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The Associations of Farm-to-School Programs on Childhood Obesity in School Breakfast

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THE ASSOCIATIONS OF FARM-TO-SCHOOL PROGRAMS ON CHILDHOOD OBESITY IN SCHOOL BREAKFAST

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by
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ABSTRACT
THE ASSOCIATIONS OF FARM-TO-SCHOOL PROGRAMS ON CHILDHOOD OBESITY IN SCHOOL BREAKFAST
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Farm to School (F2S) programs claim to increase fruit/vegetable consumption and promote healthy, lifelong food/beverage choices. Both of which are identified strategies in the prevention of childhood obesity. Long-term effects of F2S programs are largely unexplored. This cross-sectional study matched ten schools, five with F2S, and five with a traditional National School Breakfast Program (NSBP). Third- and fourth-grade students (n=1031) were recruited for study participation to assess the effects of regular breakfast consumption and participation in F2S programs on body mass index (BMI). Demographic data, anthropometric data, and frequency of breakfast participation were collected. Additionally, BMI and frequency of breakfast consumption over a ten-day period, excluding non-school days, was stratified by frequent eaters (7-10), occasional eaters (3-6), and skippers (0-2) were collected. Results showed no significant difference in BMI-for-age between F2S and traditional NSBP. This data suggests that in this population regular breakfast consumption was not correlated with BMI or BMI-for-age.

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CHAPTER I

INTRODUCTION

Childhood overweight and obesity continues to remain a persistent problem nationally as well as globally. Due to the numerous co-morbidities related to childhood obesity, such as diabetes, cardiovascular disease, stroke, and select cancers, among others,[1-12] many national coalitions have been developing and implementing strategies in an attempt to attenuate the epidemic. These strategies vary from public policy changes, marketing regulations, governmental zoning, and school-based interventions. School-based interventions are especially promising as millions of children attend public schools and consume the majority of their daily caloric intake within the academic setting.

The National School Lunch Program (NSLP) and National School Breakfast Program (NSBP) continue to be a common battleground in efforts to reduce rates of childhood obesity. In 2010 the Healthy, Hunger-Free Kids Act (HHFKA) required schools to shift towards more nutritious meals, offering more fruits, vegetables and whole grains, serving legumes, and limiting sugar sweetened beverages and serving sizes. The NSBP could have significant influence on childhood body mass index (BMI), considering the relationship of regular breakfast consumption on achieving and maintaining a healthy body weight. Other school-based interventions have been noted as potential strategies to reduce and prevent childhood obesity, such as the Farm to School (F2S) program. Which is a loosely defined initiative to implement inclusion of more local produce and foods in school meals, increase exposure to local food systems, and educate children on the importance of eating fresh minimally processed foods. As these initiatives mature and transform, it's becoming increasingly evident the need to understand how effective these interventions are and how they can be potentially improved upon.

CHAPTER II

LITERATURE REVIEW

Background

Childhood obesity remains a significant public health concern in the United States with a substantial 17% of the population ages 2-19 classified as obese.[1] Between 1980 and 2010 obesity increased exponentially; in 2-5 year olds obesity doubled and for children 6-11, obesity tripled.[1-2] This increasing trend has slightly lessened with the percentage of obese children having minimally fluctuated around 17% from 2004 to 2014.[1] Although the rate of obesity has not significantly increased from 2003 to 2012, the percentage of children who are overweight or obese remains very high at 31.8% as of 2014.[1] The Academy of Nutrition and Dietetics (AND) declares that obesity in children and youth should remain a national public health priority, especially since research shows it may co-exist with food insecurity, poverty, and hunger.[3]

Complications Associated with Childhood Obesity

Obese children suffer from an overall decreased quality of life (QOL), impacting emotional, social, and physical health.[4] They are more likely to experience weight stigma and body dissatisfaction.[5] and are not only more likely to be bullied, but ranked lowest as those with whom other children would like to be friends with,[6] further contributing to worsening emotional health. In fact, QOL is so reduced in obese children it's comparable to children diagnosed with cancer, as demonstrated by a QOL inventory generic core scale survey evaluating over 100 5-18 year olds.[4] These emotional and social obstacles transcend into the academic environment and performance. Children struggling with

obesity are more likely to suffer academically as well. According to a study by Geier et al., they miss more days of school, an average of 4.2 days per month, and have reduced academic performance,[4,7-8] likely as a result of increased absenteeism. This trend remains significant after adjusting for age, ethnicity, and gender.[7] In addition to these emotional and cognitive related complications, overweight and obese children suffer from physical and disease-related complications as well.

Physical implications related to overweight and obesity in children include increased risk of asthma, sleep apnea, earlier female puberty, as well as delayed male puberty.[9] These factors may further contribute to adverse social development and QOL as aforementioned. In addition to those risks, a well-respected team of researchers with The Bogalusa Heart Study found evidence that cholesterol, triglycerides, blood pressure, and BMI status as early as age nine can be used to predict adult atherosclerosis risk.[10] Children who suffer from obesity have higher risk and prevalence of hyperlipidemia, and abnormal glucose tolerance.[6] Consequences of this include increased risk of several chronic diseases, such as diabetes, cardiovascular disease, and stroke; as well as joint problems, fatty liver disease, and select cancers throughout child and adult life;[9,11] all diseases previously thought to be restricted to adults. In adolescents, the odds of being diagnosed with metabolic syndrome as an adult increased by 1.55 every half-unit increase in BMI z-score.[12] The consequences of childhood obesity are undeniable. The need for effective programs to prevent and treat childhood obesity is recognized and considered a public health priority on a national level among various organizations.

Recommendations in the Prevention and Treatment of Childhood Obesity

The AND recognizes the national need of prevention and treatment of childhood

obesity and recommends a systematic approach starting with early child- and school-based interventions.[13] They note that although the leveling off of obesity prevalence in youth is favorable, the rates remain alarmingly high, as well as disproportionally so in regards to race and ethnicity. While the Institute of Medicine (IOM) recommends BMI screening in school settings, the AND recommends interventions that include a focus on food marketing practices, regulations, governmental zoning, and policy changes.[13-14] There are multiple national efforts to reduce childhood obesity. The Healthy People 2020 objectives also target childhood obesity, hoping to reduce the percentage of obese children and adolescents by 10%.[15] The Center for Disease Control's (CDC) Division of Nutrition, Physical Activity, and Obesity reports the following objectives: to improve dietary quality, promote healthy child development, increase physical activity, and decrease prevalence of obesity through prevention of weight gain and maintenance of healthy weight.[16] The IOM recently released their strategy to decrease childhood obesity by making physical activity an integral and routine part of life, creating food and beverage environments and ensuring accessible healthy food and beverage options, marketing healthy messages about activity and nutrition, and making schools a national focal point for obesity prevention.[14] For schools to be a national focal point for obesity prevention the IOM must work collaboratively with the NSLP and NSBP, which currently sustain a large percentage of the nation's youth in terms of daily energy and nutrition needs.[17] How the NSBP in particular may promote achievement and maintenance of a healthy body weight from a young age is the primary focus of this research.

The Benefits of Breakfast

A large body of research exists evaluating breakfast consumption and its

protective association against obesity. Claims of improved cognitive performance, QOL, weight management, and reduced risk of cardiovascular disease and type 2 diabetes have been previously associated with regular, high-quality breakfast consumption.[4,18-31] However, it should be noted that outside of the NSBP, the meal of breakfast is not rigidly defined which may skew or attenuate previous research findings; possibly explaining varying outcomes in regards to the protective effect of breakfast consumption. A recent review by O'Neil states there is a lack of science-based guidance on what is considered to be a nutrient dense "quality" breakfast or even on how "breakfast" is defined.[32] Definitions have varied from time of day, frequency, place of consumption, activities occurring during consumption such as walking or reading, types of food groups, and energy consumed. Without a distinct and consistent definition of breakfast, gaps in the literature remain and few conclusions can be made. The proposed definition of O'Neil's analysis is "*breakfast is the first meal of the day that breaks the fast after the longest period of sleep and is consumed within 2 to 3 hours of waking; it is comprised of food or beverage from at least one food group, and may be consumed at any location"*. [32] Utilizing and implementing a standardized definition would allow for consistent inferences and conclusions to be made from the literature and would also align with the rigidity of school breakfast standards.

