similar results.[97, 118, 122] A three-year pilot study of the effects of a universal free breakfast program that was conducted in elementary schools in six school districts across the US found students' calorie consumption over a 24-hour period was not affected by the availability of free breakfast and there was no evidence of improvements in nutrition intake or health (as measured by age-adjusted BMI).[52, 118] However, students at the treatment schools were more likely to consume a substantive breakfast (a meal with food from at least two of the five food groups) and were more likely to consume more servings of fruits and dairy at breakfast than control

students.[71] A longitudinal study of middle school students that examined breakfast consumption patterns and the location in which breakfast was consumed (none, home, school, both), found an increased odds of overweight/obesity among frequent breakfast skippers compared with double breakfast eaters, and that double breakfast eaters had weight changes that were similar to other students.[122] An evaluation of a New York City breakfast in the classroom (BIC) program found that some students in elementary schools that offered free breakfast in the classroom consumed more than one breakfast and consumed a greater number of calories in the morning than students not offered BIC.[90] However, this study only examined differences in morning calories consumed and not calories over the course of a full day. A more recent study of the New York BIC program found no evidence that BIC increased student BMI or the incidence of obesity among students.[88]

VI.D.i. Limitations

All schools in the district implemented the UFB policy at the same time, so it was not possible to compare changes in participation levels and other outcomes to schools that did not adopt the policy. Future studies could compare trends in the outcome measures to other districts, but the size and demographic characteristics of LUSD make it difficult to compare to other districts in the state. It was not possible to obtain individual student FRP eligibility or meal consumption data, which limits the ability to determine student-level associations between changes breakfast participation and other outcomes. In addition, height and weight data were not available for all schools, especially for middle and high schools, and it is not clear whether standardized measurement procedures were used for collecting weight and height data. As a result, changes in the percent of overweight and obese students observed in this study may not be representative of schools across the district.

VI.D.ii. Conclusion

Despite these limitations, this study adds to the evidence that UFB policies are associated with increases in participation in the SBP. Past studies have focused primarily on elementary schools, but this study included schools of all grade-levels and results indicate that increases in participation after the implementation of UFB policies are also possible in middle and high schools. While some schools had very large increases in participation, upwards of 28%, other schools had more modest increases or no increase following the UFB policy. As a result, additional strategies may be needed to overcome barriers to participation in the SBP. The results do not provide evidence of excess calorie consumption and subsequent weight gain immediately following UFB policy implementation. Nor do they provide conclusive evidence about associations between UFB policies and attendance or test scores. Future studies should examine the longer-term effects of the policy on breakfast participation and other student outcomes. Studies could also examine the factors that led to a greater increase in SBP participation after the implementation of the UFB policy at some schools relative to others.

CHAPTER VII: SYNTHESIS

VII.A. Overview of Findings

Overall, this research examines the relationship between alternative breakfast service model programs and policies and SBP participation, attendance, academic achievement, and student weight status. Participation in the SBP is significantly lower than participation in the National School Lunch Program and given the possible benefits of breakfast for children and adolescents, the goal of alternative breakfast service model initiatives is to increase breakfast consumption by reducing barriers to participation.

A number of studies of the SBP have been conducted since its inception in the late 1960s; however, most these studies have not focused on the impact of the alternative breakfast service models that are currently being implemented in schools across the country. Through the review that we conducted, we were able to gather a range of studies of alternative breakfast service model initiatives that have been conducted and published in the peer-reviewed literature. We were able to examine relationships between these innovative programs and SBP participation, attendance, academic achievement and student nutrient intake and weight status. Overall, we found that some alternative breakfast service models may result in an increase in participation in school breakfast programs. However, the extent to which the increase in participation in the breakfast program leads to improvements in attendance, academic achievement, nutrient intake/diet quality, and weight status is not clear. The SBP may be one factor among many that may impact these outcomes. A few examples of other possible contributors include overall

health status, sleep habits, and physical activity levels. Nevertheless, further studies may be warranted since there is some evidence that alternative breakfast service models may have a positive impact on these outcomes.

Using district-level and school-level longitudinal data on breakfast participation rates and student demographics for schools across the state of North Carolina, we were able to examine whether a series of statewide policy and practice changes designed to promote participation in the SBP through alternative breakfast service models are associated with changes in participation in the school breakfast program. On average, we found there was a significant increase in the rate of change in breakfast participation on the district level of 1.1% after the *Resolution to Promote School Breakfast* was passed and the *Breakfast is Brain Fuel Toolkit* was released relative to the breakfast participation rate before the resolution and toolkit (school years 2007-08 to 2010-11). The breakfast participation rate at the district level did not increase after the 2013 Breakfast Challenge. However, the school-level analyses indicated that schools that participated in the 2013 Challenge did have a significantly greater increase in the participation rate of 5.0% between the 2012-2013 and 2013-14 school years relative to schools that did not participate. On the district level, there was a significant increase in the rate of participation after the implementation of CEP and the 2014 Breakfast Challenge. On the school level, schools that participated in CEP did have a significantly greater increase in participation than schools that did not participate in CEP during the 2014-15 school year, but there was not a significant increase in participation among schools that participated in the 2014 Breakfast Challenge relative to those who did not participate in this Challenge.

Findings from this study indicate that most of the policy and practice changes implemented in North Carolina were associated with an increase in school breakfast participation

either at the school or district level. Moreover, the findings provide evidence that broad-based programs, national- and state-level initiatives, and combinations of formal state resolutions with public/private partnerships may be effective ways to increase participation in the SBP. It is possible that the combined or accumulated effects of these initiatives may increase participation in the SBP more than any single initiative.

Using school-level longitudinal data, we were able to examine associations between a district-wide universal free school breakfast policy implemented in 2013-14 in a large urban school district in the Southeast United States and changes in school-level breakfast participation, school attendance, academic achievement, and student weight status. We found that on average, across all schools included in the study, there was an immediate uptick in participation following the implementation of the UFB policy in the school year following implementation. However, changes in participation appeared to differ among schools with different levels of FRP eligible students and students of color and among schools of different grade-levels. Following the implementation of the UFB policy, school-level increases in SBP participation were not associated with significant changes in attendance or weight gain. Due to substantial policy changes in testing in the year prior to the implementation of the UFB policy, the association between participation and test scores is not thought to be reliable. Given the fact that the changes in testing were made at the state level and additional changes in end of year testing may occur in the future as a result of changes to state or federal policy, it may be useful to use other measures of academic achievement in future studies of the SBP. The measures could include grades or other cognitive assessments designed for use in children and adolescents.

Overall, results of the LUSD study indicate that UFB policies may be effective ways to increase participation in the SBP. The results of the study do not provide evidence of excess

calorie consumption and subsequent weight gain immediately following UFB policy implementation. Nor do they provide conclusive evidence about associations between UFB policies and attendance or test scores. It is possible that changes did occur on the student level, but these changes were not apparent on the school level. For example, students who increased their participation in the SBP due to the policy may have also had improvements in attendance and test scores. Unfortunately, student-level participation data was not available for this study. Future studies should consider including student-level data if possible.

Taken together, the results of the literature review, study of statewide alternative breakfast service model initiatives, and study of the LUSD UFB policy add to the evidence that alternative breakfast service model initiatives may result in increases to SBP participation. The evidence that implementation of these initiatives leads to increases in student attendance, test scores, and nutrient intake and weight status is not clear.

VII.A.i. Limitations

The observational study designs of the statewide analyses and district analyses do not allow us to determine whether the policy interventions actually caused the observed changes in outcomes. It is possible that other factors and events not included in this study could have influenced or caused changes in participation rates and other outcomes. In the case of the statewide analyses, it was also not possible to examine the individual effects of some of the policy interventions. For the LUSD study, all schools in the district adopted the UFB policy at the same time, so it was not possible to compare changes in participation levels and other outcomes to schools that did not adopt the policy. It was also not possible to obtain individual student FRP eligibility or meal consumption data, which limits the ability to determine student-level associations between changes in breakfast participation and other outcomes. In addition,

height and weight data were not available for all schools, especially for middle and high schools, and it is not clear whether standardized measurement procedures were used for collecting weight and height data. Additional research is also needed to assess the longer-term impact of these policies (beyond the 2014-2015 school year) on participation and other relevant outcomes like academic achievement, behavior, attendance and student BMI, and to determine whether there are any unintended consequences.