O'Neil's review illustrated several trends regarding breakfast. Such as positive effects in breakfast habits in children with parents that modeled habitual breakfast consumption; but regardless of parental modeling, as children aged, breakfast consumption was reduced from 99% to 85% by age 13.[33] A national survey called What We Eat In America, which analyzed NHANES data from 2009-2010, made similar

conclusions and noted that breakfast consumption quality and quantity decreased with increasing age.[34] The researchers also saw that adolescents that reported being overweight or dissatisfied with their body were less likely to eat breakfast in hopes of weight loss or weight gain prevention.[32,35-36] Yet even with inconsistent definitions of breakfast, most studies, but not all, have shown that those who skip breakfast, including children and adolescents, are more likely to be overweight and obese and more likely to have a less healthful lifestyle. [32,37-44] This illustrates the lack of understanding regarding breakfast skipping and increased BMI and indicates a need for nutrition education regarding the importance of breakfast beginning at a young age. [22,45]

Other studies have inferred that perhaps the act of skipping breakfast is associated with other detrimental health habits, such as infrequent exercise, smoking, alcohol use, and caffeinated soda consumption [43,46] leading to potential confounding in relation to the proposed benefits of regular breakfast consumption. Breakfast skippers are more likely to be dissatisfied with their body, and are more likely to state lack of time and not being hungry in the morning as reasons for skipping breakfast.[36] It has been proposed that weight related concerns in children and teens may influence breakfast frequency, which in turn impacts dietary quality and appetite control, which than alters total energy intake adversely impacting BMI.[43]

Habitual breakfast consumption and correlation with body composition and other health-related behaviors

Multiple studies have examined the effects of habitual breakfast, though as stated earlier, the lack of universal definition of breakfast creates ambiguity. A 2010 European systematic review of 16 different cross-sectional or cohort trials evaluated breakfast

consumption and body weight in children. Out of the studies, 13 showed that breakfast had a protective effect against becoming overweight or obese,[30] but of the 13, only three studies rigidly defined breakfast. Although few studies defined breakfast clearly, most studies specified criteria a subject must meet to be identified as a breakfast skipper; primarily measured by frequency of breakfast consumption. One review study of 382 male and 429 female Greek adolescents (mean age: 16.6 yrs; mean BMI: 23.10 kg/m^2) tried to more rigidly define breakfast by dividing breakfast habits into 24 definitions, with definitions that ranged from average intake on day of survey to number of breakfast meals consumed in the last week.[47] The study concluded that the association between BMI and breakfast is dependent on the definition of breakfast; further contributing to the ambiguity around the benefits of regular breakfast consumption.

Another study evaluating male (n=4401) and female (n=4909) Greek and Finish teens (mean age: 16yo) assessed average eating behavior by categorizing breakfast habits into four groups based on normal eating behavior during the last calendar year: daily, 1-3 times per week; 1-3 times per month; and never/rarely. Interestingly, breakfast consumption was found to be inversely correlated with weight in both Greek and Finn male subjects but not females ($P<0.001$).[48] Yet in contrast to Veltsista's study, a 2005 study by Affenito et al., did find a significant inverse relationship between BMI and frequency of breakfast in nine to ten year old females (Affenito). As frequency of breakfast increased BMI was predicted to be lower x^2 [1] = 14.05 ($P<0.005$).[27] Affenito concluded that girls who routinely eat breakfast have a reduced BMI compared with girls categorized as infrequent breakfast eaters, adding to the existing body of research supporting habitual breakfast consumption and more favorable body weight.

In addition to favorable body weight, positive health habits have been identified that correlate with habitual breakfast consumption, such as exercise patterns and performance.[27,30] Children who consumed breakfast performed significantly better in the standing long jump, 20-m sprint, and the shuttle run ($P<0.005$).[49] Consistent with other findings, children in this study who reported daily breakfast consumption also had a significantly lower BMI when compared to children who seldom or never did (16.7 ± 2.2 kg/m^2 versus 18.2 ± 3.0 kg/m2 and 18.8 ± 3.4 kg/m^2, respectively; $P<0.05$).[49] This finding also adds to the overall body of evidence of the benefits of breakfast consumption on body weight and other health aspects.

The true underlying mechanism linking reduced likelihood of obesity to regular breakfast consumption among children and adults is unclear. Szajewska and Ruszczynski suggest an overall healthier lifestyle compromised of habitual meals and regular activity, as well as a satisfactory daily nutrient profile, increased fiber consumption, and good blood glucose control may be responsible for the connection.[30] In agreement with this a study by Pereira et al., also concluded that healthy weight management was best achieved in those that habitually consumed a breakfast comprised of fiber, nutrient rich whole grains, and low-fat dairy products; all of which support appetite control and blood sugar attenuation throughout the day.[23] While Timlin et al., hypothesized that breakfast frequency was affected by weight-related concerns, overall dietary quality, and daily appetite control; all of which also effect body weight. Finally, Warren et al., hypothesized that caloric composition of lunch may be down regulated by glycemic values due to breakfast components and consumption suggesting that children may over indulge or make poor food decisions at lunch if breakfast is skipped or poorly composed.[50] This

finding is consistent with the observation of generally improved macro- and micronutrient intake in association with habitual breakfast consumption.[22,24,44] For example, breakfast skippers consume fewer daily grams of protein, and greater calories at lunch, dinner, and through frequent snacking then consistent breakfast consumers;[24] indicating breakfast skippers tend to have a poorer macro- and micronutrient distribution throughout the day as well as greater overall energy intake. A study by Deshmukh analyzing NHANES data correlated mean adequacy ratio (MAR) of vitamin A, E, C, B6, B12, thiamin, niacin, riboflavin, folate, phosphorus, magnesium, iron an zinc to self-reported breakfast habits of children aged 9-18 and found MAR was lowest for subjects that were categorized as breakfast skippers.[22] An additional study noted that days in which breakfast was consumed correlated with higher calcium and fiber intake in nine -ten year old girls.[27] Participants of the study consumed an average of 75.6 mg more calcium per day (x^2 = 81.29, P<0.001) and 1.13g more fiber per day (x^2 =86.53, P<0.001) compared to infrequent breakfast consumers.[27] The established associations of habitual breakfast eating are vast and wholly beneficial and as additional research develops, it has become apparent that breakfast skipping can be as detrimental as habitual breakfast eating is advantageous.

Detrimental effects of habitual breakfast skipping

Foregoing breakfast appears to be just as harmful as regular breakfast consumption is beneficial. In Dialektakou's study, with 24 varied breakfast definitions, breakfast skipping was significantly associated with increased BMI (P<0.05), and this remained true after adjusting for factors such as physical activity, parental education, socioeconomic status, and education level.[47] One study with over 4,000 children and

adolescents found that students who only ate breakfast 0-1 weekdays per week were almost twice as likely (OR:1.8; 95% CI 1.38-2.36) to be overweight then their counterparts that ate breakfast more then three times per week.[30] This trend was also prevalent in a large NHANES sample (n=9659) examining these associations in children (9-13 years old) and teens (14-18 years old). Deshmukhl- Taskar et al. concluded that breakfast skippers in their sample had higher body mass index for age scores ($P<0.05$), larger average waist circumferences, increasing from 1.7-3.3cm ($P<0.05$), and a greater prevalence of obesity, than regular breakfast consumers and cereal eaters.[22] Among the breakfast skippers, 22.1% of the sample were classified as obese, whereas among breakfast consumers 18.4%, and ready to eat cereal consumers only 15.2% were classified as obese ($P<0.05$). The relationship between breakfast skipping and increased body weight has been well established; [22,26,27,30-31,39,43-44,47-48,51-51] what is less clear is if healthy habits, including regular breakfast consumption, formed early in life will persist along with their beneficial effects on body weight.

To address this question, Timlin et al. conducted research to determine if this trend remains through development and evolving dietary patterns. In that study, researchers reviewed adolescent eating habits at two different intervals in order to assess the relationship between body weight and breakfast habits over a five-year period. During the first wave of data collection a higher BMI was observed in adolescents that consumed breakfast intermittently ($22.5 \pm .12$ kg/m^2) or never ($23.4 \pm .24$ kg/m^2). While only 27.2% of females and 37.9% of males reported daily breakfast consumption, this group also had the lowest BMI (21.7 ± 0.16 kg/m^2) ($P<0.05$).[43] After five years of follow-up and statistical adjustment for normal growth, the inverse relationship between frequency

of breakfast and BMI remained ($P<0.01$) among the girls and boys who reported daily breakfast consumption. Breakfast consumers exhibited significantly less of an increase in BMI compared to participants that ate breakfast intermittently or skipped the meal (1.6 ± 0.16 kg/m2, 2.0 ± 0.09 kg/m2, and 2.2 ± 0.19 kg/m^2; respectively). The authors went on to note that other dietary factors, such as total energy consumption, alcohol use, ratio of macronutrients consumed, daily fiber intake, and food groups at breakfast, did not seem to explain the relationship. This study did observe that those participants from a more favorable socioeconomic status (SES) were more likely to consume daily breakfast than those who were from a less favorable SES ($P \leq 0.01$).[43] In agreement with this, Agostoni et al. concluded that parents' behaviors and family food environment significantly impacts child breakfast behavior.[36] The correlation between breakfast and other favorable health promoting activities has been further explored as described below.

Metabolically and emotionally a breakfast that is consumed in a positive environment and consists of a balanced energy supply may produce favorable long-term health results.[36] The authors suggest targeting nutrition interventions to low income and disadvantaged populations for greatest impact, stating that parental encouragement of breakfast in the home and/or participation with schools to support breakfast programs may be a powerful tool to amplify effects of existing nutrition interventions. This could be extremely valuable for youth at risk for lifelong struggles with obesity and related chronic illnesses.[42] While numerous obstacles to consuming breakfast exist, it is likely that those subjects who identify as lower SES are eligible for participation in the NSBP allowing them the opportunity to receive the vast benefits discussed above of habitual breakfast consumption.

The National School Lunch and Breakfast Program

The NSLP was established in 1946 and has grown to more than 100,000 participating schools. In 2013 alone, $11.5 billion dollars was spent to serve over 30.7 million students meals. [53] Participating schools must meet specific nutrient guidelines based on the USDA's Dietary Guidelines for Americans. The latest school lunch reform occurred in 2012 with the implementation of the HHFKA[54] which required schools to offer more fruits and vegetables and include more whole grains among many other regulations and restrictions (Appendix B). Schools must meet the following restrictions while remaining within calorie restrictions and serving sizes for appropriate age groups: offer fruits and vegetables as two separate meal components; offer fruit daily at breakfast and lunch; offer vegetables daily at lunch, including specific vegetable subgroups weekly (dark green, orange, legumes, and other as defined in the 2005 Dietary Guidelines) [54] and a limited quantity of starchy vegetables throughout the week; offer whole grains (half of the grains would be whole grain-rich upon implementation of the rule and all grains would be whole-grain rich two years post implementation); offer a daily meat/meat alternate at breakfast; offer fluid milk that is fat-free (unflavored and flavored) and low-fat (unflavored only); offer meals that meet specific calorie ranges for each age/grade group; reduce the sodium content of meals gradually over a 10-year period through two intermediate sodium targets at two and four years post implementation; prepare meals using food products or ingredients that contain zero grams of trans fat per serving; require students to select a fruit or a vegetable as part of the reimbursable meal; use a single food-based menu planning approach; and use narrower age/grade groups for menu planning.[55] The NSBP was established in 1966. [55] Ninety percent of the schools that participate in

the NSLP also participate in the NSBP.[56] This program must also meet strict federal standards as listed above. School breakfast programs must provide 25-30% of the participant's daily calorie consumption, which is calculated by age. [56] The meal must also meet one fourth of the participants recommended dietary allowance (RDA) of protein, calcium, iron, vitamin A, and vitamin C. [56]

The NSLP and NSBP are particularly important because 95% of all children and adolescents ages 5-17 spend most of their day and consume the majority of their daily calories in the academic setting.[57] A la carte options, vending machines, school stores and fundraisers, and classroom celebrations all contribute to variance in caloric consumption in the academic setting. It should also be noted that even with strict national breakfast and lunch standards fewer than ten percent of children and adolescents in the United States consume the recommended number of servings of fruits and vegetables daily.[58] Yet increasing fruit and vegetable consumption is a CDC recommended strategy to combat childhood obesity.[59] The AND, School Nutrition Association, and Society for Nutrition Education all agree that comprehensive, integrated nutrition services are an essential component that may improve nutritional status and health.[60] One method that may further improve fruit and vegetable consumption in schools is implementation of F2S programs.

Farm to School

A F2S program is defined as a school that incorporates food from local or regional farms into school meals. The radius of distance of F2S is not stringently defined; but instead has commonly ranged from 20 to 200 miles of the school. Programs such as these are included as a comprehensive and integrated nutrition service[60] and have been identified as a strategy to fight childhood obesity.[61] The Farm to School Network, a

nationwide advocacy group and networking base, states that students gain access and exposure to healthy, seasonal, and local foods. Students also are commonly involved with school gardens, cooking lessons, and farm field trips.[62] They believe that F2S programs empower children and families to make healthier choices while supporting the local economy by providing stable revenue for farmers in the region. Further, they hypothesize that F2S programs influence the adoption of early lifelong, healthy dietary behaviors contributing to achievement and maintenance of a healthier body weight in childhood as well as adulthood.[62]

Nationally over 40,000 schools have initiated a F2S program according to the 2015 Farm to School Census, this is roughly 42% of the nation's schools.[62] The data from the Farm to School Census is self-reported, and likely reflects a wide range of mildly developed to mature F2S programs. Nationally, over $598 million was invested in local communities to implement F2S programs.[62] In addition to non-federal financial support, from 2013-2015, $15.1 million dollars of federal funding was awarded to school districts through grants for planning, implementing, supporting, or training staff for F2S programs, further contributing to the increasing prevalence of F2S programs in the nation.[62]

A wide range of development tools and funding opportunities exist for schools to utilize in attempt of implementing a F2S program. Many external and internal factors determine how attainable, sustainable, intensive, and successful the F2S program will be. Without strict definition of F2S programs the program can range from serving local dairy from a region as big as the northwest several times, or serving local vegetables from less than 50 miles away throughout the school year. This ambiguity remains true in regards to educational components as well. As stated, most schools do pair F2S meals with

curriculum. But this curriculum varies in intensity and does not always remain after the hype of the new program has dwindled. This ambiguity in definition is a weakness of the F2S program, and should remain a focus if the program is to be valued as a potential strategy for preventing childhood obesity.

Despite variance in F2S, the district chosen in this study has flourished into one of the more advanced F2S programs. The program primarily serves food from nine farms within 50 miles of the school district. The program was implemented in 2009 and continues to hold events such as Harvest Of The Month and Taste of Washington. The school purchased $104,000 of local produce during the 2015/2016 school year. Other ingredients produced locally and used in school foods include dairy products, beef, legumes, and grain. The program has developed into one of the leading F2S models in the state and country.

Proposed benefits of F2S programs

As prevalence of F2S programs increase rapidly, from less than ten in 1998 to approximately 40,000 in 2015, it's pertinent to understand the existing and potential benefits of the program. A 2008 meta-analysis by Joshi et al., including 15 studies, analyzed the potential advantageous outcomes of F2S programs.[63] It should be noted, that only four of those studies were peer-reviewed. This meta-analysis demonstrates an overall lack of research regarding the benefits of F2S programs and illustrates a need for further inquiry. Joshi himself states that more research must be done to determine what types of beneficial effects these programs may have on the students and surrounding community.[63] In his analysis, he categorized studies into the following groups: individual behavior change; change in diet and other behavior of students/teachers/staff/parents;

changes in food service operations; and changes in farm sales/transactions. One positive outcome that was observed was that students who participated in F2S programs were more likely to consume extra fruits and vegetables per day than those who participated in traditional NSBPs and NSLPs, 11 of the 15 studies analyzed observed increases from 25-84% in daily intake.[63] This correlation was hypothesized to be related to increased offering of fruits and vegetables and enhanced attention to seasonal and local produce. This is noteworthy due to the fact that 60% of children do not meet daily fruit recommendations and 93% do not meet daily vegetable recommendations.[64]

Additionally, the AND as well as the IOM recommend increasing fruit and vegetable intake as a prevention strategy for obesity[14,60] which is in line with the F2S program's objectives. Of the studies Joshi reviewed, five of them evaluated dietary intake and changes at home in addition to behavior change while participating in a F2S program. The majority, four of the five studies, did observe an increased fruit and vegetable consumption outside of school as well.[63] This phenomenon may be influenced by the overall hype of the program in the academic setting, educational components that are typically introduced simultaneously to local foods offerings in the school meals, or by new food exposure and opportunity to try certain foods otherwise left unknown. This contributes to existing evidence that participation in the F2S program could be a valuable strategy to prevent or reduce obesity, due to its related behavior change in the school and home setting; lifestyle behavioral changes that may have long-term positive effects.