VII.A.ii. Strengths

These studies add to the evidence that alternative breakfast service models may increase participation in the SBP. They also provide evidence that broad-based programs, national- and state-level initiatives, and combinations of formal state resolutions with public/private partnerships may be effective ways to increase participation in the SBP. For the analyses, we had access to eight years of meal claims data, which allowed us to examine trends in participation in SBP at the district and school levels over a relatively long period of time. Past studies have also focused primarily on alternative breakfast service model policies in primary or elementary schools and our study included schools of all grade levels. Unlike other studies that have examined associations between alternative breakfast service model policies and programs in a few schools or a single district, we were able to examine associations between statewide initiatives and SBP participation in schools and districts across the state of North Carolina.

VII.B. Recommendations

After conducting this research, we have several recommendations for other researchers engaged in studies of alternative breakfast service models. Receiving approval from school districts to conduct research using school or district data and acquiring the data needed to

conduct research can be an involved and lengthy process. It may also take a significant amount of time to clean the data and format it for analyses. Researchers should take this into account when planning project timelines. Researchers should also use a variety of methods, both quantitative and qualitative, to assess the impact of alternative breakfast service models. Qualitative methods can help to validate or explain quantitative methods and the combination of the methods may help researchers gain a deeper understanding of how service models are implemented and what their effect might be.

Researchers and schools or districts interested in implementing alternative breakfast service models may want to consider combinations of initiatives. For example, examining the joint effects of a UFB policy and a BIC policy would be an interesting avenue of research. While it may be premature to determine the longer-term impact of the LUSD UFB policy, it is possible that UFB policies alone may not be able to address all barriers to SBP participation. Schools may need to implement combinations of alternative breakfast services models in order to see larger changes in participation and other outcomes.

VII.C. Future Research

Additional research on alternative breakfast service models is needed to address a variety of gaps in understanding about the implementation of these models and their effect on SBP participation and other student-level outcomes. Immediate next steps to continue this research include conducting qualitative interviews or focus groups with students, administrators, teachers, and nutrition services staff across North Carolina and within LUSD to better understand the implementation of different service models and the remaining barriers to breakfast participation. Collecting and analyzing data from more recent school years (beyond 2014-15) and future years

would also allow us to examine the longer-term trends and associations between the policy and practice changes and breakfast participation and other student outcomes and any unintended consequences.

NC DPI recently initiated a survey for tracking the implementation of alternative breakfast service models in schools in North Carolina, and data collected through this survey may also provide an opportunity for future research. This data could allow researchers to examine schools by alternative breakfast service model type and study associations between these models and participation and other outcomes.

More rigorous research is also needed to examine causal effects of alternative breakfast service models. Future research should include cluster randomized control trials (RCT) where schools are either randomly assigned to implement an alternative breakfast service model or continue with traditional service breakfast. With a clustered RCT researchers could examine causal relationships between new service programs and participation, academic achievement, attendance, and/or student health or weight status.

VII.D. Summary

Given the fact that breakfast consumption has been linked to improved weight status, nutrient intake, and academic achievement among children and adolescents, increasing participation in the SBP is a worthy goal. A number of schools, districts and states have found innovative ways to promote participation in SBP by implementing alternative breakfast service models. This study adds to the evidence alternative breakfast service models may led to increases in SBP participation. However, studies of these programs and policies are in their infancy and more rigorous evaluations need to be conducted to determine the most effective

ways to increase participation and also determine whether these initiatives lead to improvements in academic achievement, attendance, nutrient intake and weight status. Studies also need to identify any unanticipated consequences of these initiatives as well as examine their sustainability over time.

APPENDIX 1: LITERATURE REVIEW SEARCH TERMS

EBSCO (Including ERIC, CINAHL Plus with Full Text, Global Health, Health Source: Nursing/Academic Edition, and PsycINFO):

('school breakfast' OR ('breakfast' OR breakfast AND school*) OR ('school meals program' AND ('breakfast' OR breakfast)) OR 'school breakfast program') AND (alternative AND breakfast* AND school* OR (alternative AND 'service models') OR 'grab and go' OR 'grab n go' OR 'universal free breakfast' OR ('universal service provision' AND ('breakfast' OR breakfast)) OR (free AND 'school breakfast') OR 'universal breakfast' OR 'universal free school breakfast' OR 'breakfast in the classroom' OR 'breakfast after the bell' OR 'breakfast on the bus' OR 'second chance breakfast' OR 'alternative breakfast models') AND ('achievement'/exp OR achievement OR ('program' OR program AND participat*) OR 'program participation' OR 'school breakfast participation' OR attendance OR 'school attendance' OR 'school attendance' OR 'academic achievement' OR 'academic achievement' OR 'absenteeism' OR absenteeism OR 'body mass index' OR 'body mass index' OR 'pediatric obesity' OR 'pediatric obesity' OR 'diet' OR diet OR 'nutrition' OR nutrition OR 'consumption' OR consumption OR calories OR 'nutrient intake' OR 'nutrient intake' OR 'behavior' OR behavior OR "Academic Performance" OR "Eating Behavior" OR "dietary intake" OR "Nutritive Value" OR "student health" OR Psychosocial)

Embase:

("school breakfast" OR (breakfast AND school*) OR ("school meals program" AND breakfast) OR "school breakfast program") AND ((alternative AND breakfast* AND school*) OR (alternative AND "service models") OR "grab and go" OR "grab n go" OR "universal free breakfast" OR ("universal service provision" AND breakfast) OR (free AND "school breakfast") OR "universal breakfast" OR "universal free school breakfast" OR "breakfast in the classroom" OR "breakfast after the bell" OR "breakfast on the bus" OR "second chance breakfast" OR "alternative breakfast models") AND (achievement OR (program AND participat*) OR "program participation" OR "school breakfast participation" OR attendance OR "school attendance" OR "academic achievement" OR absenteeism OR "body mass index" OR "pediatric obesity" OR diet OR nutrition OR consumption OR calories OR "nutrient intake" OR behavior OR "Academic Performance" OR "Eating Behavior" OR "dietary intake" OR "Nutritive Value" OR "student health" OR Psychosocial)

Proquest (Health & Medical Collection, Public Health Database, Nursing & Allied Health Database, Science Database, Physical Education Index, Health Management Database, Family Health Database, Education Database, Psychology Database, Sociology Database, Social Science Database, Applied Social Sciences Index & Abstracts (ASSIA), Political Science Database, Sociological Abstracts, Social Services Abstracts):

ab(("school breakfast" OR (breakfast AND school*) OR ("school meals program" AND breakfast) OR "school breakfast program")) AND ft(((alternative AND breakfast* AND school*) OR (alternative AND "service models") OR "grab and go" OR "grab n go" OR "universal free breakfast" OR ("universal service provision" AND breakfast) OR (free AND "school breakfast") OR "universal breakfast" OR "universal free school breakfast" OR "breakfast in the classroom" OR "breakfast after the bell" OR "breakfast on the bus" OR "second chance breakfast" OR

"alternative breakfast models")) AND ft((achievement OR (program AND participat*) OR "program participation" OR "school breakfast participation" OR attendance OR "school attendance" OR "academic achievement" OR absenteeism OR "body mass index" OR "pediatric obesity" OR diet OR nutrition OR consumption OR calories OR "nutrient intake" OR behavior OR "Academic Performance" OR "Eating Behavior" OR "dietary intake" OR "Nutritive Value" OR "student health" OR Psychosocial))

PubMed:

((((("school breakfast" OR (breakfast AND school*) OR ("School meals program" AND breakfast) OR "School Breakfast Program"))) AND (((alternative AND breakfast* AND school*) OR (alternative AND "service models") OR "Grab and go" OR "Grab n Go" OR "Universal free breakfast" OR ("Universal service provision" AND breakfast) OR (free AND "school breakfast") OR "Universal Breakfast" OR "universal free school breakfast" OR "Breakfast in the classroom" OR "Breakfast After the Bell" OR "Breakfast on the bus" OR "Second Chance Breakfast" OR "Alternative Breakfast Models"))) AND ((achievement OR (program AND participat*) OR "program participation" OR "School Breakfast Participation" OR attendance OR "school attendance" OR "academic achievement" OR absenteeism OR "Body Mass Index" OR "Pediatric Obesity" OR diet OR nutrition OR consumption OR calories OR "nutrient intake" OR behavior OR "Academic Performance" OR "Eating Behavior" OR "dietary intake" OR "Nutritive Value" OR "student health" OR Psychosocial))

Scopus:

TITLE-ABS-KEY ((("school breakfast") OR (breakfast AND school*) OR (("School meals program") AND breakfast) OR ("School Breakfast Program") AND ((alternative AND breakfast* AND school*) OR (alternative AND ("service models")) OR ("Grab and go") OR ("Grab 'n Go") OR ("Universal free breakfast") OR (("Universal service provision") AND breakfast) OR (free AND ("school breakfast")) OR ("Universal Breakfast") OR ("universal free school breakfast") OR ("Breakfast in the classroom") OR ("Breakfast After the Bell") OR ("Breakfast on the bus") OR ("Second Chance Breakfast") OR ("Alternative Breakfast Models")) AND (program AND participat*) OR ("program participation") OR ("School Breakfast Participation") OR attendance OR ("school attendance") OR ("academic achievement") OR achievement OR absenteeism OR ("test scores") OR ("Body Mass Index") OR ("Pediatric Obesity") OR diet OR nutrition OR consumption OR calories OR ("nutrient intake") OR "dietary intake" OR behavior OR "Academic Performance" OR "Eating Behavior" OR "dietary intake" OR "Nutritive Value" OR "student health" OR psychosocial))

Web of Science:

("school breakfast" OR (breakfast AND school*) OR ("school meals program" AND breakfast) OR "school breakfast program") AND ((alternative AND breakfast* AND school*) OR (alternative AND "service models") OR "grab and go" OR "grab n go" OR "universal free

breakfast" OR ("universal service provision" AND breakfast) OR (free AND "school breakfast") OR "universal breakfast" OR "universal free school breakfast" OR "breakfast in the classroom" OR "breakfast after the bell" OR "breakfast on the bus" OR "second chance breakfast" OR "alternative breakfast models") AND (achievement OR (program AND participat*) OR "program participation" OR "school breakfast participation" OR attendance OR "school attendance" OR "academic achievement" OR absenteeism OR "body mass index" OR "pediatric obesity" OR diet OR nutrition OR consumption OR calories OR "nutrient intake" OR behavior OR "Academic Performance" OR "Eating Behavior" OR "dietary intake" OR "Nutritive Value" OR "student health" OR Psychosocial)

APPENDIX 2: LITERATURE REVIEW DATA TABLE

					Summary of Outcomes				
First Author, Publication Year	**Study Design**	**Type of Service Model**	**Sample**	**Alt Breakfast Intervention or Procedure**	**Participation**	**Attendance**	**Academic Achievement**	**Nutrient Intake**	**BMI/Weight Status**
Anzman-Frasca, 2015[86]	Natural experiment with comparison group	BIC	446 public elementary schools from a large, urban school district in the US.	During the 2012-13 school year, 257 (57.6%) of schools in the district offered BIC and 189 (42.4%) continued to offer traditional breakfast in the cafeteria. Collected data on SBP participation, attendance, and standardized test scores during the 2012-13 school year for BIC and non-BIC schools	The average participation rate during the 2012-13 school year was higher among BIC schools (~74%) than among non-BIC schools (~43%).	A small but significant main effect for attendance. Grade-level attendance rates for BIC schools (95.5%) were slightly higher than non-BIC schools (95.3%)	No significant differences on the percentages of students who achieved state benchmarks on standardized tests for math and reading among BIC and non-BIC schools.	N/A	N/A
Ask, 2006[70]	Cluster randomized controlled study	UFB	54 tenth grade students in two classes in a rural school in southern Norway.	One class randomized to UFB for 4 months. The other class received info about the importance of a healthy diet and no breakfast. Height and weight and dietary intake measured before and after the UFB. Survey for students to rate their school performance and teachers survey to gather info on student attendance.	N/A	Teachers reported an increase in attendance among intervention students, but this increase was not significant.	No significant increase in school performance as measured by time spent doing homework.	Before UFB 54% of intervention students and 43% of control students had breakfast each day. During UFB, most intervention students had breakfast, but after UFB students went back to their pre-UFB habits. Intervention males increased their healthy eating index significantly.	No significant differences prior to the intervention. After the intervention, weight and BMI increase significantly in males and females in the control class. There was a significant increase in weight among intervention males, but not among intervention females. There was not significant change in BMI in the intervention group.
Bartfeld, 2010[44]	Cross-sectional	BIC	Nationally representative sample included 6,680 third grade public school students in 1,125 schools that offer the SBP.	Outcome was SBP participation based on parental report. Breakfast location (classroom, cafeteria, common areas, or other location) was included as an independent variable.	The probability of participating in the SBP is positively associated with breakfast in the classroom (odds ratio=2.35, $p<0.01$)	N/A	N/A	N/A	N/A

					Summary of Outcomes				
First Author, Publication Year	**Study Design**	**Type of Service Model**	**Sample**	**Alt Breakfast Intervention or Procedure**	**Participation**	**Attendance**	**Academic Achievement**	**Nutrient Intake**	**BMI/Weight Status**
Baxter, 2010[33] (data from same study as Guinn, 2013)	Repeated cross-sectional	BIC	1,780 fourth-grade children in 18 schools from one district in South Carolina across the three school years of data collection.	6 of 17 schools had BIC in year 1, 6 of 17 schools had BIC in year 2 and 7 of 8 schools had BIC in year 3. Collected data on height and weight. Meal intake was observed for 465 children and energy intake estimated based on food consumed.	N/A	N/A	N/A	Based observations, researchers estimated that students consumed significantly more calories in BIC (276 calories) than in the cafeteria (250 calories; $p = 0.017$).	Average BMI was larger for students with breakfast in the classroom (21.90) than breakfast in the cafeteria (20.48).
Bro, 1994[87]	Crossover study	BIC	10 male high school students from a welding class at a vocational high school in Washington state.	There were 2 baseline and 2 breakfast periods and each period was 10 consecutive school days. During breakfast period students received BIC. Attendance was tracked throughout.	N/A	Overall attendance was high and increased during the study, but the change was not significant.	N/A	N/A	N/A
Corcoran, 2016[88]	Natural experiment with matched comparison groups.	BIC	SBP participation and attendance data included 1,000-1,100 NYC schools with 713,000- 730,000 students (elementary and middle). Height and weight data (Fitnessgram) included ~1,700 NYC schools with more than 860,000 students (all grades).	Staggered implementation of BIC in NYC schools. Examined SBP participation, student attendance, academic achievement, and student BMI.	Participation increased an average of approximately 30 percentage points in schools that had schoolwide BIC.	No significant increase in attendance.	No significant improvement in academic achievement as measured by reading and math scores on state tests.	N/A	No evidence that offering BIC resulted in an increase in BMI or the prevalence of obesity.

					Summary of Outcomes				
First Author, Publication Year	**Study Design**	**Type of Service Model**	**Sample**	**Alt Breakfast Intervention or Procedure**	**Participation**	**Attendance**	**Academic Achievement**	**Nutrient Intake**	**BMI/Weight Status**
Crepinsek, 2006[71]	Cluster randomized controlled study	UFB	153 matched elementary schools in six school districts across US--79 intervention schools and 74 control schools. ~4,300 students provided data on breakfast consumption and ~3,400 students provided data on food and beverage consumption for the full day.	Six school districts across the US were selected and participating schools within each district were paired based on demographic variables. Schools within each pair were randomly assigned to the UFB intervention or to control. Dietary recalls conducted with a subset of students in grades two to six with the assistance of parents.	Significant increase in SBP participation among intervention schools--an increase from 16% to 40%.	N/A	N/A	No significant difference in breakfast consumption between intervention and control students (4% skipping). Intervention students significantly more likely to eat a substantive breakfast. Students eating two breakfasts had higher daily energy intakes than students eating one. Calcium, magnesium, and phosphorus intakes at breakfast higher among intervention students. Cholesterol intake was lower for intervention students at breakfast and over a 24-hour period.	No significant differences in BMI or the percentage of students in control and intervention schools who were overweight.
Cueto, 2008[72]	Quasi-experimental study with matched comparison groups.	UFB	590 fourth-grade students from 20 schools in Peru	Eleven intervention schools received free breakfast at school and 9 control schools did not. Collected school breakfast consumption data and attendance data collected for students in first to sixth grade.	Based on teacher reports almost 82% of students consumed all the breakfast provided.	Increase in monthly attendance, 90 to 95% for UFB schools compared to 80 to 87% in non-UFB schools.	Increase in test scores among multiple grade schools, but not among full-grade schools after the start of the intervention.	N/A	N/A
Cullen, 2012[73]	Quasi-experimental study with matched comparison groups.	UFB	Five middle schools from a school district in the Houston area.	Three low income middle schools were selected as intervention schools and two low-income middle schools were selected as control schools. Two intervention schools offered free breakfast to all students and one intervention school offered free breakfast to students who qualified for reduced price breakfast.	Average SBP participation rate prior to the study was 17% for intervention schools and 28% for control. Participation during the intervention was ~59% for intervention schools and 35% for control schools. The number of SBP meals served during the intervention semester increased by 242% compared to the average of the previous three semesters.	N/A	N/A	N/A	N/A