School meal participation also increased; however, it's unknown whether this effect was lasting or a temporary interest in new school food service changes. Of the 15 studies, only one used BMI as an indicator for F2S success and the researchers did not

find any significant decreases in BMI with participating children.[63,65] This nine-month intervention study included several nutrition education components that encouraged kindergarteners to eat local, seasonal foods and be more aware of their community's food system. With such a short duration of participation, it is likely that the length of the intervention was not sufficient to significantly decrease BMI.[65]Additionally, school food service employees were not involved in the implementation of the study perhaps further diminishing the effectiveness of the intervention. Few reports have evaluated more mature F2S programs with only two of the studies evaluated having had programs two or more years old.[63] Older F2S programs have been associated with greater behavior change and health benefits.[66] For example, a F2S evaluation report was conducted by LaRowe et al. in Wisconsin that examined multiple F2S programs consisting of a range of F2S program implementation and levels of maturity. Primarily attitudes towards food, specifically fruits and vegetables, and general nutrition knowledge were assessed. Researchers found that schools with existing, older, F2S programs had higher scores of positive food and nutrition attitudes.[66] This trend was significant at baseline and follow up. All participating schools experienced improvements in attitudes and behaviors towards food and nutrition as evidenced by survey responses; and thus, the authors concluded that gradual, yet sustainable, positive changes on students' behaviors and attitudes is achievable.

Regardless of the lack of research on this topic, Joshi in a more recent publication, suggests a F2S program may be a causal pathway to prevent childhood obesity.[67] Even with limited data, F2S programs show increased levels of positive food awareness, willingness to try new foods, likelihood to make healthy choices, and increased

consumption of fruit and vegetables.[67] F2S programs even had a potential positive effect on family diets, parental knowledge, and healthy eating habits as previously noted.[67] Joshi argues that F2S programs, although difficult to sustain and requiring of resources (to be discussed below), are associated with the achievement of behavioral changes related to positive activities, healthier environments, and increased educational components such as cooking demos, learning gardens, and field trips. These components take place in the cafeteria, classroom, outdoor learning spaces, family, home, and community. This environmental change in turn may alter the child's attitude, skills, and behavior, and if positively reinforced, may have the additional effect of reducing the risk of childhood obesity.[67-72]

While the potential benefits of F2S programs are evident, barriers to implementation exist. Food service directors note that maintaining a F2S program and its educational components is challenging.[67] Programs often run with help of volunteers and funding via grants, two unsustainable resources in the longer term. Even with the noted challenges, Joshi observes that F2S programs have the potential to support good health, nutrition, agriculture, and local economy in any location.[67]

As F2S programs are still relevantly new, they have not been completely or sufficiently evaluated, there are many gaps in the literature yet it remains evident they have promising potential and may yield significant impact on reductions in childhood obesity rates. Given the benefits associated with regular consumption of breakfast, the NSBP is an ideal setting to evaluate F2S programs' benefits on body weight; especially given the NSBPs rigidly defined standards and guidelines. Unlike many other studies that contain ambiguity in breakfast definition, school breakfast is highly regulated and

controlled. Furthermore, the breakfast setting provides a better platform to measure effects of F2S than lunch because it is more highly correlated and predictive of BMI.[31] Since childhood obesity remains a significant public health problem nationally, public school venues to reduce childhood obesity are highly worthy of exploration.

Conclusion and Study Objectives

The purpose of this study is to determine if school breakfast participants in F2S programs have lower BMIs then school breakfast participants in schools without F2S programs and if the frequency of participation has an impact of BMI. Specifically, we hypothesize that students who participate in the NSBP in schools who have enacted F2S will have a lower BMI than students who participate in the traditional NSBP. Additionally, we hypothesize those students who consume breakfast the most frequently will demonstrate lower BMIs compared to infrequent breakfast consumers, regardless of traditional or F2S participation. Our study compares two districts with similar demographics and access to local foods. One district has a more mature F2S program that includes a variety of educational components. The other has a traditional NSBP and NSLP and does not promote or participate in similar curriculum. As the F2S movement continues to grow it is valuable to understand how this movement affects childhood obesity, specifically in regards to breakfast, as it has been strongly correlated with reduced risk for obesity.

CHAPTER III

JOURNAL ARTICLE

NATIONAL SCHOOL BREAKFAST PROGRAMS WITH IMPLEMENTATION OF FARM TO SCHOOL HAVE NO INFLUENCE ON BODY WEIGHT AMONG 3RD AND 4TH GRADE STUDENTS

National School Breakfast Programs with Implementation of Farm to School Have No Influence On Body Weight Among 3rd and 4th Grade Students.
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ABSTRACT

Objectives:

To examine the association between frequency of breakfast consumption on body mass index (BMI) among third- and fourth-grade students participating in the National School Breakfast Program (NSBP) compared to those participating in Farm to School (F2S) programs within the NSBP.

Methods:

This cross-sectional study matched ten schools, five with F2S (A), and five with a traditional NSBP (B). Third- and fourth-grade students (n=1031) were recruited for study participation. Demographic information, frequency of breakfast participation, and anthropometric data were collected. BMI and frequency of breakfast consumption over a ten-day period, excluding non-school days, was stratified by frequent eaters (7-10), occasional eaters (3-6), and skippers (0-2).

Results:

No significant difference in BMI-for-age between F2S (A) and traditional NSBP (B) was observed. There was also no significant correlation between BMI or BMI-for-age and breakfast participation observed. This data suggests that there is no effect of F2S participation on BMI-for-age and no correlation between breakfast consumption and BMI-for-age among third- and fourth-grade students. Hispanic and Latino students were more likely to qualify for free and reduced lunch ($P<0.001$). Free and reduced school meals students were more likely to be overweight or obese than students that qualify for paid school meals ($P<0.001$). In both districts, students that were offered breakfast in the classroom were 30% more likely to participate than students offered breakfast in the cafeteria.

Applications to Child Nutrition Professionals:

The F2S program is unlikely to be an effective strategy to prevent/reduce childhood overweight and obesity unless more fully implemented. Future strategies should focus on lower socio-economic status students and minority groups due to their increased rates and predisposition of overweight and obesity. Offering breakfast in the classroom may be a positive method of increasing breakfast participation in all types of school breakfast programs.

Keywords: schools, farm-to-school, breakfast, childhood obesity, classroom breakfast.

INTRODUCTION

Childhood overweight and obesity remain a persistent concern nationally. Although the increasing rate of childhood obesity has slowed to 17% (Ogden et al., 2014), a large percentage of children still suffer physically, emotionally, socially, and even academically from the detrimental effects of overweight and obesity (Fryar et al., 2012; Schwimmer et al., 2003; Fox et al., 2009; Geier et al., 2007; Hesmat et al., 2014; Biro et al., 2010). Consequences are not limited to childhood years: overweight and obese children often enter middle adulthood with more severe forms of chronic diseases such as diabetes, cardiovascular diseases, and select cancers, contributing to an overall diminished quality of life (Juonala et al.,2010; Dietz, 1998; Biro, 2010; Singh et al.,2008; Weiss et al., 2004). Beyond the physical health concerns, these conditions often co-exist with food insecurity, poverty, and hunger; creating a web of political and health issues requiring national attention (Hoelscher et al., 2004; Healthy People, 2015; State of Obesity 2015).

Due to the multifaceted cause of obesity there is an array of recommended strategies targeting childhood overweight and obesity proposed by various health organizations. These include, but are not limited to: early child- and school-based interventions, policy-based interventions, and food marketing interventions (Hoelscher et al., 2013; IOM, 2004; Healthy People, 2015; CDC, 2014). The National School Lunch Program (NSLP) and National School Breakfast Program (NSBP) provide a promising platform to increase nutritional health and health awareness among children and

adolescents.

School food components, which are federally regulated by the United States Department of Agriculture (USDA), were recently updated in 2012 with the Healthy, Hunger-Free Kids Act (HFFKA). This act required schools to provide more fresh produce, half of all grain servings as whole grains, and reduce the sodium content of meals among other various changes intended to improve the nutritional quality of school meals. Other school-based interventions include regulating available beverage and vending machine choices, promoting increased physical activity, and implementing Farm to School (F2S) programs (Briggs et al., 2010).

The F2S program is a nationwide initiative to include more local produce, dairy, meat, and grain products within school meals. Almost half of the nation's schools claim to have a F2S program, with over $15 million federal dollars spent on initiating and sustaining the programs (National Farm to School Network, 2016; Farm to School Census, 2015). The F2S program is collectively presented with relevant educational components, such as farm tours, school gardens, and interactive events encouraging students to think about where their food comes from. Currently, the program is a recommended strategy to prevent or reduce childhood obesity by the Institute of Medicine (IOM) (Hoelscher et al., 2013; Farm to School Census, 2015), though very few studies have examined the relationship between F2S participation and body mass index (BMI) to date (LaRowe et al., 2012; Joshi et al., 2008).

The effects of the F2S program may be especially visible when measuring

breakfast consumption habits. A relationship between regular breakfast consumption and a healthy body weight has been identified by numerous studies (Schwimmer et al., 2003; Kleinman et al., 2002;Widenhorn-Muller et al., 2008; Murphy et al., 1998; Adolphus et al., 2013; Deshmukh-Taskar et al., 2010; Pereira et al., 2011; Kant. Andon et al.,2008; Rampersaud et al., 2005; McCrory et al., 2011; Gleason et al., 2007). Ultimately, as discussed in ONeil's research commentary in 2014, the definition of breakfast affects the strength of the observed association between breakfast consumption and body weight. The NSBP, due to its highly regulated nature, is likely to demonstrate this inverse relationship, while promoting healthy lifestyle behaviors that may reinforce lasting maintenance of a favorable body weight.

This study aimed to explore the effect of F2S participation on childhood BMI, and furthermore if regular participation in the NSBP amplifies the proposed benefits between F2S and body weight status. If the F2S program has benefits such as increased exposure to healthy foods, positive attitude surrounding food systems and health, and increased consumption of fruit and vegetables it's likely to also have a positive effect on body composition. As the F2S movement continues to grow it is valuable to understand how the program affects childhood obesity, specifically in regards to breakfast as it has been highly correlated with reduced risk for obesity.

METHODOLOGY

Study Design

This study was a cross-sectional design assessing the effect of frequent breakfast

consumption and F2S participation on BMI among third- and fourth-grade students. The study protocol was reviewed and approved by Central Washington University's Institutional Review Board prior to collection of any data. All guardians were mailed study information and were provided with opt out forms, envelopes, and postage if they did not want their child to participate. Assent was attained from students prior to data collection. Students were informed that they could choose to opt out at any time.

STUDY DESIGN

Figure 1: Flow of study

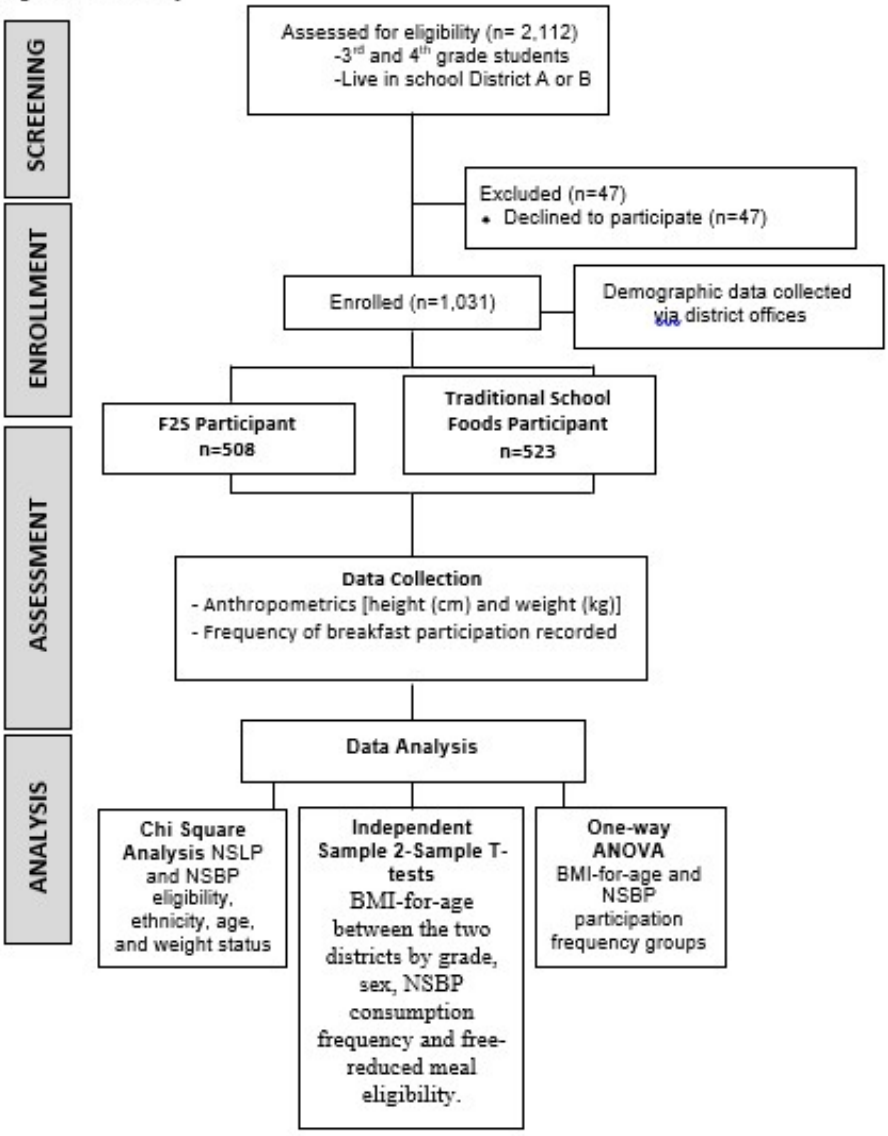

Table 1. Sample Demographic Information.

	District A (F2S)	District B (NSBP)
NSLP & NSBP Eligibility % (n)		
Free	56.6% (n=288)	53.5% (n=280)
Reduced	8.3% (n=42)	10.9% (n=57)
Paid	35.0% (n=178)	35.5% (n=186)
Ethnicity % (n)		
Hispanic or Latino	53.1% (n=270)	49.9% (n=261)
Non-Hispanic White	43.7% (n=222)	46.2% (n=242)
Age (Mean, SD)		
Years	9.2 $\pm$ .8	9.1 $\pm$ .8
Weight Status % (n)		
Underweight	2.5% (n=13)	1.3% (n=7)
Normal	50.6 % (n=257)	55.8% (n=292)
Overweight	19.7% (n=100)	17.5% (n=91)
Obese	29.9% (n=137)	25.4% (n=133)
N total	508	523

Status ranked according to CDC standards. BMI-for-age is an index of weight-for-height that iss based
on a normal distribution of the national population. Underweight (<5%), normal (5-85%), overweight
(85-95%), and obese (>95%). None of the above measures were statistically significantly different

between districts.