					Summary of Outcomes				
First Author, Publication Year	**Study Design**	**Type of Service Model**	**Sample**	**Alt Breakfast Intervention or Procedure**	**Participation**	**Attendance**	**Academic Achievement**	**Nutrient Intake**	**BMI/Weight Status**
Dykstra, 2016[74]	Cross-sectional	UFB	821 fourth- through sixth-grade students and their parents from 16 schools in Philadelphia, PA school district.	Surveyed students on location breakfast obtained and breakfast composition. Surveyed parent on household food security status. Received SBP data from school district.	16.9% of students reported skipping breakfast. Students participated in the SBP on 31.2% of days they attended school. No differences in SBP participation by FRP, grade, or weight status, but differences by race/ethnicity and gender. Most students ate at home (79.2%), followed by school (38.8%) and the corner store (19.4%).	N/A	N/A	Most frequently reported items consumed for breakfast were milk (47%), cereal (37%), and 100% fruit juice (32%).	N/A
Guinn, 2013[67] (data from same study as Baxter, 2010)	Repeated cross-sectional	BIC	Sample included 692 fourth-grade students from 17 schools in year 1 and 368 from 8 schools in year 2. All schools were from one district in South Carolina.	Six schools had BIC in year 1 and 7 schools had BIC in year 2.	More students participating on Wed than Mon. Highest participation for Sep and lowest for April. Participation lower for schools with traditional breakfast (38%) vs. those with BIC (71%).	N/A	N/A	N/A	N/A
Huang, 2006[75]	Natural experiment with matched comparison groups	UFB	Six schools in the St. Joseph School District in Missouri. Matched student samples for SBP participation (n=264) and for attendance (n= 341). Matched student sample for math test scores for K and first grade (n=169) and for science test scores for fourth and fifth grade (n=176)	Three intervention schools were selected to offer UFB and three schools served as control schools and offered traditional breakfast. Researchers collected data on SBP participation, attendance, and academic performance.	Control school SBP participation remained constant between 2001-02 (pre-implementation) and 2002-03 (post-implementation). Intervention school 1 increased from ~48% to 67%, school 2 from 45% to 92%, and school 3 from 41% to 93%.	Attendance at intervention schools increased significantly between 2001-02 and 2001-03--from approximately 91% to 94% (p=0.006)	No significant increases in test scores before and after the implementation of UFB.	N/A	N/A

					Summary of Outcomes				
First Author, Publication Year	**Study Design**	**Type of Service Model**	**Sample**	**Alt Breakfast Intervention or Procedure**	**Participation**	**Attendance**	**Academic Achievement**	**Nutrient Intake**	**BMI/Weight Status**
Imberman, 2014[89]	Natural experiment with matched comparison groups	BIC	Students from a large urban school district in the Southwest US. 6,353 students from 84 schools in 2009 to 2010 for the achievement sample, 37,309 students in 87 schools for the grades sample, and 38,425 students in 87 schools for the attendance sample. Only elementary schools.	33 schools in the district implemented BIC in the 2008-09 school year. Analyzed longitudinal data on participation, attendance, test scores, and grades.	80% of BIC students ate breakfast at school post BIC, whereas only 41% did in non-BIC schools. Participation at BIC schools increased by between 40 and 50 percentage points.	No evidence of an impact of BIC on absenteeism.	On average, there was an increase of 0.09 standard deviations in math scores and 0.06 standard deviations in reading scores associated with BIC. Did not find a significant impact of BIC on grades.	N/A	N/A
Jenkins, 2015[64] (data from same study as Moore, 2014 and Murphy, 2011)	Cross-sectional study using data from an RCT	UFB	A sub sample of 581 students interviewed at baseline and 582 students at follow-up from 55 intervention and 56 wait-list control primary schools in Wales, UK.	Analyzed dietary recall data from a sub-set of students who participated in the RCT.	N/A	N/A	N/A	Quality of students' diets was relatively good prior before UFB. Large portion of students not consuming adequate amounts of certain micronutrients, especially students from deprived backgrounds. Post UFB very little difference in the nutrient composition of breakfasts eaten at school vs. home.	N/A
Kleinman, 2002[76]	Natural experiment without comparison group	UFB	97 fourth to sixth grade students from three schools in the Boston Public School system.	Collected data on dietary intake of students before and six months after UFB program. Also, collected data on attendance and grades.	Participation for children whose nutritional status improved increased by ~56%, participation for those that stayed the same increased by ~20% and participation for those who worsened decreased by 11%.	Students who improved their nutritional intake after the start of the intervention decreased the number of days they were absent.	Students who improved nutritional intake after intervention improved their math grades.	Before UFB 29% of students had two or more nutrient intakes ≤50% of the RDA. Students who ate school breakfast rarely more likely to be nutritionally at risk than students who ate school breakfast sometimes or often. Post UFB 19% of students improved their nutrition, 64% did not change, and 18% got worse.	N/A

					Summary of Outcomes				
First Author, Publication Year	**Study Design**	**Type of Service Model**	**Sample**	**Alt Breakfast Intervention or Procedure**	**Participation**	**Attendance**	**Academic Achievement**	**Nutrient Intake**	**BMI/Weight Status**
Lawman, 2014[77]	Cross-sectional	UFB	651 fourth to sixth grade students from three K-8 schools in Philadelphia.	Collected data on height and weight and on breakfast patterns	N/A	N/A	N/A	~50 % of students ate one breakfast, ~40% consumed multiple breakfasts, and ~12% skipped the morning of the survey. Sixth graders had lower odds of eating breakfast than fourth and fifth graders. Obese students consumed fewer breakfasts than healthy weight students and more likely to report not eating breakfast than overweight and health weight students.	N/A
Leatherdale, 2016[78]	Natural experiment with matched comparison groups	UFB	23,921 students in year 1 of the study and 23,117 students in year 2 of the study from 43 secondary schools in Ontario, Canada.	Five schools implemented a new breakfast program. Two schools increased number of days free breakfast available from 4 to 5 and one school increased days available from 3 to 5. One school switched from traditional breakfast to free breakfast 5 days a week. Fifth school changed from free breakfast 2 days a week to no free breakfast. Collected data on breakfast participation and breakfast skipping.	In three intervention schools, no significant change in participation in the breakfast program relative to the control schools. School that switched from 3 free days of breakfast to 5 had an increase of 16.5% in the prevalence of students participating in breakfast one or more days a week.	N/A	N/A	Only one of the intervention schools had a significant decrease in breakfast skipping relative to the control schools. In the school that started a new free breakfast program, the prevalence of students skipping breakfast at least once per week decrease by approximately 15 % between year 1 and 2.	N/A
Leos-Urbel, 2013[79]	Natural experiment with matched comparison groups	UFB	Sample for student attendance and test score analyses included 723,843 students in grades 3–8 in NYC.	Data on participation, attendance, and academic achievement analyzed.	Participation increased among all students of all income levels (those eligible for free, reduced, and full price meals) at UFB schools in the year after implementation. The greatest increase among full-price students. UFB program increased participation by approximately 20%.	Small significant increases in attendance for black students eligible for free meals and Asian students not eligible for free meals.	No significant effect of UFB on academic achievement.	N/A	N/A