Study Sample

The study sample included ten elementary schools, from adjacent school districts in North Central Washington. Five with F2S breakfast programs (A), and five with traditional NSBP (B) were selected. Third- and fourth-grade students (N=1031) were recruited for participation. This age group was selected due to two or more probable years of F2S participation. Furthermore, this age group is less likely to be as affected by peer social influence of school meal participation compared to older children (Adolphus et al., 2013). All third- and fourth-grade students within districts were eligible for participation in this study. This resulted in 568 students who qualified for free-breakfast, 99 students who qualified for reduced-breakfast, and 364 students who purchased their breakfast (**Figure 1**). Might want to mention demographic profile

Data Collection

Demographic data. Demographic data was collected from each district office and through statewide public reports. Ethnicity as well as individual, district, and state wide free and reduced lunch status were assessed.

Anthropometric data. Anthropometric data (height [cm] and weight [kg]) were collected by trained investigators and co-investigators following standardized procedures in a private location. Standing height was measured using a portable stadiometer (Charder HM200P Portstad) to the nearest 0.1 cm. Weight was measured using a portable, digital display floor scale to the nearest 0.1 kg (Detecto SlimPRO Digital Low Profile). All equipment was calibrated prior to use. Participants were asked to remove heavy clothing; footwear remained on for all subjects. Participants were unable to see their recorded

measurements, height and weight was kept confidential and not shared with other subjects.

School breakfast participation data. School breakfast participation information was retrieved from the databases at each food service establishment; Mealtime by the CLM Group Inc. at district A and NutriKids by Heartland Payment Systems at district B. Participation of breakfast and lunch was recorded in a consecutive ten-day span, excluding non-school days. Only frequency of breakfast consumption was recorded; meal components or nutrients consumed were not recorded. Frequency of breakfast was organized into three groups; skippers (0-2 meals), occasional eaters (3-6 meals), and frequent breakfast consumers (7-10 meals).

Data Analyses

Summary statistics (means, standard deviations, ranges) were calculated for baseline characteristics. BMI-for-age was calculated using anthropometric data collected and birthdates provided by district office database. The software used for analysis was the Center for Disease Control and Prevention's (CDC) group BMI calculator, English v1.1 (Center for Disease Control, 2015). Chi-square tests were used for NSLP and NSBP eligibility, ethnicity, age, and weight status sample comparisons. Independent 2-sample t-tests were used to compare BMI-for-age between the two districts by grade, sex, NSBP consumption frequency and free-reduced meal eligibility. One-way ANOVA was used to compare BMI-for-age and NSBP participation frequency groups. In a *post-hoc* analysis, the effect of the location of breakfast was also assessed. The SPSS 20.0.0.0 software was used for analysis. Significance was set at 0.05.

RESULTS AND DISCUSSION

In contrast to our hypothesis, there was no difference in BMI-for-age among third- and fourth-grade students regardless of participation in a traditional NSBP or a NSBP with a F2S program. There was no relationship observed between BMI and breakfast participation frequency.

Socioeconomic Status and Ethnicity

No significant differences in summary statistics between districts were demonstrated; indicating a highly homogenous sample (**Table 1)**. The majority of students at each district qualified for free- or reduced-breakfast demonstrating a similar socioeconomic status (SES) distribution ($P = 0.48$). However Hispanic/Latino students (comprising 71.3% of the sample who qualified for free and reduced meals) were more likely than non-Hispanic white students to qualify ($P < 0.0001$). Other ethnicities were not included in this statistical analysis due to their very small prevalence within the sample.

The overall sample had a similar ethnic profile with no significant differences noted. Hispanic/Latino students comprised a large portion of the sample. Though the majority of the entire sample had normal BMI-for-age (n=527), a greater proportion of Hispanic/Latino students were classified as obese/overweight (65.3% and 60.8%, districts A and B, respectively) compared to non-Hispanic white students (36.4% and 34.3%, districts A and B, respectively $P < 0.0001$).

Table 2. Mean BMI-for-Age compared by grade, gender, breakfast frequency, and eligibility.

	District A	**District B**
BMI-for-Age (% + SD)		
3rd Grade Girls	68.5 + 30.3	72.6 + 24.4
3rd Grade Boys	71.3 + 27.9	75.0 + 24.0
4th Grade Girls	69.0 + 27.9	71.3 + 26.5
4th Grade Boys	73.0 + 28.5	73.9 + 25.6
Breakfast Frequency (% + SD)		
Skippers	69.4 ± 29.2	71 ± 27.1
Occasional	75.8 ± 26.72	75.7 ± 24.9
Frequent	70.9 ± 26.8	76.4 ± 19.5
NSLP + NSBP Eligibility (% + SD)		
Free	74.5 ± 26.5	76.3 ± 24.1
Reduced	66.4 ± 34.5	72.6 ± 24.9
Paid	65.1 ± 29.5	68.6 ± 26.1

Status ranked according to CDC standards. BMI-for-age is an index of weight-for-height that's based on a normal distribution of the national population. Underweight (<5%), normal (5-85%), overweight (85-95%), and obese (>95%). None of the above measures were statistically significantly different between districts.

Anthropometric Data

No significant differences were found between weight status and school districts (**Table 1**). Of our entire sample, 26% were classified as obese based on BMI-for-age; much higher than the national average of approximately 17% (Center for Disease Control, 2015). This discrepancy between our sample and the national population may have attenuated the F2S program's ability to positively affect body weight status.

No significant differences were found between BMI-for-age and grade or gender. Though BMI-for-age averages were slightly less in all categories in district A, all mean BMI-for-age scores fell within normal weight status percentiles ($5^{th} < 85^{th}$ percentile-for-age; **Table 2)**; although it should be noted that they were much higher than the expected average of 50%.

No significant differences were found between districts when stratified by breakfast frequency consumption. As **Table 2** illustrates, skippers, occasional eaters, and frequent eaters all had mean BMI-for-age scores within normal weight status percentiles ($5^{th} < 85^{th}$ percentile-for-age); although again, markedly above the average of 50%.

With complete sample analysis of all participants in both districts, statistically significant relationships were observed between students that qualified for free breakfast and lunch and overweight and obesity status ($P<0.001$); as well as between students who purchased breakfast and a normal BMI-for-age status ($P<0.001$). This supports previous literature (Timlin et. al., 2008) suggesting SES status is inversely correlated with BMI. When districts were compared, no significant difference was found between free and reduced meal eligibility and BMI-for-age (**Table 2**).

School Breakfast Location

In a *post-hoc* analysis it was observed that children who consumed breakfast in the classroom had greater participation in the NSBP regardless of whether the school had implemented a F2S program. In both school districts, students were 30% more likely to consume breakfast at school if it was served in the classroom rather than the cafeteria ($P < 0.05$; data not shown). However, BMI-for-age was not statistically different among classroom and cafeteria eaters. Of the classroom breakfast eaters, 51.6% qualified for free school meals, making the SES distribution of classroom breakfast eaters similar to the entire sample (51.1%).

Previous studies suggest offering breakfast in the classroom is a positive nutritional reinforcement as well as a potential strategy to increase academic performance and behavior (Food Research and Action Center, 2016, Adolphus et al., 2013). Adolphus et al., reviewed 21 studies analyzing habitual breakfast consumption and children and adolescent academic performance They concluded participation in school breakfast positively impacted test scores. The effect was more apparent if breakfast met >20-25% of daily caloric needs, the NSBP is required to provide an estimated 25% of daily needs. In addition to positive academic and behavior outcomes, increased habitual breakfast participation within the classroom it is likely to have a positive effect on childhood BMI. Although not demonstrated in this study, numerous studies have illustrated an inverse relationship between breakfast consumption and BMI (Affenito et al., 2007, Baldinger et al., 2012, Merten et al., 2009, Szajewska et al., 2010, Timlin et al., 2008).

In contrast, some researchers argue breakfast in the classroom as an unfavorable addition of excess calories for children that may be consuming breakfast both at home and school (Van Wye et al., 2013). During a NSBP study, it was noted that over 20% of students consumed more than one breakfast. Of the double breakfast consumers, almost half (46%) consumed a nutritionally substantive breakfast prior to consuming school breakfast (Bernstein et al., 2004). However, in Bernstein's study, no anthropometric data was collected to determine a potential positive or negative influence on BMI. Wang et al. measured weight gain over two academic years and assessed breakfast habits; the authors concluded that even those students who consumed breakfast at home as well as at school had more favorable BMIs than those who skipped breakfast all together, which further supports the role of breakfast in maintaining a healthy body weight ($P < 0.05$) (Wang et al., 2016).

Strengths and Limitations

This study hypothesized that with F2S exposure an effect on BMI would be measurable, but without subjective data analysis, it is impossible to determine if attitudes towards food or dietary behaviors have changed or improved. The history and level of involvement in F2S related programs were also not measured in our study. Variance may occur by teacher, school year, or schools within district. Lastly, limited information on educational level, demographics, anthropometric data, or health behavior of the legal guardians was not obtained; all of which may significantly influence childhood BMI status.

It is likely we did not see a statistically significant effect of the F2S program on body weight in part due to the high percentage of students classified as obese and of a lower SES; both known risk factors for childhood obesity (Timlin et al., 2008). Significant results may have been more likely with a population with average obesity rates. Despite the noted limitations, this research is one of very few studies that evaluated F2S and BMI-for-age. Other strengths include: the large sample size; the high proportion of Hispanic/Latino students; and two homogenous populations that provided an excellent platform to control for extraneous variables. The region of North Central Washington is an agricultural hub, allowing the schools accessibility to grains, legumes, dairy, vegetables, orchard fruits, and meats locally. The same task would prove more challenging to a more urban school or a district in a less bountiful region.

CONCLUSIONS AND APPLICATIONS

Although originally thought to be a promising strategy, our results show no significant effect on childhood BMI between participation in a F2S NSBP compared to a traditional NSBP. Our sample population had a higher prevalence of obesity than the national average (26% vs. 17%). This likely skewed our findings but emphasizes the need for these high-risk populations to be a primary focus of future childhood obesity interventions.

Additionally, it's likely the food served within NSLP and NSBP have little variance between districts due to strict regulations schools must already follow. With increased fruit and vegetable offerings among all schools due to the HHFKA; it's

improbable that F2S programs are in fact serving more fruit and vegetables than other schools. If in fact, F2S programs serve more fruit and vegetables, it's unknown if students are consuming more of them or contributing to greater overall food waste.

The F2S Network recommends a complete F2S program consist of procurement, education, and school gardens, but does not have detailed objectives. The current study found no relationships between F2S procurement and a healthy body weight; however, it's likely the educational components have a greater impact on a child's nutritional choices. We recommend that the educational components of F2S programs be expanded and more defined, as this component of F2S is likely a stronger contributor to child dietary habits than food served at NSLP and NSBP alone. We recommend that all schools, not just schools with F2S programs, develop and implement a standard nutrition curriculum. Additionally, in population's with markedly higher rates of obesity, such as our sample, a greater emphasis should be placed on nutrition education. It would be beneficial for schools to be aware of their school's obesity rates to align with this recommendation.

We recommend future studies analyze the population during different years within the child's schooling to analyze how the F2S program exposure affects child dietary patterns and body composition over time. We also recommend conducting a detailed history of F2S involvement to explore which aspects of F2S curriculum are most effective. For example, it would be helpful to know roughly how many school hours they spent learning about or working in the school garden, how many field trips each student participated in, and what nutrition-related events the child was exposed to. Nationally,

F2S programs have vast variability between programs, making it difficult to determine its true effect without more comprehensive measurement and analysis. The F2S program in our study, although mature, varies among season, year, schools within each district, grade level, and teacher. Nationally, programs range by ingredients purchased, volume of food purchased, promotion of the program, and extent of involvement in complementary educational components; all of which make comparing and measuring effects of programs challenging. This study revealed the need for school-based interventions, such as F2S, to be continuously evaluated and regulated. Future studies may consider surveying students on attitudes and experiences after involvement in such programs, in addition to evaluating BMI.

We did not observe a significant relationship between breakfast consumption and BMI; contrary to our hypothesis. Although our sample's prevalence of obesity is higher than the national average, skippers in our sample had a mean normal, but above average BMI-for-age. We did see a significant relationship between location of breakfast and participation. Regular breakfast participation has been correlated with an array of benefits in addition to favorable body composition. The NSBP provides a platform to address and improve our nation's food security status and the childhood obesity epidemic, while reinforcing healthy behaviors like habitual breakfast participation. Considering the positive effects of habitual breakfast as evidenced by previous research, school food services may elect to shift breakfast to the classroom instead of the cafeteria to extend on those benefits. Previous studies have also noted universal breakfast as a potential opportunity to increase food security, decrease hunger, increase meal participation,

increase school attendance, and enhance academic achievement (Leos-Urbel et al., 2013, No Kid Hungry, 2014). Universal breakfast, specifically in the classroom, should be further explored in hopes of expanding previously stated benefits to all students. Another area for expansion is Breakfast After The Bell, a program that integrates breakfast into the school day, often in the classroom, greatly improving the likeliness of breakfast consumption. Both types of SBPs could significantly increase meal participation while simultaneously reducing stigma that may be associated with school breakfast consumers. School food service staff and teachers may consider working together to offer breakfast in the classroom in hopes of providing optimal health and success for their school's student population.

In conclusion, the potential effectiveness of F2S programs as a promising obesity prevention or reduction was not illustrated by this study. This finding is likely related to the high obesity prevalence and low SES in the sample analyzed. Results showed that participation in school breakfast did not significantly impact BMI-for-age. Breakfast consumption participation increased significantly when breakfast was served in the classroom versus the cafeteria. This information may be beneficial for schools to not only increase participation rates but also enable more students to benefit from habitual breakfast, which has been historically associated with maintenance of a healthy body weight. Future classroom based interventions, like breakfast in the classroom, fruit and vegetable curriculum, and food system based lesson plans may be more favorable than food service based interventions, though it's clear external factors, such as SES, continue to highly influence a child's body weight. The results from this study suggest the need for

strong intervention and specific prevention methods to target this already high-risk population.

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APPENDIXES

Appendix A
Summary of research analyzed for review

Author/Year	Population	Methods	Results	Conclusions
Keski-Rahkonen /2003	16 yo n= 5448 Parents n= 4660	Self-report questionnaire Questions such as: How often do you eat breakfast (for example, sandwiches, milk, hot cereal, other similar food) before going to school or work?" and asked subjects to answer "every morning", "a few times a week", or "about once a week or less often"	P<0.001 P<0.001 P<0.001 P<0.001 P<0.001 P<0.001 P<0.001 P<0.001	High body mass index (≥25) is assoc breakfast skipping Infrequent exercise is correlated with adolescents; Exercise 1-2x/month and breakfas OR 2.33 (1.66-3.28CI) Exercise less than 1x/month and b OR 4.03 (2.84-5.72CI) Exercise 0x/month and breakfast 1 OR 3.75 (2.57-5.47CI) Parental breakfast habits are significa habits Breakfast skippers are more likely to adjusted multinomial logistic regress Alcohol (weekly use): OR: 2.89 (2.1 Caffeinated soda (1+ bottle/day): OR Cigarettes (daily): OR 4.17 (3.34-5.2 Girls consumed daily breakfast 68.4% consumed breakfast 73.5%
Dialektakou/2008	n= 811 383 boys 429 girls 14-21 yo **Mean age:** 16.62 **Mean BMI:** 23.10 **% of overweight and obesity:**28.1 %	Anonymous questionaries' distributed in classrooms. Investigators weighed and measured participants with a digital scale and stadiometer. Height and weight was recorded on corresponding questionnaire. Compared BMI and overweight/obesity with 24 definitions of breakfast skipping.	P<0.05 P<0.05	Significant association between breal BMI was found in 29 of 48 linear reg Significant association between breal overweight/obesity was found in 35 c used Association of breakfast skipping an overweight/obese status, varied by de