					Summary of Outcomes				
First Author, Publication Year	**Study Design**	**Type of Service Model**	**Sample**	**Alt Breakfast Intervention or Procedure**	**Participation**	**Attendance**	**Academic Achievement**	**Nutrient Intake**	**BMI/Weight Status**
Lieberman, 1976[80]	Quasi-experimental study with matched comparison group	UFB	Two elementary schools in a low-income area in Los Angeles, CA. There were 294 students initially included in the sample from the intervention school and 323 from the control school.	Students from third to sixth grade at one school received free breakfast for 8 months and one school served as a control. Collected data on height and weight, attendance, dietary intake, and academic performance.	Students at the intervention school ate breakfast 60 % of the days they attended school.	No significant difference in attendance between intervention school and comparison school	No significant differences in math and reading scores or psychological tests between control and intervention schools.	Not able to demonstrate that the breakfast program provided improved daily nutrient intake in comparison to control student dietary intake.	No significant change in heights and weights among intervention students after five months of the intervention.
Mhurchu, 2012[81]	Stepped-wedge, cluster randomized controlled trial	UFB	424 children from 14 New Zealand primary schools in low SES areas.	One year UFB program. Collected data on participation, student attendance, academic achievement, self-reported grades, and breakfast habits.	After UFB program implementation the proportion of students eating breakfast at home dropped and there was an increase in students eating breakfast at school. Weekly student UFB program participation ranged from 4 to 38% of days.	Overall no significant effect of the UFB on attendance. Students who participated in the UFB more frequently were significantly more likely to achieve an attendance rate greater that 95%.	No significant effects of the intervention on academic achievement as measured by reading, writing and numeracy tests.	The proportion of students who consumed breakfast daily did not change during the intervention.	N/A
Moore, 2014[66] (data from same study as Jenkins, 2015 and Murphy, 2011)	Secondary data analysis of data collected through a cluster-randomized controlled trial	UFB	4350 students at baseline and 4472 at 12-month follow-up from 55 intervention and 56 wait-list control primary schools in Wales, UK.	Schools randomized to serve as intervention (n=55) or control schools (n=56). 12-month evaluation period. Collected data on breakfast consumption, cognitive performance, and dietary habits. Examined interactions between deprivation and dietary intake and cognitive performance.	N/A	N/A	No significant effects of the intervention on academic achievement.	Students from intervention schools consumed significantly more healthy items at breakfast than students from control schools. Deprivation associated with higher levels of breakfast skipping, consumption of unhealth items, and fewer fruits and vegetables. Breakfast skipping was reduced among children from more deprived UFB schools and students from deprived households.	N/A
Morris, 2010[91]	Pre-post study without comparison group.	Grab and go	209 middle school students from one middle school in the US.	A 2-week grab and go pilot program was implemented during statewide academic testing. Surveyed students on participation.	Nearly half of surveyed students who reported rarely eating breakfast participated in grab and go. Almost two-thirds of surveyed students reported participating in grab and go.	N/A	N/A	N/A	N/A

					Summary of Outcomes				
First Author, Publication Year	**Study Design**	**Type of Service Model**	**Sample**	**Alt Breakfast Intervention or Procedure**	**Participation**	**Attendance**	**Academic Achievement**	**Nutrient Intake**	**BMI/Weight Status**
Murphy, 1998[92]	Natural experiment without comparison group.	UFB	384 students from grades 3-5 and 108 students from grades 6-8 from one public school elementary school in Philadelphia, PA and 2 public elementary schools in Baltimore, MD.	Implemented UFB program and compared data on SBP participation, grades, and attendance from before the program to data from 4 months after the start of the program.	Before UFB SBP participation was 14% in the Baltimore schools and 11% in the Philadelphia school. After 4 months of the program, participation increased to 24% and 47% in the Baltimore schools and 20% in the Philadelphia schools.	No significant differences in attendance before UFB among students who participated in SBP often vs. students who participated rarely or never. After UFB, students who participated in the SBP rarely were absent and tardy more often than students who participated sometimes or often. Students who increased their participation were significantly less likely to be absent or tardy than those that remained the same or decreased their participation.	Before UFB students who participated in the SBP had higher math grades than those who did not. Students who increased their participation in SBP were significantly more likely to increase their math grades.	N/A	N/A
Murphy, 2011[65] (data from same study as Jenkins, 2015 and Moore, 2014)	Cluster randomized controlled trial with repeated cross-sectional design	UFB	4350 students (aged 9–11 years) at baseline and 4472 at follow-up in 111 primary schools in Wales, UK	Schools randomized to serve as intervention (n=55) or control schools (n=56). 12-month evaluation period. Collected data on breakfast consumption, cognitive performance, and dietary habits.	41% of students at intervention schools report attending the breakfast scheme at least once a week, 30 % report going 5 days per week.	N/A	No significant differences in cognitive performance as measured by episodic memory tests among students from intervention and control schools.	Students in intervention schools reported eating more healthy items at breakfast, but no differences in healthy or unhealthy items consumed during the rest of the day. No differences in breakfast skipping in intervention vs. control schools.	N/A
Nanney, 2011[68]	Pre-post study without comparison group.	Grab and go, hallway cart, breakfast after the bell.	One middle school in Minneapolis, Minnesota.	6-week expanded SBP intervention. Collected data on participation.	Before intervention only 11% of students participated in the SBP. Among sixth graders, SBP participation increased from an average of 0.74 days per week to 1.21 at the end of the six-week intervention.	N/A	N/A	N/A	N/A

					Summary of Outcomes				
First Author, Publication Year	**Study Design**	**Type of Service Model**	**Sample**	**Alt Breakfast Intervention or Procedure**	**Participation**	**Attendance**	**Academic Achievement**	**Nutrient Intake**	**BMI/Weight Status**
Powell, 1998[83]	Randomized controlled trial	UFB	407 undernourished and 407 nourished second through fifth grade children from 16 rural Jamaican schools.	Students randomized to control or intervention groups. Intervention students received breakfast and control students received one-quarter of an orange. Breakfast was served on campus before the start of classes. Attendance, achievement test, and height and weight data were collected. Dietary intake was observed at breakfast and lunch.	N/A	Small, but significant improvements in attendance among students who received breakfast.	Significant benefit of intervention on math scores, but not in spelling or reading.	Breakfast group consumed fewer calories at lunchtime, but had an overall net increase in calories consumed.	Heights and weights increased more among intervention than control students. Increases for these students indicate an improvement in nutrient intake and weight status.
Olsta, 2013[41]	Pre-post study without comparison group.	Breakfast after the bell and mobile cart (grab and go).	One high school in a midwestern suburb in US with 2,560 students	Breakfast after the bell and a mobile cart that study hall student could purchase food from. Collected data on SBP participation.	80 school breakfast were served before implementation. The number of breakfast served tripled after implementation--by the end of the school year an average of 324 meals were served per day.	N/A	N/A	Over 18% of students reported never eating breakfast prior to the intervention.	N/A
Ribar, 2013[84]	Natural experiment with matched comparison groups	UFB	Three North Carolina elementary schools changed from UFB to traditional and 1 changed from traditional to UFB. These "change" schools were compared to six matched control schools--5 maintained UFB and one maintained traditional breakfast.	Schools switched from UFB to traditional. Analyzed data on SBP participation, attendance and academic achievement.	UFB provision associated with a 12-16% increase in SBP participation.	Schools that changed from UFB to traditional had a small increase in attendance equivalent to about 1 day more present per year.	No evidence that UFB is associated with math or reading test scores. Positive association between science test proficiency among economically disadvantaged children only.	N/A	N/A

					Summary of Outcomes				
First Author, Publication Year	**Study Design**	**Type of Service Model**	**Sample**	**Alt Breakfast Intervention or Procedure**	**Participation**	**Attendance**	**Academic Achievement**	**Nutrient Intake**	**BMI/Weight Status**
Ritchie, 2015[69]	Cross-sectional study of baseline data collected as part of a cluster randomized controlled trial	BIC and SC	3,944 fourth and fifth graders from 43 schools in San Diego, CA.	Examined the number and location of breakfast (none, one at school, one at home, two—at home and school) and energy intake and diet quality by location.	N/A	N/A	N/A	No significant differences in mean daily calorie intake between breakfast policy groups. BIC students had higher diet quality, as quantified using the HEI-2010. BIC students consumed more total fruit, whole fruit and fewer empty calories than other groups.	N/A
Van Wye, 2013[90]	Cross-sectional	BIC	2289 third to fifth grade students in high need NYC neighborhoods. Students were from 9 schools with BIC and 7 matched schools without BIC.	Questionnaire on breakfast consumption was administered to students during the first 30 minutes of class. Estimated student calorie consumption based on responses to questionnaire.	N/A	N/A	N/A	Students in BIC less likely to skip breakfast than comparison classes (8.7% vs 15.0%, P< .001). ~45% BIC students consumed breakfast in the classroom and at least one other location. BIC students consumed an estimated average of 95 calories more than comparison students. Students actually consuming BIC consumed 151 more calories than students eating in other locations.	N/A
Wahlstrom, 1999[85]	Natural experiment with matched comparison groups.	UFB	6 elementary schools in Minnesota selected to be UFB schools starting in in 9/04. Three matched control schools were also selected.	Intervention schools implemented UFB program. Collected data on SBP participation and achievement.	Before UFB ~13% of participated in SBP. After UFB, average daily participation rate for UFB schools was between ~75 and 98% in year 1, 75 and 92% in year 2, and 69 to 94% in year 3.	N/A	Increase in test scores between when students were in third grade (prior to UFB) and when the same students were in sixth grade (year 3 of UFB).	N/A	N/A

REFERENCES

1. Rampersaud GC, Pereira MA, Girard BL, Adams J, Metzl JD. Breakfast Habits, Nutritional Status, Body Weight, and Academic Performance in Children and Adolescents. *Journal of the American Dietetic Association.* 2005;105:743-760.

2. Benton D, Parker PY. Breakfast, blood glucose, and cognition. *The American journal of clinical nutrition.* 1998;67:772S-778S.

3. Geier AB, Foster GD, Womble LG, et al. The Relationship Between Relative Weight and School Attendance Among Elementary Schoolchildren. *Obesity.* 2007;15:2157-2161.

4. Pollitt E, Mathews R. Breakfast and cognition: an integrative summary. *The American journal of clinical nutrition.* 1998;67:804S-813S.

5. Mahoney CR, Taylor HA, Kanarek RB, Samuel P. Effect of breakfast composition on cognitive processes in elementary school children. *Physiology & Behavior.* 2005;85:635-645.

6. Pollitt E. Does Breakfast Make a Difference in School? *Journal of the American Dietetic Association.* 1995;95:1134-1139.

7. Siega-Riz AM, Popkin BM, Carson T. Trends in breakfast consumption for children in the United States from 1965-1991. *The American journal of clinical nutrition.* 1998;67:748S-756S.

8. Deshmukh-Taskar PR, Nicklas TA, O'Neil CE, Keast DR, Radcliffe JD, Cho S. The Relationship of Breakfast Skipping and Type of Breakfast Consumption with Nutrient Intake and Weight Status in Children and Adolescents: The National Health and Nutrition Examination Survey 1999-2006. *Journal of the American Dietetic Association.* 2010;110:869-878.

9. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the united states, 2011-2012. *JAMA : the journal of the American Medical Association.* 2014;311:806-814.

10. United States Department of Agriculture, Food and Nutrition Services. School Breakfast Program: Program History. http://www.fns.usda.gov/sbp/program-history. Accessed September 17, 2014.

11. United States Department of Agriculture, Food and Nutrition Services. The School Breakfast Program Fact Sheet. http://www.fns.usda.gov/sites/default/files/SBPfactsheet.pdf. Accessed September 17, 2014.

12. Food and Nutrition Service, United States Department of Agriculture. Child Nutrition Programs: Income Eligibility Guidelines. https://www.federalregister.gov/documents/2017/04/10/2017-07043/child-nutrition-programs-income-eligibility-guidelines. Accessed May 23, 2017.

13. National School Lunch Program and School Breakfast Program: Nutrition Standards for All Foods Sold in School as Required by the Healthy, Hunger-Free Kids Act of 2010; Interim Final Rule. In: Department of Agriculture Food and Nutrition Service, ed. Vol 78. 7 CFR Parts 210 and 220 ed: Federal Register; 2013.

14. Secretary of Agriculture of the United States of America. USDA Commitment to School Meals: A Proclamation. https://www.usda.gov/sites/default/files/documents/secretary-perdue-child-nutrition-proclamation.pdf. Accessed May 18, 2017.

15. Bhattacharya J, Currie J, Haider SJ. Breakfast of Champions?: The School Breakfast Program and the Nutrition of Children and Families. *Journal of Human Resources.* 2006;XLI:445-466.

16. Hanson KL, Olson CM. School Meals Participation and Weekday Dietary Quality Were Associated after Controlling for Weekend Eating among U.S. School Children Aged 6 to 17 Years. *The Journal of Nutrition.* 2013;143:714-721.

17. Gordon AR, Devaney BL, Burghardt JA. Dietary effects of the National School Lunch Program and the School Breakfast Program. *The American journal of clinical nutrition.* 1995;61:221S-231S.

18. Clark MA, Fox MK. Nutritional Quality of the Diets of US Public School Children and the Role of the School Meal Programs. *Journal of the American Dietetic Association.* 2009;109:S44-S56.

19. Affenito SG, Thompson D, Dorazio A, Albertson AM, Loew A, Holschuh NM. Ready-to-eat cereal consumption and the School Breakfast Program: relationship to nutrient intake and weight. *The Journal of school health.* 2013;83:28-35.

20. Longacre MR, Drake KM, Titus LJ, et al. School food reduces household income disparities in adolescents' frequency of fruit and vegetable intake. *Preventive Medicine.* 2014;69:202-207.

21. Gleason PM, Dodd AH. School Breakfast Program but Not School Lunch Program Participation Is Associated with Lower Body Mass Index. *Journal of the American Dietetic Association.* 2009;109:S118-S128.

22. Kimbro RT, Rigby E. Federal Food Policy And Childhood Obesity: A Solution Or Part Of The Problem? *Health Affairs.* 2010;29:411-418.

23. Millimet DL, Tchernis R, Husain M. School Nutrition Programs and the Incidence of Childhood Obesity. *Journal of Human Resources.* 2010;45:640-654.

24. von Hippel PT, Powell B, Downey DB, Rowland NJ. The effect of school on overweight in childhood: gain in body mass index during the school year and during summer vacation. *Am J Public Health.* 2007;97:696-702.

25. Downey DB, Boughton HR. Childhood body mass index gain during the summer versus during the school year. *New Directions for Youth Development.* 2007;2007:33-43.

26. Adolphus K, Lawton CL, Dye L. The effects of breakfast on behavior and academic performance in children and adolescents. *Frontiers in human neuroscience.* 2013;7:425.

27. Frisvold DE. Nutrition and cognitive achievement: An evaluation of the School Breakfast Program. *Journal of public economics.* 2015;124:91-104.

28. Belot M, James J. Healthy school meals and educational outcomes. *Journal of Health Economics.* 2011;30:489-504.

29. Meyers AF, Sampson AE, Weitzman M, Rogers BL, Kayne H. School breakfast program and school performance. *American Journal of Diseases of Children.* 1989;143:1234-1239.

30. Bartfeld JS, Ahn H-M. The School Breakfast Program Strengthens Household Food Security among Low-Income Households with Elementary School Children. *The Journal of Nutrition.* 2011;141:470-475.

31. Condon EM, Crepinsek MK, Fox MK. School Meals: Types of Foods Offered to and Consumed by Children at Lunch and Breakfast. *Journal of the American Dietetic Association.* 2009;109:S67-S78.

32. Robinson-O'Brien R, Burgess-Champoux T, Haines J, Hannan PJ, Neumark-Sztainer D. Associations Between School Meals Offered Through the National School Lunch Program and the School Breakfast Program and Fruit and Vegetable Intake Among Ethnically Diverse, Low-Income Children. *The Journal of school health.* 2010;80:487-492.

33. Baxter SD, Hardin JW, Guinn CH, Royer JA, Mackelprang AJ, Devlin CM. Children's body mass index, participation in school meals, and observed energy intake at school meals. *The international journal of behavioral nutrition and physical activity.* 2010;7:24-24.

34. Paxton AE, Baxter SD, Tebbs JM, et al. Non-significant relationship between participation in school-provided meals and body mass index during the fourth-grade school year. *Journal of the Academy of Nutrition and Dietetics.* 2012;112:10.1016/j.jada.2011.1008.1037.

35. Hofferth SL, Curtin S. Poverty, food programs, and childhood obesity. *Journal of Policy Analysis and Management.* 2005;24:703-726.

36. Hewins J, Burke M. *School Breakfast Scorecard: 2012-2013 School Year*: Food Research and Action Center; 2014.

37. Fox MK, Crepinsek MK, Connor P, Battaglia M. School Nutrition Dietary Assessment Study-II Final Report. Alexandria, VA: United States Department of Agriculture, Food and Nutrition Service, Office of Analysis, Nutrition and Evaluation; 2001.

38. Marples CA, Spillman D-M. Factors affecting students' participation in the Cincinnati public schools lunch program. *Adolescence.* 1994;30:745-754.

39. James DCS, Rienzo BA, Frazee C. Using Focus Group Interviews to Understand School Meal Choices. *Journal of School Health.* 1996;66:128-131.

40. Meyer MK, Conklin MT. Variables Affecting High School Students' Perceptions of School Foodservice. *Journal of the American Dietetic Association.* 1998;98:1424-1431.

41. Olsta J. Bringing Breakfast to Our Students: A Program to Increase School Breakfast Participation. *The Journal of School Nursing.* 2013;29:263-270.

42. Maurer KM. The National Evaluation of School Nutrition Programs: factors affecting student participation. *The American journal of clinical nutrition.* 1984;40:425-447.

43. Barnes RO. Modeling Student Participation in School Nutrition Programs. 1988.

44. Bartfeld J, Kim M. Participation in the School Breakfast Program: New Evidence from the ECLS-K. *Social Service Review.* 2010;84:541-562.