Veltsista /2010	n=6468 16-18yo	Mail surveys were dispersed among subjects. Breakfast habits, weight control methods, dietary habits, height, and weight were accessed. Breakfast consumption was grouped into four categories; A: daily B: 1-3 times/week C: 1-3 times/month D: never/rarely	P<0.001	Males, but not females, who consume of overweight/obesity OR and 95% CI of overweight/obesit Daily breakfast Finnish boys: 0.60 (0.46-0.78) Greek Finnish girls: 0.84 (0.63-1.11) Greek Daily breakfast adjusted for socioeco Finish boys: 0.72 (0.54-0.95) Greek girls: 1.01 (0.75-1.37) Greek girls: 1.
Timlin /2008	n=2216 mean age at time of EAT-I = 14.9 mean age at time of EAT-II = 19.4	EAT-I survey, a 221 item self-report addressing behavior, socioenvironmental, and personal information. Height and weight measured by research staff EAT-II survey, five years following EAT-I assessed changes in eating behavior and weight status.	P<0.01 P<0.01 P<0.05	Among sample, 27.2% of girls and 3 breakfast at time of EAT-I. At time o 21.2% of boys consumed daily break Participants who were either Caucasi engaged in higher levels of physical a consume daily breakfast. A higher BMI was observed in partic or ate breakfast intermittently. Signif adjusting for age, gender, race, SES, liquor use (model 1). Significance re factors in model 1 and adjusting for t items (model 2). Significance remai psychosocial variables, weight contro in addition to adjustments in model 2 Over the 5 year period, regular break associated with lower BMI increases gender, race, SES, exercise, cigarette breakfast consumers had an average intermittent breakfast eaters 2.0 ± 0.0 ± 0.19
Merten /2009	n=7788 National Longitudinal Study of Adolescent Health 12-19yo at wave 2 18-26yo at wave 3	Subjects recruited from 134 middle and high schools. 74.8% Caucasian, 25.2% African American. Community disadvantage, family poverty, parental presence in mornings, regular breakfast consumption, height, weight, and demographics were assessed at wave 2 and 3. Data were collected from US census, survey, and self-reported anthropometrics.	P<0.001 P<0.001	Higher levels of community disadvan the likelihood of adolescent breakfas [OR] 0.85; 95% confidence interval Breakfast consumption in adolescenc likelihood of chronic obesity (OR 0.5 Consuming frequent breakfast, defin adolescence as well as young adultho lower likelihood of chronic obesity th breakfast frequently in adolescence a CI: 0.34 to 0.48).

Affenito /2005	n=2379 Girls aged 9-10 at study start	9 year- longitudinal biracial cohort study by the National Heart, Lung, and Blood Institute Growth and Health Study. 3 day annual food records collected by interview. Annual height and weight recorded by trained examiners.	P<0.05 P<0.0001 P<0.0001 P<0.001	Number of days of breakfast consum predictor of BMI (x^2 [1] =14.05). Tl for location, race, age, race-by-age, a When parental education and physica well, breakfast behavior did not signi Parental education x^2 [1]16.06 Physical activity x^2 [1]21.00 Energy intake x^2 [1]12.03
Deshmukh-Taskar /2010	n=4320 9-10yo n=5339 14-18yo	Self-reported breakfast consumption patterns and anthropometric data from NHANES records 1999-2006. Dietary recalls achieved from single multipass 24h recall. Weight, height, and waist circumference were measured by NHANES professionals in the Mobile Examination Center.	P<0.05 P<0.05 P<0.05	20% of children and 31.5% of adoles Mean adequacy ratio (MAR) was hig cereal consumers and other breakfast breakfast skippers. Children who classified as breakfast scores for age than other breakfast co Child breakfast skippers had higher v cereal and other breakfast consumers
Szajewska /2010		16 cross-sectional or cohort trials involving more than 59,000 children/adolescents from Europe		Thirteen studies (n = 57,481) consist has a protective effect against becom The effect of eating breakfast on the analyzed in 4 studies (n = 2897). Bre BMIs.
Dubois /2008	n=1549 average age= 49mo	Children and parents were seen at 5 months of age and one year intervals following. Questionnaires, interviews, and anthropometric data was accessed at each visit.	 P<0.05 P<0.05 P<0.05 P<0.05 P<0.05	10% of children at breakfast fewer th Breakfast skippers consumed fewer g Breakfast skippers consumed more k eaters. And more carbohydrates in th Breakfast skippers consumed less veg OR: 1.14, 1.24 SEM: .046, .016 resp Breakfast skippers consumed less gra 3.93, 4.09 SEM: .071, .024 respectiv Breakfast skippers consumed less mi eaters OR: 1.77, 1.98 SEM: .059, .02 Breakfast skipping and body weight: Model 1: breakfast skippers were two overweight than breakfast consumers Model 2: After adjustment for energy skipping even more so significantly a overweight/obesity.

Baldinger /2012	n=656 7-10yo	Self-reported nutrition survey reflective of eating habits, specifically of breakfast/morning snack at school. Anthropometric measurements taken by research team. Five standardized motor function tests; sidewise jumping, tapping, standing long jump, 20-m sprint, and shuttle run.	P<0.05 P<0.05	Children consuming breakfast almos lower BMI (16.7 ± 2.2 kg/m2) comp breakfast only sometimes or almost n 18.8 ± 3.4 kg/m2, respectively). Children consuming breakfast had be in 3 of the 5 tests.
Kontogianni /2020	n=1305 3-18yo	Telephone interviews. Sample selection multistage, stratified, and random. Self-stated information on anthropometrics, dietary intake and eating behavior, and physical activity.	P<0.01 P<0.001	Breakfast consumption and higher K associated with BMI whole sample: s Acceptable energy reporters: standar
Warren /2013	n=37 9-12yo	3-way crossover study 5 groups were devised whereby, week by week, each group would randomly receive 1 of 3 test breakfasts for 3 consecutive days, with a minimum of 5 weeks between the test breakfasts. 3 breakfasts include low-glycemic index (GI), low-GI +10% sucrose, and high-GI. Breakfasts were composed of fruit juice, cereal, and milk with and without bread. Children were directed to abstain from eating until lunchtime except water and one small fruit serving. Lunch, buffet style, was assessed by research team and analyzed to type of breakfast consumed.	P<0.05	The type of breakfast eaten had a sta mean energy intake at lunchtime. Lunch intake was significantly highe Caloric differences between test brea high-GI versus low-GI = 145 $\pm$ 54 kc high-GI versus low-GI plus sucrose = low-GI plus sucrose versus low-GI= No difference was found between bo
Barton /2005	n=2379 9-10yo	9 year- longitudinal biracial cohort study by the National Heart, Lung, and Blood Institute Growth and Health Study. 3 day annual food records collected by interview. Annual height and weight recorded by trained examiners.	P<0.0001 P<0.0001	Days eating cereal was predictive of [repeated-measures Mantel-Haenzel :$x^2(10)$=1,603.09 Frequency of breakfast and cereal co age.

Williams /2008	n=1389 1-12yo	Data from NHANES 1999-2002. Dietary recalls achieved from single multipass 24h recall. Weight, height, and waist circumference were measured by NHANES professionals in the Mobile Examination Center.	P<0.05 P<0.05	The lowest mean BMI and mean wai children 1–12 years of age who cons compared with other consumption gr No differences in percentiles or Z-sc weight-for-age were observed betwe groups in children.
Hunty/2013		14 research papers.	P<0.0001	The computed effect size for mean B and low or non-consumers over all 2 kg/m2 (95% CI -0.81, -1.46) Adjustment for age and publication b somewhat but they remained statistic

Appendix B

SBP Regulations Following the HHFKA

Breakfast Meal Pattern
Grade K-5

	Amount of food per week (minimum per day)
Fruits (cups)	5 (1)
Vegetables	0
Addition Veg to Reach Total	0
Grains (oz eq)	7-10 (1)
Meats/Alternatives	0
Fluid milk (cups)	5 (1)
Min-max (kcal)	350-500
Saturated fat (% of total kcal)	<10
Sodium	<430

Trans fat	Nutrition Label or manufacturer specifications must indicate zero grams of trans fat per serving.

Adapted from the Federal Register (2012) Nutrition Standards in the National School Lunch and School Breakfast Programs; Final Rule; and USDA. Exceptions to SBP: at breakfast only, vegetables may be served in place of fruits Schools may substitute meat/meat alternate for grains once daily grains alternate for grains once daily grains minimum is met. Milk options must be low fat (unflavored) or fat free (flavored or unflavored).