45. Moore Q, Hulsey L, Ponza M. Factors Associated with School Meal Participation and the Relationship between Different Participation Measures. Final Report. *Mathematica Policy Research, Inc.* 2009.

46. Gleason PM. Participation in the National School Lunch Program and the School Breakfast Program. *The American journal of clinical nutrition.* 1995;61:213S-220S.

47. Burghardt J, Gordon A, Chapman N, Gleason P, Fraker T. The School Nutrition Dietary Assessment Study: school food service, meals offered, and dietary intakes: Mathematica Policy Research; 1993.

48. Mirtcheva DM, Powell LM. Participation in the National School Lunch Program: Importance of School-Level and Neighborhood Contextual Factors. *Journal of School Health.* 2009;79:485-494.

49. 111th Congress. Healthy, Hunger-Free Kids Act of 2010. http://www.gpo.gov/fdsys/pkg/PLAW-111publ296/pdf/PLAW-111publ296.pdf. Accessed January 31, 2012,

50. Child Nutrition Programs, Food and Nutrition Service, United States Department of Agriculture. Eligibility Manual for School Meals: Determining and Verifying Eligibility. https://www.fns.usda.gov/sites/default/files/cn/SP40_CACFP18_SFSP20-2015a.pdf. Accessed June 12, 2017.

51. Food Research and Action Center. Why Offer School Breakfast Free To All Children? http://frac.org/wp-content/uploads/2009/09/universal_sbp.pdf. Accessed September 17, 2014.

52. Bernstein LS, McLaughlin JE, Crepinsek MK, Daft LM. Evaluation of the School Breakfast Program Pilot Project: Final Report. Special Nutrition Programs. Report Number CN-04-SBP. Nutrition Assistance Program Report Series. *US Department of Agriculture.* 2004.

53. Food Research and Action Center. Making Breakfast Part of the School Day: What's the Right Alternative Breakfast Service Model for my School? http://frac.org/wp-content/uploads/how_it_works_bic_fact_sheet.pdf. Accessed May 18, 2017.

54. North Carolina Nutrition Education and Training Program, North Carolina Department of Public Instruction, North Carolina Division of Public Health. Breakfast is Brain Fuel Toolkit. http://childnutrition.ncpublicschools.gov/programs/sbp/breakfast-is-brain-fuel-toolkit. Accessed August 30, 2014.

55. United States Department of Agriculture, Food and Nutrition Services. Community Eligibility Provision. Web page. http://www.fns.usda.gov/school-meals/community-eligibility-provision. Accessed May 20, 2015.

56. Public Schools of North Carolina, Financial and Business Services. Data and Reports - Free and Reduced Meals Application Data. http://www.ncpublicschools.org/fbs/resources/data/. Accessed June 17, 2015.

57. Public Schools of North Carolina, Financial and Business Services. Data and Reporting - Student Accounting. http://www.ncpublicschools.org/fbs/accounting/data/. Accessed May 5, 2016.

58. National Center for Education Statistics. Elementary/Secondary Information System (ElSi). https://nces.ed.gov/ccd/elsi/. Accessed July 2, 2015.

59. United States Department of Agriculture, Economic Research Service. Rural-Urban Commuting Area Codes. https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx. Accessed July 2, 2015.

60. United States Department of Agriculture, Economic Research Service. Rural-Urban Continuum Codes. Web page. http://www.ers.usda.gov/data-products/rural-urban-continuum-codes/documentation.aspx. Accessed November 3, 2016.

61. Center on Budget and Policy Priorities. Community Eligibility Database: Take Up of Community Eligibility During the 2014-2015 School Year. http://www.cbpp.org/research/community-eligibility-database-take-up-of-community-eligibility-during-the-2014-2015-school?fa=view&id=4187. Accessed November 13, 2015.

62. Murphy JM. Breakfast and learning: An updated review. *Curr. Nutr. Food Sci.* 2007;3:3-36.

63. Moher D, Liberati A, Tetzlaff J, Altman DG, The PG. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLOS Medicine.* 2009;6:e1000097.

64. Jenkins KT, Benton D, Tapper K, Murphy S, Moore L. A cross-sectional observational study of the nutritional intake of UK primary school children from deprived and non-deprived backgrounds: implications for school breakfast schemes. *International Journal of Behavioral Nutrition and Physical Activity.* 2015;12:(25 June 2015)-(2025 June 2015).

65. Murphy S, Moore G, Tapper K, et al. Free healthy breakfasts in primary schools: a cluster randomised controlled trial of a policy intervention in Wales, UK. *Public Health Nutrition.* 2011;14:219-226.

66. Moore GF, Murphy S, Chaplin K, Lyons RA, Atkinson M, Moore L. Impacts of the Primary School Free Breakfast Initiative on socio-economic inequalities in breakfast consumption among 9-11-year-old schoolchildren in Wales. *Public Health Nutrition.* 2014;17:1280-1289.

67. Guinn CH, Baxter SD, Finney CJ, Hitchcock DB. Examining variations in fourth-grade children's participation in school-breakfast and school-lunch programs by student and program demographics. *Journal of child nutrition & management (Online).* 2013;37:5.

68. Nanney MS, Olaleye TM, Wang Q, Motyka E, Klund-Schubert J. A pilot study to expand the school breakfast program in one middle school. *Translational behavioral medicine.* 2011;1:436-442.

69. Ritchie LD, Rosen NJ, Fenton K, Au LE, Goldstein LH, Shimada T. School Breakfast Policy Is Associated with Dietary Intake of Fourth- and Fifth-Grade Students. *Journal of the Academy of Nutrition & Dietetics.* 2016;116:449-457.

70. Ask AS, Hernes S, Aarek I, Johannessen G, Haugen M. Changes in dietary pattern in 15 year old adolescents following a 4 month dietary intervention with school breakfast--a pilot study. *Nutr J.* 2006;5:33.

71. Crepinsek MK, Singh A, Bernstein LS, McLaughlin JE. Dietary Effects of Universal-Free School Breakfast: Findings from the Evaluation of the School Breakfast Program Pilot Project. *Journal of the American Dietetic Association.* 2006;106:1796-1803.

72. Cueto S, Chinen M. Educational Impact of a School Breakfast Programme in Rural Peru. *International Journal of Educational Development.* 2008;28:132-148.

73. Cullen KW, Thompson DI, Watson KB. Exploring Strategies to Promote Middle School Student Participation in the School Breakfast Program. *Journal of Child Nutrition & Management.* 2012;36.

74. Dykstra H, Davey A, Fisher JO, et al. Breakfast-Skipping and Selecting Low-Nutritional-Quality Foods for Breakfast Are Common among Low-Income Urban Children, Regardless of Food Security Status. *Journal of Nutrition.* 2016;146:630-636.

75. Huang H, Lee Kuei I, Shanklin CW. Evaluation of the free school breakfast program in St. Joseph, Missouri. *Journal of Child Nutrition and Management.* 2006;30:un-un.

76. Kleinman RE, Hall S, Green H, Korzec-Ramirez D, et al. Diet, breakfast, and academic performance in children. *Annals of nutrition & metabolism.* 2002;46:24-30.

77. Lawman HG, Polonsky HM, Vander Veur SS, et al. Breakfast patterns among low-income, ethnically-diverse 4th-6th grade children in an urban area. *Bmc Public Health.* 2014;14.

78. Leatherdale ST, Stefanczyk JM, Kirkpatrick SI. School Breakfast-Club Program Changes and Youth Eating Breakfast During the School Week in the COMPASS Study. *Journal of School Health.* 2016;86:568-577.

79. Leos-Urbel J, Schwartz AE, Weinstein M, Corcoran S. Not just for poor kids: The impact of universal free school breakfast on meal participation and student outcomes. *Economics of Education Review.* 2013;36:88-107.

80. Lieberman HM, Hunt IF, Coulson AH, Clark VA, Swendseid ME, Ho L. Evaluation of a ghetto school breakfast program. *Journal of the American Dietetic Association.* 1976;68:132-138.

81. Mhurchu CN, Gorton D, Turley M, et al. Effects of a free school breakfast programme on children's attendance, academic achievement and short-term hunger: results from a stepped-wedge, cluster randomised controlled trial. *Journal of Epidemiology and Community Health.* 2013;67:257-264.

82. Murphy JM, Pagano ME, Nachmani J, Sperling P, et al. The relationship of school breakfast to psychosocial and academic functioning: Cross-sectional and longitudinal observations in an inner-city school sample. *Archives of pediatrics & adolescent medicine.* 1998;152:899-907.

83. Powell CA, Walker SP, Chang SM, Grantham-McGregor SM. Nutrition and education: a randomized trial of the effects of breakfast in rural primary school children. *The American journal of clinical nutrition.* 1998;68:873-879.

84. Ribar DC, Haldeman LA. Changes in meal participation, attendance, and test scores associated with the availability of universal free school breakfasts. *Social Service Review.* 2013;87:354-385.

85. Wahlstrom KL, Begalle MS. More than test scores: results of the Universal School Breakfast Pilot in Minnesota. *Topics in Clinical Nutrition.* 1999;15:17-29.

86. Anzman-Frasca S, Djang HC, Halmo MM, Dolan PR, Economos CD. Estimating impacts of a breakfast in the classroom program on school outcomes. *JAMA pediatrics.* 2015;169:71-77.

87. Bro RT, Shank L, Williams R, McLaughlin TF. The Effects of an In-Class Breakfast Program on Attendance and On-Task Behavior of High School Students. *Child & Family Behavior Therapy.* 1994;16:1-8.

88. Corcoran SP, Elbel B, Schwartz AE. The Effect of Breakfast in the Classroom on Obesity and Academic Performance: Evidence from New York City. *Journal of policy analysis and management : [the journal of the Association for Public Policy Analysis and Management]*. 2016;35:509-532.

89. Imberman SA, Kugler AD. The Effect of Providing Breakfast in Class on Student Performance. *Journal of Policy Analysis and Management.* 2014;33.

90. Van Wye G, Seoh H, Adjoian T, Dowell D. Evaluation of the New York City breakfast in the classroom program. *Am J Public Health.* 2013;103:e59-64.

91. Morris CT, Courtney A, Bryant CA, McDermott RJ. Grab 'N' Go Breakfast at School: Observations from a Pilot Program. *Journal of Nutrition Education and Behavior.* 2010;42:208-209.

92. Murphy J, Pagano ME, Nachmani J, Sperling P, Kane S, Kleinman RE. The relationship of school breakfast to psychosocial and academic functioning: Cross-sectional and longitudinal observations in an inner-city school sample. *Archives of pediatrics & adolescent medicine.* 1998;152:899-907.

93. Adolphus K, Lawton CL, Champ CL, Dye L. The Effects of Breakfast and Breakfast Composition on Cognition in Children and Adolescents: A Systematic Review. *Advances in Nutrition: An International Review Journal.* 2016;7:590S-612S.

94. Food Research and Action Center. FRAC Facts: The School Breakfast Program. http://frac.org/research/resource-library/frac-facts-school-breakfast-program. Accessed May 7, 2017.

95. Fox MK, Condon E. School Nutrition Dietary Assessment Study-IV. In: United States Department of Agriculture FaNS, Office of Research and Analysis, ed. Alexandria, VA2012.

96. Ribar D, Haldeman L. Universal Free and Eligibility-based school breakfast programs in Guilford County, North Carolina: Student Outcomes. *The University of North Carolina at Greensboro.* 2011.

97. Schanzenbach DW, Zaki M. Expanding the School Breakfast Program: Impacts on Children's Consumption, Nutrition and Health: National Bureau of Economic Research; 2014.

98. NC Public Schools. Facts and Figures 2012-2013. http://www.ncpublicschools.org/docs/fbs/resources/data/factsfigures/2012-13figures.pdf. Accessed October 30, 2014.

99. North Carolina Department of Public Instruction School Business Services School Reporting. School Attendance and Student Accounting Manual. http://www.dpi.state.nc.us/docs/fbs/accounting/manuals/sasa.pdf. Accessed December 6, 2016.

100. Nanney MS, Davey CS, Kubik MY. Rural Disparities in the Distribution of Policies that Support Healthy Eating in US Secondary Schools. *Journal of the Academy of Nutrition and Dietetics.* 2013;113:1062-1068.

101. Kehm R, Davey CS, Kubik MY, Nanney MS. A Comparison of the Vending Environment Among Three Rural Subtypes of Secondary Schools. *Journal of Hunger & Environmental Nutrition.* 2016:1-12.

102. National Center for Education Statistics. Identification of Rural Locales. https://nces.ed.gov/ccd/rural_locales.asp. Accessed

103. North Carolina Department of Public Instruction. Facts and Figures 2011-12. http://www.dpi.state.nc.us/docs/fbs/resources/data/factsfigures/2011-12figures.pdf. Accessed June 13, 2017.

104. School Nutrition Association, School Superintendents Association. Joint Letter on Child Nutrition Reauthorization. https://schoolnutrition.org/uploadedFiles/News_and_Publications/Press_Releases/Press_Releases/JointLetterOnCNRFINAL.pdf. Accessed April 7, 2017.

105. Johnson DB, Podrabsky M, Rocha A, Otten JJ. Effect of the healthy hunger-free kids act on the nutritional quality of meals selected by students and school lunch participation rates. *JAMA pediatrics.* 2016;170:e153918.

106. United States Government Accountability Office. School Nutrition: USDA Has Efforts Underway to Help Address Ongoing Challenges Implementing Changes in Nutrition Standards 2015.

107. Dotter DD. Breakfast at the Desk: The Impact of Universal Breakfast Programs on Academic Performance. *Association for Public Policy Analysis and Management 2013 Fall Research Conference*. Washington, DC2013.

108. Charlotte-Mecklenburg Schools. CMS Fast Facts. http://www.cms.k12.nc.us/mediaroom/aboutus/Documents/CMS%20Fast%20Facts%20Sheet%202015-2016.pdf. Accessed April 18, 2017.

109. Charlotte-Mecklenburg Schools. Child Nutrition Services: A recipe for excellence. http://www.cms.k12.nc.us/mediaroom/aboutus/Documents/Child%20Nutrition%202013.pdf. Accessed April 18, 2017.

110. The Institute for Social Capital. http://charlotteresearch.info/. Accessed January 17, 2015.

111. Public Schools of North Carolina, Accountability Services Division. Accountability and Test Results. http://www.ncpublicschools.org/accountability/reporting/. Accessed March 18, 2017.

112. Centers for Disease Control and Prevention, Division of Nutrition, Physical Activity, Obesity. A SAS Program for the 2000 CDC Growth Charts (ages 0 to <20 years). https://www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm. Accessed March 28, 2017.

113. Centers for Disease Control and Prevention, Division of Nutrition, Physical Activity, Obesity. Recommended BMI-for-age Cutoffs. https://www.cdc.gov/nccdphp/dnpao/growthcharts/training/bmiage/page4.html. Accessed March 28, 2017.

114. Public Schools of North Carolina, Accountability Services Division. 2013 READY Accountability Background Brief. http://www.ncpublicschools.org/docs/accountability/readybackgroundpack13.pdf. Accessed April 17, 2017.

115. North Carolina Department of Public Instruction. North Carolina Public Schools Post Strong Academic Growth; Higher Standards Mean Fewer Students Marked Proficient. http://www.ncpublicschools.org/newsroom/news/2013-14/20131107-02. Accessed May 7, 2017.

116. North Carolina Department of Public Instruction. Student Academic Growth Increases in 2013-14; Proficiency Now Reported Under Five Achievement Levels http://www.ncpublicschools.org/newsroom/news/2014-15/20140904-02. Accessed May 7, 2017.

117. Imberman SA, Kugler AD. The effect of providing breakfast on student performance: Evidence from an in-class breakfast program: National Bureau of Economic Research; 2012.

118. Schanzenbach DW. Do School Lunches Contribute to Childhood Obesity? *Journal of Human Resources.* 2009;44:684-709.

119. Ogden CL, Carroll MD, Lawman HG, et al. Trends in obesity prevalence among children and adolescents in the united states, 1988-1994 through 2013-2014. *JAMA : the journal of the American Medical Association.* 2016;315:2292-2299.

120. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (CDC), National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition, Physical Activity and Obesity. Nutrition, Physical Activity and Obesity Data, Trends and Maps. http://www.cdc.gov/nccdphp/DNPAO/index.html. Accessed May 8, 2017.

121. Grynbaum MM. With Classroom Breakfasts, a Concern That Some Children Eat Twice. New York Times. http://www.nytimes.com/2012/04/20/nyregion/with-classroom-breakfasts-some-children-may-eat-twice.html. Accessed May 8, 2017.

122. Wang S, Schwartz MB, Shebl FM, Read M, Henderson KE, Ickovics JR. School breakfast and body mass index: a longitudinal observational study of middle school students. *Pediatric Obesity.* 2016:1-8.